Wellington Water

Wednesday 30 August 2023

OIA IRO-472
Name: [redacted]
Email: [redacted]@stuff.co.nz

Kia ora [redacted]

Official information request for copy of the 2012 Annual Compliance Report and the most recent investigation report on leachate discharge.

Thank you for your official information request dated Monday 31 July 2023.

We have considered your request in accordance with the Local Government Official Information and Meetings Act 1987 and determined that we are able to grant your request in full.

The information you have requested is enclosed in this Drop Box folder.

You have the right to seek an investigation and review by the Ombudsman of this decision. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

Ngā mihi,

[redacted]
Acting Group Manager, Customer Operations Group

Houghton Bay Investigation

Reference: Global consent No. WGN090219 [3051], Houghton Bay contamination identification and management options.

Purpose
The purpose of the investigation is to comply with condition 10 of the consent WGN090219 [3051], which states that the causes of existing contaminants at the Houghton Bay storm water outfall should be identified, and based on results, management options should be proposed if necessary.

Investigation approach

The objective of the investigation was to identify the impact of hazardous components as heavy metals and Polycyclic Aromatic Hydrocarbons (PAH) on the receiving environment (mixing waters), based on ANZECC guidelines (2000), the RMA[1] and as agreed with Greater Wellington (1st February 2012). In this study, Houghton Bay was classified as a *slightly to moderately disturbed ecosystem*, therefore, the focus of the investigation were the environmental effects on the mixing zone[2] on an area with a level of protection between 95% and 99%. Additionally, sediment samples were taken and compared to the ANZECC sediment guidelines, selecting the low values (ISQG-Low) as these show contaminant concentrations where biological effects could possibly occur on indicator species.

A precautionary approach was selected and samples were collected at the outfall, above the jumping weir and at the mixing waters. Additionally, control samples were taken 90 meters to the right of the culvert (outside the 50 meter mixing zone radius) to identify the normal concentrations of heavy metals in an unaffected area (see Appendix 1). With this approach we identified the concentrations of heavy metals flowing to the sewer network, and the likely concentrations that would flow to the storm water outfall during rain events (when jumping weir overflows).

Furthermore, CCTV inspections were carried out to identify the condition of the storm water pipeline running beneath the landfill. Additionally, a comparison of iron encrustations before and after a high pressure jetting was carried out to identify the iron removal effectiveness.

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[1] *According to the RMA, any standards imposed though classification or though s107 be met after reasonable mixing". This implies the existence of a zone in which the underlying standards need not be met.*

[2] Global consent No. WGN090219, "The boundary of the mixing zone shall be a maximum 50 meter radius extending in any direction from the storm water outfall".

Findings

Source of heavy metals

The main source of contamination at Houghton Bay is the leachate entering the storm water pipes from the closed landfill. This is caused by the lack of capping or layers in the landfill to retain the leachate. This situation is exacerbated by the existence of field drains connected in the storm water system to capture groundwater from the landfill. Water is percolating from rain and subsurface water which contains dissolved and suspended components from the biodegrading activity of anaerobic bacteria in the landfill. Consequently, the combination of water and chemical components form leachate, which enters the storm water network that lies beneath the landfill. This water then discharges on to Houghton Bay beach above the high water mark.

Water quality analysis

The heavy metals and PAH results were compared and analysed with the ANZECC guidelines (2000), table 3.4.1[3]. The results show that trace metal concentrations are below the trigger values for the *ANZECC water quality guidelines* on the near field mixing zone (Appendix 2).

Furthermore, metals such as Cadmium, Copper and Mercury were above the ANZECC trigger values for a *slightly to moderately* disturbed ecosystems (Appendix 2). However it has been noted on this study and others around New Zealand that those trigger values are not practical[4].

The iron and manganese levels appeared to be high when compared to the *ANZECC water quality guidelines for recreational purposes*, but there are no trigger values for these parameters under the level of protection for *slightly to moderately* disturbed areas, which is the focus of this investigation. Therefore a control site was selected to compare the values with. The control samples showed high values for iron and manganese. It is to be determined if the control point selected is not affected by the mixing zone.

Because of the lack of information in the guidelines, sediment samples were collected and analysed**.**

Sediment analysis

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[3] ANZECC Guidelines 2000 suggest trigger levels for aquatic ecosystems in marine water. Houghton Bay is identified as a slightly to moderately disturbed ecosystem with a level of protection between 95% and 99%.

[4] Several sources have identified that some values on the ANZECC guidelines are below the analytical detection limits of almost all laboratories, and probably represent a level that would be present at most rural and urban estuaries in New Zealand.

After heavy metals are being discharged in the effluent, they tend to due to their density with respect to the one of water. Therefore, sediment samples were taken from the discharge point, the mixing zone and control site.

Results showed that the concentration of the seven heavy metals analysed were below the ANZECC ISQG-low values, as shown on table 2 (Appendix 3). However, as stated before, there are no trigger values for the concentration of iron in the sediments. Therefore, control samples were used as a base to compare the results from the mixing zone with.

There are no other sediment quality studies in the south coast area. However a MWH study suggested that due to the relatively exposed area, and the frequent strong wave and current action, significant accumulation of contaminants in marine sediments in the vicinity of outfalls are unlikely[5].

Polycyclic aromatic hydrocarbons analysis

Results for PAH show that all compounds where below the detection limit, and therefore, below the trigger values for aquatic marine environments (Appendix 4).

CCTV inspections review

CCTV inspections were done to identify the condition of the pipe, and the effectiveness of the flushing programme.
The inspection shows several open joints allowing infiltration; however the overall condition of the drains is satisfactory. Leachate is also entering the storm water network through connected field drains, allowing the formation of iron encrustations only from the top of the catchment to the jumping weir. It is important to consider that there is a need to keep open joints to allow the migration of water, as the groundwater table is very high in this area.

The last 150 meters of pipe and joints (from the jumping weir to the outlet) are in good condition. There is no sign of infiltration or iron encrustation. These last pipes were installed and grouted in 1995. Since then, no iron has accumulated, demonstrating the functionality of the jumping weir (installed in 1992).

CCTV inspections were undertaken twice in December 2011, before and after high pressure water jetting. The later inspections demonstrated that the flushing contributes in the reduction of iron encrustations by 10 to 20% as shown on the examples below. This shows that the encrustations removed are the ones deposited in the last year, as they haven't had time to sufficiently harden[6].

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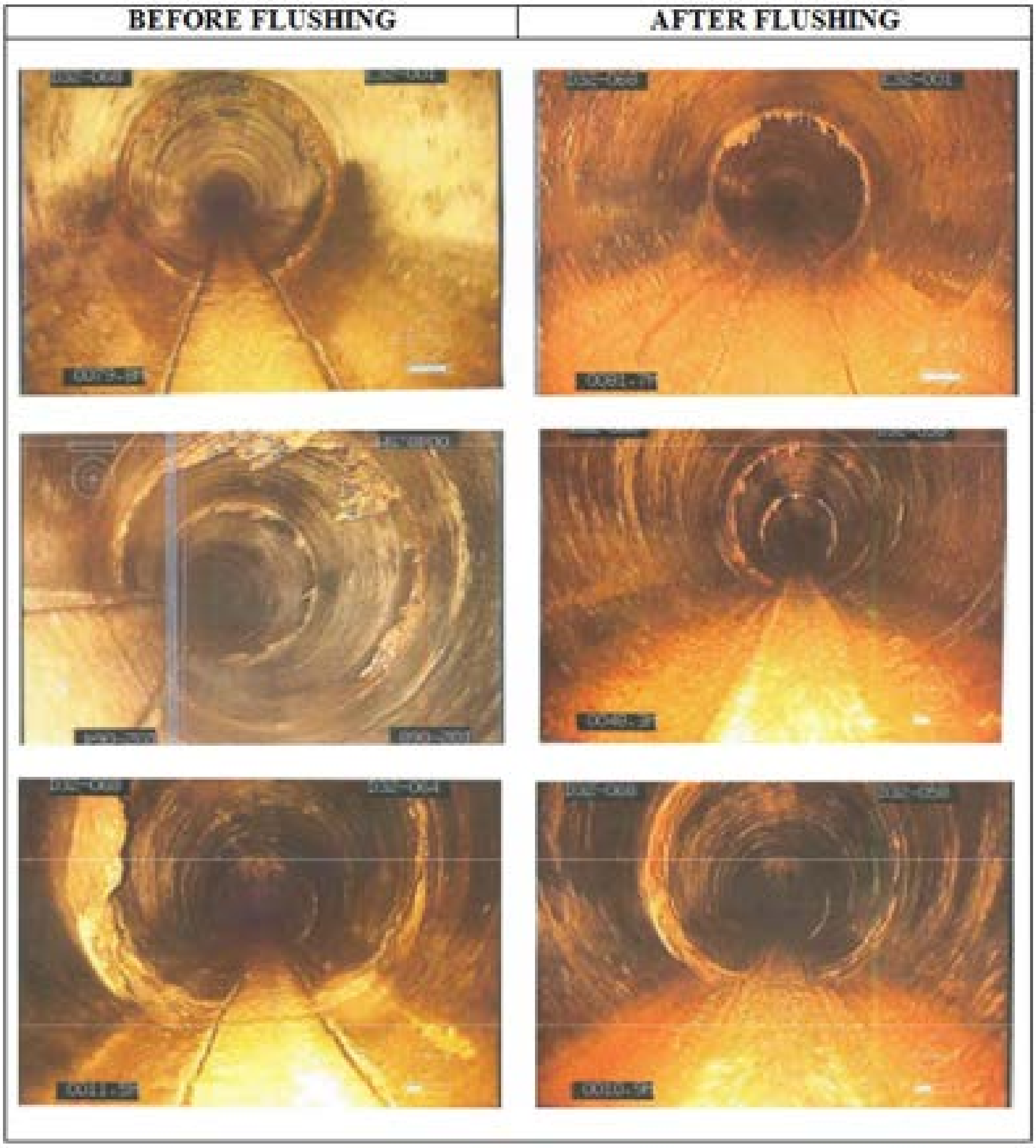
[5] *MWH,2003. Baseline Assessment of Environmental Effects of contaminated urban Storm water Discharges into Wellington Harbour and the South Coast. Volume 2.*

[6] Flushing programme started in 2008. Before this year, no attempts to reduce iron encrustations were carried on, and hence, the exposure to air over the last 40 years accelerated the build-up, hardening the mineral deposits and incrustation.



Discussion

The composition of leachate varies according to the amount of precipitation and the type of wastes disposed. Therefore, leachate can contain hazardous constituents (as heavy metals and PAH), and other parameters (as dissolved metals of iron and manganese), salts (e.g., sodium and chloride), and/or common anions and cations (e.g., bicarbonate and sulphate). The exact composition of wastes at Houghton Bay landfill is unknown.

Iron concentration levels were high, however section 8.3.7 of the guides state that there is insufficient data to derive a reliable trigger value for iron and manganese as no data for marine receiving environments is available. Furthermore, the guidelines recognizes Iron as the fourth most abundant element in the earth's crust and may be present in natural waters in varying quantities depending on the geology of the area and other chemical components of the waterway (USEPA 1986). There is no available geological data in this area.

It was noted that the laboratory detection levels for some heavy metals (copper and mercury) were higher than the limits specified in ANZECC guidelines, even on the control samples. Therefore a site specific approach could be considered in this case as detailed in the ANZECC guidelines.

Heavy metals such as zinc, copper and lead are likely to be occurring naturally in high concentrations as shown at the control site which had values above the ANZECC guidelines for ecosystems with 95%-99% of the protection level. In addition to this, these metals are not uncommon in the storm water network due to runoff from vehicles tyres and brake pads, galvanised building material, paints, roads and parking lots and driveways.

Finally, literature from the EPA and from the New Zealand guide to manage closing and closed landfill suggests that after 50 to 60 years, leachate cease to be hazardous to the environment. The Houghton Bay landfill was closed in two different stages. The first one was in 1963 and the second one was on 1971[7]. This suggests that leachate composition levels (for inorganic compounds- heavy metals) could be decreasing by now.

Conclusions

- Mean concentrations of heavy metals from sediment samples and water quality samples show that these are below the possible negative effects for recreational purposes or health issues.

- Under the strict environmental guidelines with a level of protection between 95 and 99%, high concentrations of metals such as lead, copper and zinc occur in the outlet from Houghton Bay. However, the data from the mixing zone showed heavy metals levels below the ANZECC trigger values. Furthermore, these metals were also high in the control area, outside the mixing zone defined in the consent WGN090219 [3051].

- From the control sampling point results, it was identified that iron at this location occurs in high concentrations; however there is no geological information from the area.

- The CCTV inspection identified several infiltrations through open joints, displaced joints, and through the intentionally created laterals to drain the groundwater. Open joints are essentially needed in the storm water system to reduce the water table levels in the area and hence, avoid flooded grounds.

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[7] http://www.mfe.govt.nz/publications/waste/closed-landfills-guide-may01.pdf,
http://www.epa.ie/downloads/advice/licensee/epa%20landfill%20site%20design.pdf
http://cues.rutgers.edu/bioreactorlandfill/pdfs/15Kjeldsenetall2002CritRevEnvSciLandfillLeachat.pdf

- The flushing programme has shown to reduce the accumulation of iron in the joints between 5 and 20%, and therefore the discoloration at the outfall when compared to previous years has reduced.

Proposed management options

1. Flushing programme to reduce the encrustations in the pipes and discoloration in the outfall. This will help mitigating metals concentrations and visual effects. It is proposed to carry out the flushing once per year to reduce the discolorations that are currently visible, or more than once according to heavy discoloration circumstances.

2. Leave the weir arrangement to divert the dry weather flows into the wastewater.

3. Monthly monitoring of the weir overflows and storm water outlets.

Appendix 1. Houghton Bay sampling points: *Jumping weir, Houghton Bay outfall, mixing zone and control site.*

Appendix 2. Toxic constituents on Houghton Bay Stormwater outlet (2011-2012). The table summarizes results for samples taken at the jumping weir, outfall, mixing zone and a control area.

Analyte	Units	N	Mean Outfall	Mean Jumping weir	Mean mixing point	Control sample	ANZECC 95-99%	Recreational ANZEC
Arsenic - Acid Soluble	µg/L	5	8.002	0.66	4.66	9	ID	50
Cadmium - Acid Soluble	µg/L	5	<0.0010	0.3	<0.001	<1	0.7	5
Chromium - Acid Soluble	µg/L	5	2.5	1	1	9	4.4	50
Copper - Acid Soluble	µg/L	5	10.02	<1.5	<2.15	9.8	1.3	1000
Iron - Acid Soluble	µg/L	5	2563	14225	1370	9010	ID	300
Lead - Acid Soluble	µg/L	5	26.4	1.04	1.6	16.9	4.4	50
Manganese - Acid Soluble	µg/L	3	398.6	654	31.65	283	ID or 1900 (ANZECC 2000)	100
Mercury - Acid Soluble	µg/L	2	<0.7	<1	<0.7	<1	0.4	1
Nickel - Acid Soluble	µg/L	5	1.45	1.06	2.6	9.1	70	100
Zinc - Acid Soluble	µg/L	5	80.5	20.2	<10	37	15	5000

Appendix 3. Sediment quality on Houghton Bay Stormwater outlet. Samples taken from the streambed on Houghton Bay at three points: Outlet, the mixing zone and a control sample 90 m right from the outfall. The following table summarizes the results.

Analyte	**Units**	**Outlet**	**Mixing Zone**	**Control**	**ANZECC VALUES ISQG-low**
Arsenic - Total	mg/Kg	5.92	7.38	7.23	20
Cadmium - Total	mg/Kg	<0.01	0.01	<0.01	1.5
Chromium - Total	mg/Kg	13.2	9.8	8.6	80
Copper - Total	mg/Kg	2.15	2.2	2.2	65
Iron - Total	mg/Kg	17300	18900	15400	ID
Lead - Total	mg/Kg	5.35	5.3	4.6	50
Manganese - Total	mg/Kg	182	216	188	ID
Mercury - Total	mg/Kg	<0.1	<0.1	<0.1	0.15
Nickel - Total	mg/Kg	6.75	6.9	6.3	21
Zinc - Total	mg/Kg	22	25	21	200

Appendix 4. Polycyclic aromatic hydrocarbons (PAH) on Houghton Bay Storm water outlet and mixing waters and control site.

08 February 2012

Results: Polycyclic Aromatic Hydrocarbons

Sample Identification: 12/1802 02 Houghton Bay Outlet

Laboratory Reference: 105858-2 | Date Received: 26 Jan 2012

Date Extracted: 01 Feb 2012 | Date Analysed: 04 Feb 2012

Polycyclic Aromatic Hydrocarbon	Conc.† (µg/L)	
Acenaphthene	<	0.1
Acenaphthylene	<	0.1
Anthracene	<	0.1
Benz[a]anthracene	<	0.1
Benzo[a]pyrene	<	0.1
Benzo[b]fluoranthene	<	0.1
Benzo[g,h,i]perylene	<	0.2
Benzo[k]fluoranthene	<	0.1
Chrysene	<	0.1
Dibenz[a,h]anthracene	<	0.2
Fluoranthene	<	0.2
Fluorene	<	0.1
Indeno[1,2,3-c,d]pyrene	<	0.2
Naphthalene	<	0.2
Phenanthrene	<	0.1
Pyrene	<	0.2

† = Results are reported on an as received basis.

< = Less than limit of detection.

Lab Analyst: [redacted] Data Analyst: [redacted] Authorised: [redacted]

08 February 2012

Results: Polycyclic Aromatic Hydrocarbons

Sample Identification: 12/1802 04 Houghton Bay Sea

Laboratory Reference: 105858-4

Date Received: 26 Jan 2012

Date Extracted: 01 Feb 2012

Date Analysed: 04 Feb 2012

Polycyclic Aromatic Hydrocarbon	Conc.† (µg/L)	
Acenaphthene	<	0.1
Acenaphthylene	<	0.1
Anthracene	<	0.1
Benz[a]anthracene	<	0.1
Benzo[a]pyrene	<	0.1
Benzo[b]fluoranthene	<	0.1
Benzo[g,h,i]perylene	<	0.2
Benzo[k]fluoranthene	<	0.1
Chrysene	<	0.1
Dibenz[a,h]anthracene	<	0.2
Fluoranthene	<	0.2
Fluorene	<	0.1
Indeno[1,2,3-c,d]pyrene	<	0.2
Naphthalene	<	0.1
Phenanthrene	<	0.1
Pyrene	<	0.2

† = Results are reported on an as received basis.

< = Less than limit of detection.

Lab Analyst: [redacted] Data Analyst: [redacted] Authorised: [redacted]

Results: Polycyclic Aromatic Hydrocarbons

Sample Identification: 12/1273 03 Miscellaneous Houghton Bay SW Outfall

Laboratory Reference: 105501-3 Date Received: 19 Jan 2012

Date Extracted: 24 Jan 2012 Date Analysed: 24 Jan 2012

Polycyclic Aromatic Hydrocarbon		Conc.† (µg/L)
Acenaphthene		**2.1**
Acenaphthylene	<	0.1
Anthracene	<	0.2
Benz[a]anthracene	<	0.1
Benzo[a]pyrene	<	0.1
Benzo[b]fluoranthene	<	0.1
Benzo[g,h,i]perylene	<	0.2
Benzo[k]fluoranthene	<	0.1
Chrysene	<	0.1
Dibenz[a,h]anthracene	<	0.2
Fluoranthene	<	0.2
Fluorene		**0.95**
Indeno[1,2,3-c,d]pyrene	<	0.2
Naphthalene	<	0.1
Phenanthrene	<	0.2
Pyrene	<	0.2

† = Results are reported on an as received basis.

< = Less than limit of detection.

Lab Analyst: [redacted] Data Analyst: [redacted] Authorised: [redacted]

08 February 2012

Results: Polycyclic Aromatic Hydrocarbons

Sample Identification: 12/1802 01 Soil Houghton Bay Outlet

Laboratory Reference: 105858-1

Date Received: 26 Jan 2012

Date Extracted: 31 Jan 2012

Date Analysed: 01 Feb 2012

Polycyclic Aromatic Hydrocarbon	Conc.† (mg/kg)	
Naphthalene	<	0.2
Acenaphthylene	<	0.1
Acenaphthene	<	0.1
Fluorene	<	0.1
Phenanthrene	<	0.1
Anthracene	<	0.1
Fluoranthene	<	0.2
Pyrene	<	0.2
Benz[a]anthracene	<	0.1
Chrysene	<	0.1
Benzo[b]fluoranthene	<	0.1
Benzo[k]fluoranthene	<	0.1
Benzo[a]pyrene	<	0.1
Indeno[1,2,3-c,d]pyrene	<	0.2
Dibenz[a,h]anthracene	<	0.2
Benzo[g,h,i]perylene	<	0.2

† = Results are reported on a dry weight basis.

< = Less than limit of detection.

Lab Analyst: [redacted] Data Analyst: [redacted] Authorised: [redacted]

08 February 2012

Results: Polycyclic Aromatic Hydrocarbons

Sample Identification: 12/1802 03 Soil Houghton Bay Sea

Laboratory Reference: 105858-3

Date Received: 26 Jan 2012

Date Extracted: 31 Jan 2012

Date Analysed: 01 Feb 2012

Polycyclic Aromatic Hydrocarbon		Conc.† (mg/kg)
Naphthalene	<	0.2
Acenaphthylene	<	0.1
Acenaphthene	<	0.1
Fluorene	<	0.1
Phenanthrene	<	0.1
Anthracene	<	0.1
Fluoranthene	<	0.2
Pyrene	<	0.2
Benz[a]anthracene	<	0.1
Chrysene	<	0.1
Benzo[b]fluoranthene	<	0.1
Benzo[k]fluoranthene	<	0.1
Benzo[a]pyrene	<	0.1
Indeno[1,2,3-c,d]pyrene	<	0.2
Dibenz[a,h]anthracene	<	0.2
Benzo[g,h,i]perylene	<	0.2

† = Results are reported on a dry weight basis.

< = Less than limit of detection.

Lab Analyst: [redacted] Data Analyst: [redacted] Authorised: [redacted]

08 February 2012

Results: Polycyclic Aromatic Hydrocarbons

Sample Identification: Laboratory Blank

Laboratory Reference: 105858/BLANK

Date Extracted: 31 Jan 2012

Date Received: Not applicable

Date Analysed: 01 Feb 2012

Polycyclic Aromatic Hydrocarbon	Conc.† (mg/kg	)
Naphthalene	<	0.2
Acenaphthylene	<	0.1
Acenaphthene	<	0.1
Fluorene	<	0.1
Phenanthrene	<	0.1
Anthracene	<	0.1
Fluoranthene	<	0.2
Pyrene	<	0.2
Benz[a]anthracene	<	0.1
Chrysene	<	0.1
Benzo[b]fluoranthene	<	0.1
Benzo[k]fluoranthene	<	0.1
Benzo[a]pyrene	<	0.1
Indeno[1,2,3-c,d]pyrene	<	0.2
Dibenz[a,h]anthracene	<	0.2
Benzo[g,h,i]perylene	<	0.2

† = Results are calculated using the average weight of samples in this batch.

< = Less than limit of detection.

Lab Analyst: [redacted] Data Analyst: [redacted] Authorised: [redacted]

Wellington Water Ltd Stage One Global Stormwater Discharge Consent

Resource Consent Application and Assessment of Environmental Effects

Our water, our future.

Prepared by GHD Limited
for Wellington Water Limited
July 2017

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Final	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	27/07/17

Scope and Limitations

This report has been prepared for the benefit of Wellington Water Ltd for the purpose agreed between GHD Ltd and Wellington Water Ltd as set out in section 1.1 of this report. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person. This disclaimer shall apply notwithstanding that the report may be made available to other persons for a permission or approval or to fulfil a legal requirement.

Executive Summary

The Proposed Natural Resources Plan (PNRP) was notified on 31 July 2015, introducing a two-stage consenting regime for local authority network stormwater discharges. Discharges under Rule R50 are a Controlled Activity, requiring a 'global' consent for stormwater discharges to promote a holistic approach to stormwater management. This rule requires the consent holder to prepare a Stormwater Monitoring Plan (SMP) and implement monitoring to identify any adverse quality or quantity effects from stormwater discharges. This monitoring will help to inform the development of a prioritised programme for improvements in a Stormwater Management Strategy (SMS).

Wellington Water Limited (WWL, the applicant) is a council controlled organisation (CCO) that manages Wellington City Council (WCC), Porirua City Council (PCC), Hutt City Council (HCC), and Upper Hutt City Council (UHCC) stormwater networks. Accordingly, WWL is seeking global stormwater discharge resource consents to continue to discharge stormwater from these local authority stormwater networks to land which may enter water, and directly to water (fresh water and the Coastal Marine Area (CMA)). The ultimate receiving waters are the Porirua Harbour, Wellington Harbour and the Porirua to Wellington coastline.

Consent is sought for a **five year** period, in line with the maximum term allowed under Rule R50 of the PNRP.

The effects of the stormwater discharges have been outlined and evaluated in the Assessment of Environmental Effects (AEE) in section 8 of this report. The available evidence, from historic and current monitoring, existing information and assessments, indicate that subject to implementing the proposed mitigation measures outlined in section 8.10, the continued discharge of stormwater will not have a significant adverse effect on the receiving environments over the term of this consent.

The key conclusions of the AEE are:

- There are some potential and actual adverse effects but these mostly occur within the immediate vicinity of the stormwater outfalls and during high rainfall events when there is a higher probability of a wastewater overflow event occurring;
- Stormwater discharges have the potential, from time to time, to affect water quality at bathing beaches, temporarily increase the health risks for bathers, and those engaged in other contact recreation activities at such times;
- Stormwater discharges have increased contaminant concentrations in marine sediments around stormwater outlets and to a lesser extent at more distant locations in the Porirua and Wellington harbours;
- Stormwater discharges can disturb marine benthic biota communities, but there is no evidence of adverse effects on biological communities beyond the immediate vicinity of outfalls;
- Stormwater discharges are substantially free of oil and grease.
- The suspended solids content is normally lower in natural water courses during an equivalent rainfall event;

- The River State of Environment (SoE) and coastal bathing beaches monitoring undertaken by GWRC suggests that recreation values are not currently being compromised by stormwater discharges, except immediately after a sustained wet weather event.
- The cultural concerns of tangata whenua relate predominantly to the water quality effects of stormwater discharges to fresh water, the Porirua and Wellington harbours, and coastal environments. Concerns include water quality affecting the health of shellfish, mahinga kai, Māori customary use, and values associated with sites of significance to mana whenua.

WWL proposes monitoring and modelling in the form of:

- Participating in and utilising existing GWRC monitoring programme data for analysis, such as the recreational bathing beach monitoring , River SoE monitoring, and WCC and PCC stormwater outfall monitoring;
- Establishing five new temporary River SoE sampling locations for up to 24 months;
- Undertaking stormwater outfall monitoring in new locations within HCC and UHCC catchments from key urban culverts/outfalls;
- Collaborating with GWRC to undertake one marine sediment and benthic habitat survey;
- Providing or engaging suitably qualified and experienced personnel to contribute to the development of the Regional Kaitiaki Monitoring Framework (RKMF); and
- Adopting a collaborative approach with GWRC for costs, information sharing and project management to enable contaminant load, water quality and sediment quality models being developed as part of the Porirua Whaitua process, also cover the Wellington Harbour/Hutt Valley Whaitua.

The proposed monitoring and modelling programme will help to determine if contaminant concentrations in stormwater discharges are likely to increase, or whether adverse effects are likely to occur in the future, beyond a reasonable mixing zone, from the continued discharge of stormwater.

Appropriate management and mitigation of acute effects on human health detected during monitoring will be undertaken by WWL in line with framework identified in section 9.6.

The AEE concludes that the continued discharge of stormwater (subject to the implementation of mitigation measures), can be carried out without adversely the quality of the fresh water and coastal receiving environments.

The continued discharge of stormwater has been assessed against the provisions of the following legislation and documents. Overall, the continued discharge of stormwater is considered to be consistent with the following:

- Resource Management Act 1991 (RMA);
- New Zealand Coastal Policy Statement (NZCPS);
- National Policy Statement for Freshwater Management;
- Regional Policy Statement for the Wellington region;
- Operative Regional Plans (Coastal Plan, Freshwater Plan, Discharges to Land Plan); and

- Proposed Natural Resources Plan.

The proposed consent conditions in section 13:

- Provide a framework to enable effects associated with the discharge of stormwater to be monitored in accordance with an approved SMP;
- Requires a Sanitary Survey to be undertaken for E.coli bacteria counts exceeding a trigger level;
- Requires WWL to undertaken timely follow-up of incidents/spills and report these to GWRC;
- Requires WWL to undertake appropriate management of acute effects on human health detected during monitoring;
- Requires WWL to contribute to the development of the RKMF (led by GWRC), to enable regional cultural health monitoring to be developed in a coordinated way;
- Enables the establishment of a Stormwater Working Party to advise on monitoring results, remedial or mitigation works and the development of the SMS; and
- Provide for a review of consent conditions.

In preparing the draft SMP and consent application, consultation has been undertaken with iwi, Regional Public Health, Fish and Game, the Department of Conservation, a representative from the WCC Stormwater Consultative Committee, and GWRC officers. In particular, the establishment of a Technical Reference Group and sub-group has resulted in a collaborative process for the development of the draft SMP.

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Figures

Tables

1 Introduction

1.1 Purpose of this report

GHD Ltd has prepared this consent application and Assessment of Environmental Effects (AEE) report for Wellington Water Ltd's (WWL) Stage One global stormwater discharge consent application.

The AEE and supporting information has been prepared to fulfil the requirements of Section 88 and the Fourth Schedule of the RMA.

The intent of the consent application is to authorise all discharges from the Wellington City Council (WCC), Porirua City Council (PCC), Hutt City Council (HCC), and Upper Hutt City Council (UHCC) stormwater networks.

Two integral components of this consent application are the Existing Environment Report (EER) attached in Appendix B, and a draft Stormwater Monitoring Plan (SMP) attached in Appendix F. The EER is a summary of the known information about the existing environment, prepared by Stantec. The draft SMP has also been prepared by Stantec, with collaborative input from the Technical Reference Group and sub-group, comprising representatives from Greater Wellington Regional Council (GWRC) and their technical consultants. Both of these documents should be read and considered in conjunction with this report.

1.2 Consent sought

WWL applies for two global resource consents:

- To discharge stormwater from urban Wellington City, Porirua, Hutt City, and Upper Hutt catchments via the stormwater network to the Coastal Marine Area of Porirua Harbour, Wellington Harbour and the Porirua to Wellington coastline where there are urban areas, including occasional contaminated stormwater (namely untreated wastewater from constructed overflows into the stormwater system), and into or onto land where it may enter the CMA; and

- To discharge stormwater from urban Wellington City, Porirua, Hutt City, and Upper Hutt catchments via the stormwater network to water, including occasional contaminated stormwater (namely untreated wastewater from constructed overflows into the stormwater system), and into or onto land where it may enter water.

The resource consents will authorise the continued discharge from local authority stormwater networks managed by WWL on behalf of WCC, PCC, HCC and UHCC. This covers catchments that contribute discharges to the ultimate receiving environments of the Porirua Harbour, Wellington Harbour and the Porirua to Wellington coastline.

1.3 Proposed term of consent

Consent is sought for a **five year** period. WWL considers this an appropriate term to enable sufficient monitoring of stormwater discharges to inform a Stage Two consent application and Stormwater Management Strategy (SMS).

1.4 Information sources

The main information sources used to prepare the EER and draft SMP are listed in Appendix A. Documents referenced in the text of this report are listed in the References section.

2 Background

2.1 Wellington Water Limited

WWL is a council controlled organisation jointly owned by GWRC, WCC, PCC, HCC, and UHCC (WWL's client councils).

The relationship between WWL and its client councils is outlined below in Figure 1. WWL's client councils own their water assets and are accountable for levels of service. WWL is accountable for delivery of the work programme.

Figure 1: Relationship of WWL and its client councils[1]

WWL takes a regional approach to providing "three water" services which comprises drinking water, stormwater, and wastewater. The current three waters asset replacement value is $5.3 billion, serving a population of 395, 500[2].

2.2 WWL customer outcomes and service goals

The overall vision of WWL is:

We create excellence in regional water services so communities prosper.

[1] WWL Statement of Intent 2016-19 (June 2016)
[2] WWL Annual Report for year ending 30 June 2016

WWL has three overarching long-term (20-30 year) Customer Outcome objectives supported by 12 service goals[3]. The relevant Customer Outcome objectives and service goals for stormwater are identified in Table 1 below.

Table 1: WWL Customer Outcome and service goals for stormwater

Customer Outcome	Relevant Service Goals
Safe and healthy water *We provide water services, to ensure safe drinking water and will work to eliminate the harmful effects of wastewater and stormwater over time.*	We operate and manage assets that are safe for our suppliers, people and customers. We minimise public health risks associated with wastewater and stormwater: • The public is protected from direct exposure to untreated wastewater onto land; and • The public is protected from direct exposure to untreated wastewater onto beaches.
Respectful of the environment *When we provide water services, we seek to avoid harm to the natural and built environment and over time, enhance it for the benefit of future generations.*	We will enhance the health of our waterways and the ocean: • Water quality of the waterways and harbours is not adversely affected by discharges from any of the three waters network; and • Integrated catchment management plans are used in a collaborative approach with stakeholders to carry out improvements to the water quality of waterways and harbours. We influence people's behaviour so they are respectful of the environment: • Communities are educated to use our infrastructure in ways that reduce the impact on the natural environment in areas such as stormwater pollution and water conservation. We ensure the impact of water services is for the good of the natural and built environment: • Water services are managed to comply with consents; and • Water services are built and managed in ways that are not intrusive to communities.
Resilient networks support the economy *We provide reliable day-to-day water services, that are able to withstand shock and stresses, and future proof the network to enable a strong regional economy and enhanced natural environment.*	We minimise the impact of flooding on people's lives and proactively plan for the impacts of climate change: • The potential impact of increased sea levels and flooding on property and key transport links from stormwater is identified and the impacts are minimised. We provide reliable services to customers: • Customers have access to reliable Three water service; and • Stormwater networks perform as intended when it rains.

The development and implementation of a SMP will help WWL to meet these outcomes and goals as monitoring will help to identify any adverse quality or quantity effects from stormwater discharges. The monitoring data will contribute to developing the long-term SMS in Stage Two.

WWL is committed to meeting its regulatory obligations, including the RMA. WWL has in place compliance monitoring and performance measures for each of its service goals. Performance monitoring against each of the service goals is recorded in its corporate Statement of Intent, as well as half-yearly and annual reports.

[3] WWL Statement of Intent 2016-19 (June 2016).

2.3 Other influences on WWL's approach to managing stormwater discharges

There are a number of other influences which drive WWL's approach to managing stormwater discharges. These include:

2.3.1 Health Act 1956

Under section 23 of the Health Act 1956, WWL's client councils have a general responsibility "to improve, promote and protect public health within its district". This involves identifying potential health risks and ensuring that these risks are managed to within acceptable levels. This responsibility extends to stormwater drainage for the stormwater network.

2.3.2 Building Act 1991

Under section 24 of the Building Act 1991, WWL's client councils are responsible for enforcing the provisions of the New Zealand Building Code, which requires that "buildings and site work be constructed in a way that protects people and other property from the adverse effects of surface water". This requirement is achieved by the provision of stormwater drainage from properties into the stormwater network.

2.3.3 National Policy Statement for Freshwater Management 2014 (NPSFM)

The NPSFM reformed the management of fresh water in New Zealand including the requirement for regional councils to set fresh water objectives and account for fresh water takes and contaminants. This policy direction has informed the development of the PNRP and its objectives, policies and rules. The NPSFM is directly relevant to the management of stormwater discharges entering fresh water environments, as its fresh water bottom lines and limits need to be met.

2.3.4 Whaitua process

The Whaitua process was set up as part of GWRC's programme to implement the NPSFM. This process enables the establishment of Whaitua committees, tasked with working collaboratively with the community to make informed decisions about land and fresh water management for future generations. To date, the Porirua Whaitua Committee has been established and they are developing their Whaitua Implementation Programme. Sediment quality, contaminant load and water quality modelling has commenced as part of the Porirua Whaitua. The Wellington Harbour/Hutt Valley Whaitua is yet to be established.

2.3.5 Increased community awareness of water quality

The quality of stormwater discharges has become more of a focus partly due to increased community awareness of the impact stormwater has on water quality. The management of stormwater has traditionally focused largely on the reduction of flood risk.

3 Stormwater discharges

Stormwater is defined in the PNRP as:

"Runoff that has been intercepted, channeled, diverted, intensified or accelerated by human modification of a land surface, or runoff from the external surface of any structure, as a result of precipitation and including any contaminants contained therein."

3.1 Stormwater catchments

The scope of this consent application covers 28 catchments contained with WCC, PCC, HCC and UHCC boundaries.

The Wellington Harbour/Hutt Valley area comprises a total of 21 catchments, nine in Wellington and 12 in the Hutt Valley. The Porirua Harbour catchment comprises seven catchments. An overview map is provided in Figure 2 below.

A full description of the Wellington Harbour/Hutt Valley and Porirua Harbour catchments is provided in the EER. Maps of each catchment are provided in Appendix N of the EER.

The characteristics of each catchment is summarised in Tables 1-3, 1-4 and 1-5 in the EER and in more detail in catchment data sheets in Appendix A of the draft SMP.

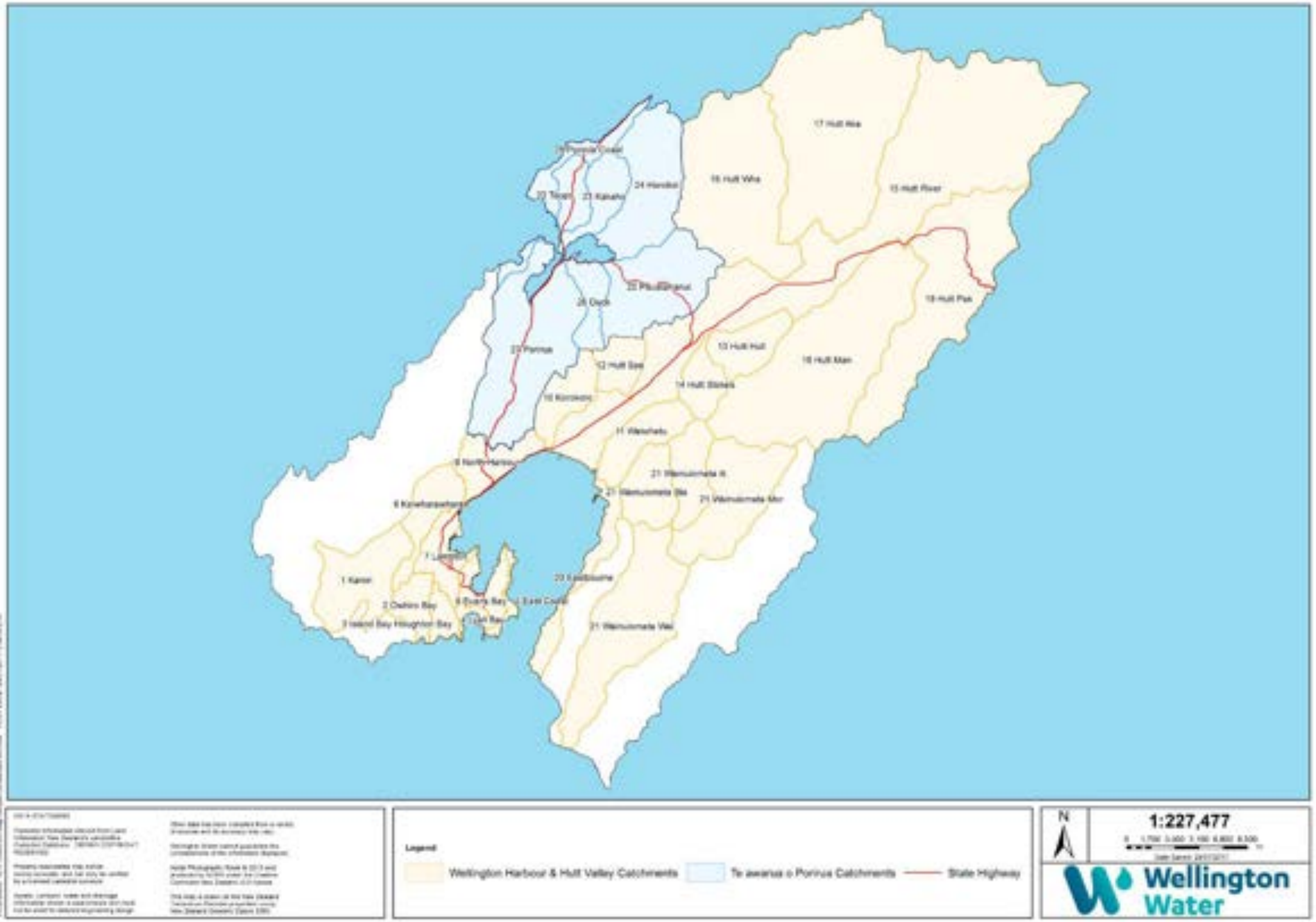

Figure 2: The 28 catchments within the scope of this application

3.2 Stormwater discharges

Local authority networks discharge stormwater to land which may enter water, or directly to water (fresh water or coastal) via a pipe and outlet.

3.2.1 To land

Stormwater can discharge to land. The opportunity to design stormwater attenuation features such as wetlands and swales is mostly limited to new developments, as it becomes more difficult to 'retrofit' in developed areas.

Managing stormwater at or close to its source, can help to moderate stormwater flows and improve stormwater quality. A range of soft infrastructure and low impact design measures can be undertaken to help achieve this, including rainwater tanks, rain gardens, swales, and permeable paving surfaces. These features can help increase rainfall infiltration, groundwater recharge, rain water capture and re-use.

The discharge of stormwater to land is less common than network discharges to fresh water and coastal environments.

3.2.2 To fresh water and coastal water

Stormwater that does not soak into the ground is channeled into the stormwater network. The stormwater network via pipes and outlets discharges stormwater to either fresh water (rivers, streams or their tributaries which ultimately flow to the Porirua Harbour or Wellington Harbour), or to the Porirua to Wellington coastline.

A list of known major stormwater outlets greater than 600mm in diameter and the receiving watercourse for each of the 28 catchments is provided in Appendix C.

3.2.3 Alternative approaches to discharging stormwater

Alternative approaches to managing the quality of stormwater discharges include the treatment of stormwater before it is discharged (such as diverting stormwater to a treatment plant or facility or discharges to land treatment to remove contaminants), or treatment at the point of discharge.

There has been no consideration of alternatives to discharging stormwater as part of this Stage One consent process, as alternative approaches to treat all stormwater prior to discharge is unrealistic and unfeasible to undertake.

The range of proposed mitigation measures for addressing the effects of stormwater discharges within the Rule R50 matters of control and WWL's 'business as usual' management measures are identified in section 8.10 of this report.

3.3 Common contamination sources affecting stormwater quality

The passage of stormwater runoff over impervious surfaces provides a pathway for contaminants to become entrained. Contaminants can accumulate over time during dry periods between storms (antecedent periods). During storm events, contaminants are washed off impervious surfaces into the stormwater network.

Stormwater can be contaminated by sediments, oils, greases, metals and organic material washed from roads and other impervious areas. Rubbish and contaminants accidentally and illegally discharged into the stormwater system also contribute.

The degree of contamination can be influenced by land use and considerations such as transport routes and the amount of impervious surfaces. Contamination from surface run-off is an inherent part of stormwater. Other contaminants such as rubbish, wastewater, high sediment loads and toxins that enter stormwater other than through surface run-off can be managed to some degree by physical installations (e.g. grates and sumps to remove debris), earthworks management practices and educating the community about what is inappropriate to put into the stormwater network.

Common contaminant sources are identified in Table 2 below.

Table 2: Common contaminant sources

Common contaminant source	Description
Roads, especially those with heavy traffic	An accumulation of fine particles of zinc and rubber from motor vehicle wear, copper from brake components, hydrocarbons from oil drips and exhaust pipes, and grit from wear and tear of roading materials.
Brownfields development areas and the opening up of new land for roads and construction	If poorly controlled, development can result in significant soil loss from the combination of high rainfall, hilly terrain, clay soils and the underlying geology. If soil is disturbed during site development, it is easily washed away by rainfall, causing serious impacts on streams, beaches and harbours.
Industrial areas	These areas are home to a host of activities that pose a risk of spills of all sorts of materials. If not properly controlled, these too will flow across the ground and into the stormwater network.
Land contaminated by historical land uses, including old landfills	Surface runoff from these sites can pick up hydrocarbons, heavy metals, pesticides, herbicides and fertiliser used on private and public land.
Domestic and commercial building materials	Unpainted galvanised iron roofs and walls are commonly used in commercial and industrial areas. Rain washing over these materials picks up zinc.
Domestic activities	A lack of understanding about the connectivity of the stormwater network to fresh water and coastal receiving environments contributes to people putting contaminants directly into the stormwater network. Such activities include car washing, spills, paint brush washing, and gardening activities (domestic fertilizer, herbicides and pesticides).
Litter	Litter is dropped or blown around urban areas. This can be carried by runoff into the stormwater network, onto beaches and into coastal waters.

Rural farmland	Some of the catchments within the scope of this application have semi-rural farmland. Depending on the type of farming carried out, contaminants can wash into streams or the stormwater network.
Illegal cross-connections	Contamination between domestic wastewater and stormwater systems is a potential source of stormwater contamination. The majority of plumbing and drainage works require a Building Consent and a formal Code of Compliance certificate, and these formal processes that manage these connections. However there are also illegal connections beyond the control of WWL or their client councils, where untreated wastewater directly enters the stormwater network.
Constructed and un-constructed wastewater network overflows (WNO)	Where wastewater networks have insufficient capacity or there are high rainfall events, wastewater can overflow into the stormwater network. During these events, the volume of water in the wastewater network increases significantly as stormwater enters the wastewater network. Constructed and un-constructed wastewater network overflows (WNO) provide a pressure release mechanism which allows for wastewater (which is untreated but may be diluted through an increase in rainwater) to enter the stormwater network, rather than spill onto public or private land where public health risks are increased.

3.4 Factors affecting stormwater quantity

3.4.1 Groundwater infiltration

In areas where the water table is high, stormwater networks also carry groundwater. The volume of groundwater in stormwater flow varies but is particularly high where old watercourses have been culverted. Groundwater can continue to enter the stormwater network after heavy rainfall events, increasing the quantity of stormwater discharged to receiving environments.

3.4.2 Climate change impacts

Climate change may influence the long term management of stormwater quantity with increased incidences of extreme weather events and sea level rise. A predicted increase of heavy rainfall events could create stormwater network capacity issues, stormwater flooding in low lying areas, and continue to flush contaminants into receiving environments. Sea level rise can contribute to raised groundwater levels, in turn reducing ground soakage capacity, and ultimately intensifying pressure on the stormwater network.

3.5 Historic and current stormwater discharge monitoring

GWRC is responsible for managing water quality within the Wellington Region. This includes regulating the discharge of urban stormwater, a function undertaken through rules in regional plans and through the conditions of resource consents.

A summary table listing historic and current monitoring undertaken in each catchment is provided in Appendix D.

At the time of preparing this application, WWL is aware that GWRC Environmental Science has commenced a review of the River State of Environment (SoE) monitoring programme to look at rationalising existing monitoring, funding, and the consistency of data collection.

WWL has commenced discussions with GWRC Environmental Science about rationalising existing regional monitoring to be more efficient, particularly where several agencies monitor at sampling locations close together. WWL is cognisant of how important these discussions are as the outcomes will directly affect finalising proposed monitoring sites in the SMP, and confirming which existing GWRC monitoring programme sites WWL can utilise.

4 Local authority stormwater networks

4.1 Overview

The PNRP defines the stormwater network as:

"The network of devices designed to capture, detain, treat, transport and discharge stormwater, including but not limited to kerbs, intake structures, pipes, soak pits, sumps, swales and constructed ponds and wetlands, and that serves more than one property".

Further, the stormwater network is identified in the PNRP as 'regionally significant infrastructure'. The HCC, UHCC and PCC District Plans identify stormwater networks as 'regionally significant network utilities'. The Wellington City District Plan identifies the stormwater network within the definition of a 'lifeline'.

The stormwater network provides a principal service to the community in urban areas by removing stormwater primarily through a piped network. Disposal of stormwater also makes a major contribution to keeping the physical environment clean, safe and attractive. The stormwater network is a core infrastructure service required to sustain the economy and contribute to the social, environmental and cultural wellbeing of the community.

The nature of the stormwater networks covered by this consent application varies. Stormwater networks include both natural watercourses and built infrastructure (drains, sumps, pipes and pump stations) to help channel rainwater from streets and away from buildings to prevent flooding.

This consent application concerns the known WCC, PCC, HCC, and UHCC stormwater networks totaling 1,640km in length, including 38.5km of channels, seven detention dams and 21 pump stations. The length of the stormwater network owned by each local authority is identified in Table 3 below.

Table 3: Stormwater network lengths owned by each local authority

Local Authority	Stormwater network length (km)
Hutt City Council	526
Porirua City Council	275
Upper Hutt City Council	151
Wellington City Council	688
Total	**1,640km**

Sections 4.2 to 4.5 below provide a brief description of each local authority network. More detailed descriptions and maps of the stormwater network in each catchment is provided in:

- Sections 4 (Wellington and Hutt Valley) and 6 (Porirua) of the EER;

- Appendix N of the EER. Each catchment map shows the following known features of the stormwater network including:
    - Stormwater pipes;
    - Open channels;
    - Main sewer trunk;
    - Wastwater network overflows (WNO); and
    - Stormwater outlets.
- Appendix A of the draft SMP – catchment data sheets.

4.2 Wellington City stormwater network

Wellington City's stormwater network consists of nine catchments and extends from Karori in the west, Owhiro, Island, Houghton and Lyall bays to the south, through to Seatoun, Miramar, Lambton Harbour, Kaiwharawhara, Ngauranga and Korokoro to the north-east. These catchments drain either to Wellington's very exposed southern coast or to the relatively sheltered waters on the western side of Wellington Harbour.

Most of Wellington City is serviced by a piped stormwater network, as natural watercourses have become increasingly confined or piped to allow more intensive use of land as the population has grown. However, some urban streams still remain, including the Kaiwharawhara, Owhiro and Karori streams. In the Lambton harbour catchment, which is intensively urbanised, all streams have most or all of their length piped and none flow freely to the sea as open channels. The remnant open sections typically occur in the remaining vegetated open space encompassed by the town belt, reserves and the Botanic Gardens. A total of 139 remnant open channel sections from 48 separate watercourses are identified in the Lambton Harbour catchment[4].

Wellington City's steep topography generally enables gravity-flow of stormwater to discharge points. Stormwater pump stations are only used in low lying areas such as Kilbirnie.

The majority of properties drain to kerb outlets, with occasional soak holes in older areas that are difficult to service by the existing piped network.

There are 40 constructed WNO and 59 pump station emergency overflows in the Wellington City catchments. A six year staged wastewater overflow monitoring programme conducted by WWL (then Capacity) from mid-2008 to mid-2014 included 59 overflow weir structures. The results of the first five years of that monitoring programme are summarised in Appendix L of the EER. The monitoring data and modelling output to date indicates that the most significant WNO point in the Wellington City network is at Murphy Street. At this location, the constructed WNO provides significant flood relief for the downstream network.

4.3 Hutt City stormwater network

Hutt City's stormwater network consists of nine catchments, including those in Lower Hutt and Petone. The network extends from Korokoro in the east and around the Wellington Harbour to

[4] James, 2015

include the Eastern Bays. Most catchments drain into the Hutt River which enters the north-eastern side of Wellington Harbour, with the exception of the Wainuiomata catchment which drains to the south coast near Baring Head.

Most of Hutt City is serviced by a piped stormwater network and includes 27km of open drains, 14 pumping stations (to supplement gravity drainage in low-lying areas), and five earth retention dams (to reduce the peak load in the system during heavy rainfall events). The stormwater network is particularly crucial as Hutt City is located on a natural flood plain.

Properties in Hutt City are generally serviced by kerb outlets or direct connection to the stormwater main. There are generally more direct connections in Hutt City than the other cities.

There are nine constructed WNO and 39 pump station emergency overflow points in the Hutt City catchments. The locations of these overflows is known. However information is not available for the average annual frequency or volume of WNO.

4.4 Upper Hutt stormwater network

Upper Hutt's stormwater network consists of six catchments each with their own discharge point to the Hutt River. Upper Hutt is serviced by a piped network that includes 11.4km of open drains, six pump stations and two detention dams (at Heretaunga and Emerald Hill).

The majority of residential properties drain to soak pits or kerb outlets, and many road side sumps also drain to soak pits. New developments are able to drain to soak pits that are appropriately designed and specified.

There are no known constructed WNO as part of the Upper Hutt stormwater network.

4.5 Porirua stormwater network

Porirua's stormwater network extends across seven catchments from Pukerua Bay at the northern end of Porirua CBD, to the boundary with Tawa at the southern end. To the east, the stormwater network serves all Whitby residential areas. The proximity of two harbours and numerous streams results in a system of localised networks. There are many rural catchments made up of open streams and watercourses. However, in built-up urban areas, these streams have become part of the enclosed piped network.

Older residential properties drain mainly to the street kerb or rely on the disposal of stormwater to ground (soak pits). Run-off from residential properties and streets is directed into reticulation wherever possible, with all new developments required to provide for stormwater reticulation.

Porirua has only one constructed WNO but nearly 20 confirmed WNO locations, mostly from pump station weirs. WWL preliminary modelling predictions for overflow discharge volumes via constructed sewer outlets or pump station weirs during a six month average return interval rainfall event, indicate approximately 95% of the total overflow volume will discharge via the constructed WNO immediately upstream of pump station 20 to the Porirua Stream. Further refinement of monitoring and modelling of WNO locations, volumes and flow rates is currently underway through the Porirua Whaitua process.

4.6 Stormwater capital expenditure

The age of the stormwater network is a consideration when undertaking maintenance planning. The theoretical life of most stormwater infrastructure is approximately 100 years.

Stormwater capital expenditure by local authority over the past four years up to 30 June 2016 is identified in Table 4 below.

Table 4: Stormwater capital expenditure by local authority from 2013-2016 ($000)[5]

Year to 30 June	2013	2014	2015	2016
HCC	$2, 566	$1, 012	$1, 327	$2, 706
PCC	$647	$921	$688	$573
UHCC	$733	$751	$755	$1, 002
WCC	$2, 564	$4, 193	$4, 821	$4, 867
TOTAL	**$6, 510**	**$6, 877**	**$6, 891**	**$9, 148**

Proposed stormwater capital expenditure for the duration of this Stage One global consent (2017-2022) is identified in Table 5 below.

Table 5: Stormwater capital expenditure by local authority from 2017-2022 ($000)

Year to 30 June	2017 (Proposed stormwater capex spend as at July 2017)	2018	2019	2020	2021	2022
HCC	$2,788	$3, 099	$2, 998	$2, 363	$2, 030	$3, 099
PCC	$1, 252	$3, 507	$2, 161	$410	$923	$3, 507
UHCC	$508	$4,231	$7, 108	$1, 147	$1, 110	$4, 231
WCC	$1, 0539	$5, 344	$11, 969	$7, 028	$11, 368	$5, 344
TOTAL	**$1, 5087**	**$16, 181**	**$24, 236**	**$10, 947**	**$15, 429**	**$16, 181**

4.7 Renewal and maintenance of stormwater networks

Funding for maintenance is generally based on 20% planned and 80% reactive works.

[5] WWL Annual Report for year ending 30 June 2016

4.7.1 Renewals

Continual deterioration of pipe condition and performance leads to the need for renewal works. Priorities for pipe renewals are often given to 'known' or 'predictable' problem areas, performance and condition issues, or where the risks are greatest. This includes critical drains (deep drains, drains under buildings, or drains under major roads and railways), drains with ongoing faults, and drains at risk of collapse.

4.7.2 Routine maintenance

Routine maintenance relates to proactive inspections and testing to monitor asset condition and identify the need for maintenance or repair work. Inspections are generally carried out with closed circuit television (CCTV), include some visual inspections, and clearing of silt and gravel from the network. Typical routine maintenance works include:

- Stormwater intakes – inspected and cleared on various frequencies throughout the year;
- Stormwater culverts (annual inspection programme) – significant culverts are inspected annually and gravel/silt removed as required;
- Stormwater pits - inspected annually with the removal of gravel/silt as required;
- Stormwater outlets - stormwater outlets along the coastlines are inspected and cleared;
- Silt traps - silt/gravel is removed annually from traps if required; and
- Sumps and street cleaning – maintenance of street sump boxes is carried out by contractors on a routine and reactive basis. This includes transit, CBD and 'critical sumps' at least three times per year and suburban street sumps one or two times per year.

4.7.3 Scheduled maintenance

Scheduled maintenance is performed on stormwater infrastructure based on an inspection programme, with the intention of minimising the occurrence of faults.

Network inspections are carried out on the basis of risk, taking account of the likelihood of an event based on factors such as capacity, lifespan, site assessments and the cost of an event taking account of the damage that could occur, as well as the criticality of the infrastructure and any public health and environmental risk. The schedule of criticality is described below:

- **Critical A** (most expensive and disruptive to repair) – inspections are carried out on a five year cycle;
- **Critical B** (failure would have a high social impact and be expensive to repair) – inspections are carried out on a 10 year cycle; and
- **Critical C** (failure would have a moderate social and financial cost) – inspections are carried out on a 15 year cycle.

The majority of the stormwater network is considered 'non-critical', and so is inspected and repaired on a reactive basis. This is largely in response to service requests and the investigation of incidents (e.g. flooding, odour, blockages). Reactive maintenance ensures the reliability of system through the timely response and repair of faults.

4.8 WWL’s response to complaints, general incidents and WNO incidents

In the quarter ending 31 March 2017, WWL managed 382 incidents including blockages, overflows, leaks and faults. There has been a declining trend in the number of incidents managed over the preceding three quarters being 392 (31 December 2016), 520 (30 September 2016) and 700 (30 June 2016). While WWL have been managing and responding to such complaints and incidents with the intention of reducing future incidents, the number of incidents is also heavily related to the type and frequency of weather events, and activities undertaken by public, developers and contractors in the catchments.

4.8.1 Complaints and general incidents

The process WWL will follow when an external complaint is received during the term of this consent is identified in Figure 3 below.

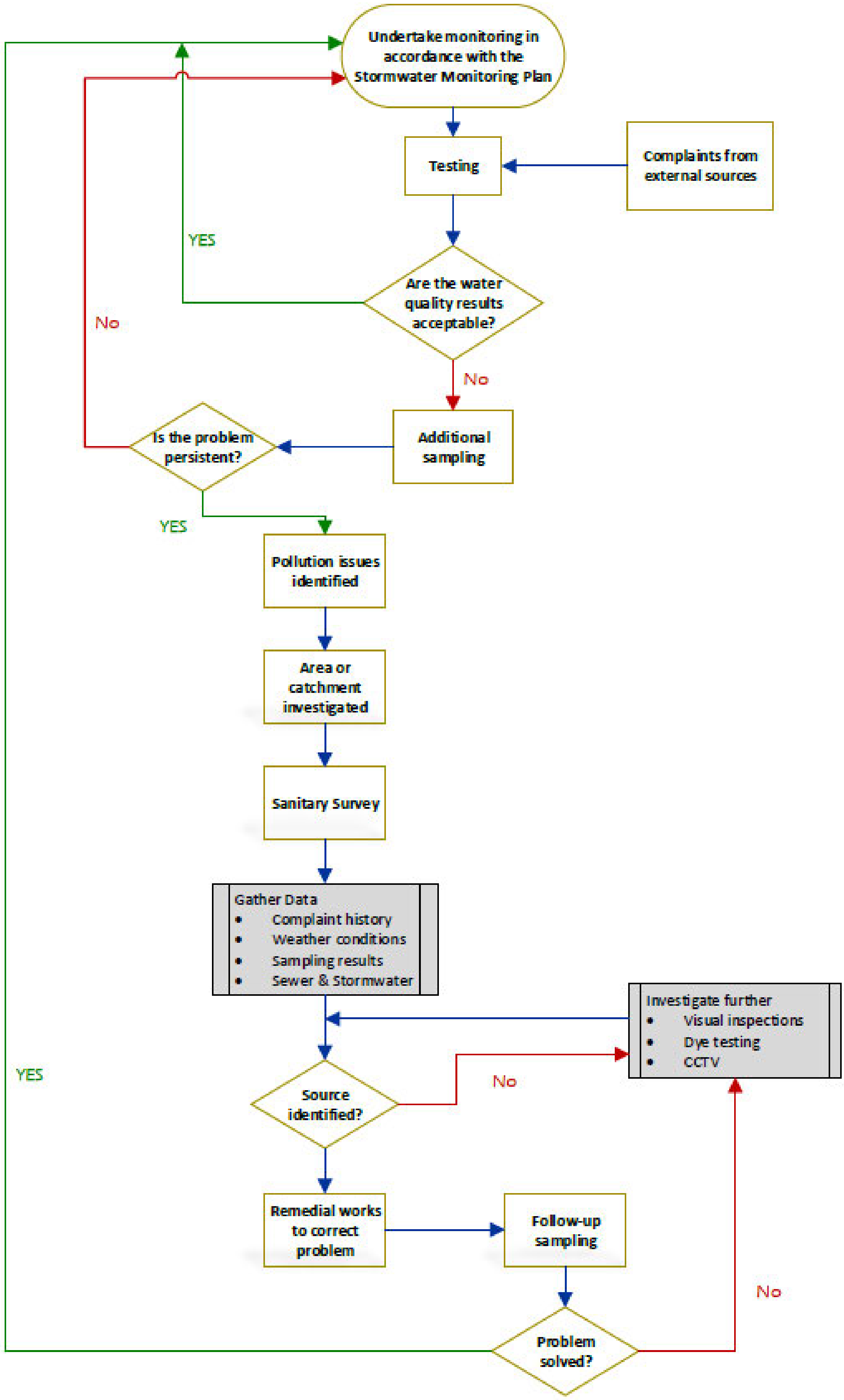

Figure 3: Management of external complaints process

The WWL website provides a ‘Report a Fault’ function for the community to easily report a fault associated with any of its infrastructure (refer to Figure 4 below).

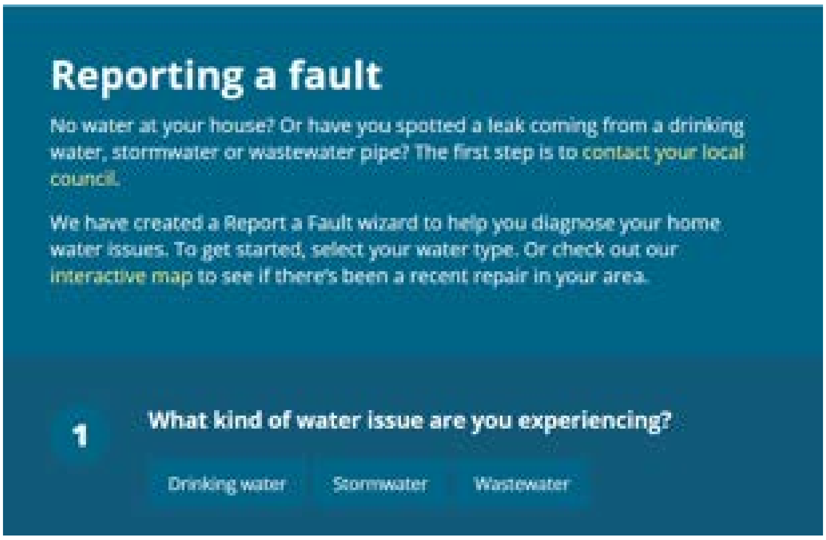

Figure 4: Report a fault function on the WWL website

WWL also have systems in place, utilising their website and social media to inform the community of any complaints or incidents.

4.8.2 Management of WNO incidents

WWL has several procedures in place to manage WNO incidents and these are primarily managed through wastewater discharge consents which have well outlined procedures and protocols for incident responses. Whilst the majority of the remaining WNO do not have a resource consent, WWL proactively follow a similar procedure to respond to overflow incidents.

The following is a summary of activities undertaken by different parties to monitor, respond to, notify and investigate WNO incidents. Aspects of this procedure are specific to WCC but the response will be undertaken for WNO incidents in Porirua, Hutt City and Upper Hutt catchments. WWL use procedural diagrams and standardised forms for the below detailed activities.

Monitoring WNO – overflow points are mainly monitored via telemetry systems. However, some overflows get reported through external parties (e.g. community, WWL, client council staff, and Regional Public Health).

Response to WNO discharges - contain the overflow and clean up. Within an hour of notification, a contractor and/or WWL will investigate and confirm the overflow.

Assessment of the WNO discharge and escalation – this is initially undertaken by the maintenance contractor, and then escalated to WWL. An appropriate response is then initiated depending on whether the discharge is likely to result in a significant environmental impact or increase of risk to public health.

Escalation can also call for extra signage to be put in place in suitable locations to warn the public of the potential for risk to their health (as required by WCC discharge permit WGN090219). The use of additional signs is intended to reduce the chances of a person being exposed to microbiological contaminants unwittingly. These signs are over and above the permanent warning signs that are located at stormwater discharge points that may impact recreational marine areas or beaches.

Information pertaining to significant or persistent discharges will be advised to WWL and client council communications staff. This is to allow for informed comments to be made to the media (if required) and allow for additional messages to be conveyed to the community.

Notification of a WNO by WWL – a WNO to a waterway is reported by WWL irrespective of its significance. A "Standard Overflow Notification" form is distributed to GWRC, Regional Public Health and the relevant client council.

If the WNO discharge takes place within the marine reserve, a notification form is sent to the Programme Manager Biodiversity, at the Department of Conservation.

An interactive map that identifies known outages and wastewater overflows is provided on WWL's website (refer to Figure 5 below).

Figure 5: Interactive map of known outages and WNO on WWL's website

4.9 Community education

Community education is an important part of WWL's maintenance of the stormwater networks. Raising customers' awareness of the value of the stormwater network, their impact and how they can minimise this impact is one of WWL's core functions.

4.9.1 Community Education Strategy

A Community Education Strategy has been drafted by WWL, which informs the WWL Community Education Plan December 2016-June 2017. The Community Education Plan captures a comprehensive whole-of-network approach to delivering education and other initiatives to support behavior change.

4.9.2 Community Education Implementation

WWL has worked with its client councils to identify priority areas where education can make a difference. Activity plans have been developed to deliver messages and support community awareness of the impact of everyday activities on the stormwater network.

WWL are currently undertaking a Facebook education campaign with short videos which focus on reducing contaminants in the stormwater network.

The WWL website includes information about the stormwater network and educational material about the responsibility of households to prevent cross-connections between domestic wastewater and stormwater.

WWL stormwater network works are regularly reported on. Publications and education material currently available on the WWL website includes:

- Stormwater Newsletter
- Three Waters Newsletters
- Annual Reports
- Half-yearly reports
- Three waters report and outlook for each quarter of the year
- Statement of Intent
- Cross-connections fact sheet
- Managing our waterways – a guide for homeowners
- WCC Integrated Catchment Management Plan Newsletter and Progress Reports
- Fact sheets on "planning some plumbing or drainage work at home" and cross-connections.

WWL's client council websites also provide a plethora of information and educational material related to stormwater discharges and the network. Examples include:

- The **WCC website** contains information on the impact of stormwater pollution, how to minimise stormwater pollution and a link to a 'How you can help stop stormwater pollution factsheet'.
- **The Water Sensitive Urban Design Guide[6] produced by WCC** provides guidance on implementing water sensitive urban design concepts. Examples in Wellington includes rain gardens along the quays, tree pits in lower Cuba Street, wetlands at Waitangi Park and Westchester Drive swales.
- The **HCC website** contains information about who is responsible for stormwater drains, how the public can protect their property and the environment, including not discharging motor oil, fuels, solvents or other toxic substances into the stormwater network.
- The **UHCC and PCC websites** explain what contaminants should not enter stormwater drains, how to dispose of these contaminants, and the impacts of pollution on stormwater.
- The **PCC website** contains information about their commitment to low impact design for developments and redevelopments across its various asset classes - property, parks, reserves, roads and urban public space. Low impact measures are encouraged to be explored as part of investigation and design phases, and pursued where viable. New subdivisions near

[6] Wellington Water Ltd. 2017.

ecologically sensitive areas are encouraged to install stormwater treatment devices (e.g. swales, or wetlands) to reduce silt and heavy metal discharges.

5 Stormwater receiving environments

5.1 Overview

The scope of this application covers stormwater runoff from 28 catchments, ultimately discharging to fresh water, estuarine and coastal receiving environments. The main receiving environments are identified in Table 6 below.

Table 6: Main fresh water, estuarine and coastal receiving environments

Freshwater environments		
Karori Stream	Waiwhetu Stream	Akatarawa River
Owhiro Stream	Stokes Valley Stream	Mangaroa River
Kaiwharawhara Stream	Hulls Creek	Pakuratahi River
Ngauranga Stream	Opahu Stream	Days Bay Stream
Korokoro Stream	Hutt River	Wainuiomata River
Speedy's Stream	Whakatikei River	
Estuarine and coastal environments		
Wellington Harbour	Miramar Peninsula	North Harbour
Owhiro Bay	East Coast	Petone and Hutt Estuary
Island Bay	Evans Bay	Eastbourne
Houghton Bay	Lambton Harbour	Porirua Harbour
Lyall Bay		Porirua East Coast

The existing state of these receiving environments is discussed in detail in the EER and will not be repeated in this section. Instead, this section provides an overview of the values of the receiving environments.

5.2 Land use

Urban areas in the Wellington region tend to be close to the coastal environment. This means the opportunity for contaminant attenuation and dilution between the source and the coastal environment is limited.

The percentage of urban land and impervious surface in each catchment and sub-catchment within the scope of this application is provided in Table 7 below.

Table 7: Percentage urban and impervious surface for each catchment and sub-catchment

Catchment	Sub-catchment	Catchment Area (km²)	% Urban[7]	% Impervious surface[8]
Karori	Karori	30.93	14	5.50
Owhiro Bay	Owhiro Stream	9.71	51	10.52
Island/ Houghton bays	Island Bay	5.12	81	33.49
	Houghton Bay	0.88	54	14.84
Lyall Bay	Lyall Bay	2.84	93	47.94
East Coast	Southeast coast Seatoun/ Karaka Crawford	2.93	44	22.24
Evans Bay	Miramar/ Strathmore	4.40	92	44.14
	Kilbirnie/ Rongotai	1.75	92	56.36
	Hataitai	1.39	83	39.41
	Grafton-Rata	0.84	82	39.00
Lambton	Oriental Bay	0.49	97	42.32
	Southern CBD	8.23	82	48.59
	Northern CBD	4.94	86	46.57
Kaiwharawhara	Kaiwharawhara	16.60	56	17.85
North Harbour	Onslow/Ngauranga/Horokiwi	15.84	67	23.8
Korokoro	Korokoro	15.70	2.6	4.68
Waiwhetu	Waiwhetu	18.65	59	54.53
Hutt – Speedy's	Speedy's	11.61	12	7.90
Hutt River	Hutt main stem	199.16	26	10.67
Eastbourne	Eastbourne	19.37	18	15.77
Wainuiomata	Black Creek	18.44	44	32.89
	Wainuiomata-iti	17.38	0.00	1.64
	Wainuiomata	57.85	3.1	2.21
	Morton	40.06	0.5	0.45
Hutt - Hull	Hulls Creek	16.58	43	0.23
Hutt - Stokes	Stokes Valley	11.96	39	37.36
Hutt - Whakatiki	Whakatiki	81.84	0.5	0.00
Hutt - Akatarawa	Akatarawa	116.42	0.06	0.00
Hutt - Mangaroa	Mangaroa	104.10	0.89	0.00
Hutt - Pakuratahi	Pakuratahi	81.38	0.00	0.00
Taupo	Taupo	10.58	7.5	12.23
Kakaho	Kakaho	17.76	9.6	7.95
Horokiri	Horokiri	41.02	0.0	0.55
Pauatahanui	Pauatahanui	41.56	2.8	4.78
Duck	Duck	10.03	33	24.47
Porirua	Aotea/Porirua Harbour	10.71	67	45
	Porirua	31.59	59	36.93
	Paparangi	8.99	12	5.29

[7] Catchments that are more than 25% urban or impervious surface are categorised as a having a 'high' pressure on the stormwater network. These catchments are highlighted in orange.
[8] Ibid

Catchment	Sub-catchment	Catchment Area (km^2)	% Urban[7]	% Impervious surface[8]
	Churton	15.25	61	15.03
Porirua coast	Porirua coast	14.4	16	20.19

Wellington City catchments are approximately 72% urban, meaning there is a high level of pressure on the stormwater network. All but one of the Wellington City catchments is greater than 25% urban. This urban land use pressure is less so in the Hutt City, Upper Hutt and Porirua catchments.

5.3 Population and housing growth

Demand for stormwater drainage is indirectly affected by growth in population and households. The Wellington region is expected to grow in population, with the highest rate of growth occurring within Wellington City. It follows that growth creates more urban built-up areas, increasing the percentage of urban and impervious areas, leading to the potential for higher storm flows and stormwater discharge quantity. Growth also provides demand for the expansion of stormwater networks.

For the quarter ending 31 March 2017, WWL received 88 applications for new water connections. Over the past year this number has been varied between 59 to 111 applications each quarter. While not directly related to stormwater, these figures provide an indication of the increase in urban development activity.

5.3.1 Wellington City

Wellington has a population of 209,102, and is expected to increase by almost 20% to reach approximately 250,000 by 2043[9].

The Wellington Urban Growth Plan 2014 – 2043 predicts an additional 21,400 residential dwellings will be required by 2043. The demand for more central city apartments, medium-density (townhouse and apartment complexes) and infill housing is expected to continue.

Most of the growth is expected to occur in the central city (Wellington Central, Te Aro, Pipitea and Thorndon) putting pressure on the Lambton Harbour catchment. Greenfield development is anticipated to occur mainly in the northern suburbs beyond Johnsonville, in the Korokoro catchment and the southern part of the Porirua catchment.

5.3.2 Hutt City

Hutt City has a population of 102,003, and is expected to increase by 7.7% to reach approximately 110,000 by 2043[10].

The Hutt Urban Growth Strategy 2012-2032 describes a preference for a moderate approach to intensification, with a balance between infill and greenfield development. This Strategy anticipates 3,950 new homes by 2032. The four key locations being considered for low rise apartment housing are Waterloo, Hutt City CBD fringe, Petone (The Esplanade and Jackson Street), and Eastbourne Village/foothills. These areas are within the Hutt – Mainstem catchment.

9 .id Consulting Ptd Ltd. 2017.
10 Ibid

In addition, HCC is working with developers to provide the infrastructure needed to bring over 74ha of land onto the market. These locations are in Kelson (at the end of Major Drive) in the Korokoro catchment, Wainuiomata (around the lower Upper Fitzherbert Road and Wise Street area) in the Waiwhetu and Wainuiomata/Black Creek catchments.

5.3.3 Upper Hutt

Upper Hutt has a population of 42,381, and is expected to increase by 17.8% to reach approximately 49,900 by 2043[11].

The Upper Hutt Land Use Strategy 2016-2043 anticipates a growth of between 3,960 to 4,500 new dwellings over the next 30 years. Targeted infill areas are Silverstream, Trentham, Wallaceville, Maidstone, Brentwood, Central and Brown Owl. Edge expansion has been earmarked for a Southern Growth Area, at Wallaceville, Gabites Block and Gillespies Road. This growth will place additional pressure on the Hutt – Mainstem catchment.

5.3.4 Porirua

Porirua has a population of 55,024, and is expected to increase by 17.9% to reach approximately 65,000 by 2043[12].

Growth in Porirua is being led by the Northern Growth Area Structure Plan project. This is a land-use planning exercise to develop a 30-year strategy for future growth in Porirua's northern suburbs, most of which is currently rural. This area is within the Taupo, Kakaho and Horokiwi catchments.

5.4 Values of the receiving environments

5.4.1 Schedules of the PNRP

The schedules of the PNRP have been reviewed to identify the values of the relevant fresh water and coastal receiving environments.

Schedule A – Outstanding water bodies

The tidal flats of Pauatahanui Inlet are identified in Schedule A as an outstanding waterbody. This is relevant to the Kakaho, Horokiwi, Pauatahanui and Duck catchments, as streams in these catchments discharge into the Pauatahanui Inlet.

Schedule B - Ngā Taonga Nui a Kiwa

Ngā Taonga Nui a Kiwa are waterbodies that have particular importance to mana whenua at a catchment scale. The waterbodies within the scope of this application identified in Schedule B are detailed in Table 8 below.

Table 8: Waterbodies identified in Schedule B of the PNRP

Catchment	Waterbody
Island and Houghton Bays, Lyall Bay, East Coast, Evans Bay	Wellington City southern coastal waters

11 .id Consulting Pty Ltd. 2017.
12 Ibid

Lambton Harbour, Kaiwharawhara, North Harbour, Korokoro, Waiwhetu, Eastbourne	Wellington Harbour (including the Hutt/Waiwhetu estuary)
Kaiwharawhara	Te Manga o Kaiwharawhara (including Te Mahanga Korimako Streams)
Hutt River	Hutt River main stem
Taupo Swamp	Taupo swamp
Kakaho, Horokiwi, Pauatahanui, Duck	Pauatahanui Inlet
Porirua	Onepoto Inlet
Porirua Coast	Porirua southern and western coastal waters

Schedule C – Sites with significant mana whenua values

The iwi within the scope of this application are Ngāti Toa Rangatira (Schedule C3) and Taranaki Whānui kit e Upoko o te Ika a Maui (Schedule C4). Schedules C3 and C4 list the particular values that mana whenua recognise for each site. The sites identified in Schedule C3 and C4 within the scope of this application are detailed in Table 9 below.

Table 9: Sites identified in Schedules C3 and C4 of the PNRP

Catchment	Site(s)
East Coast, Evans Bay	The rocky shore and coastal area at Hue tē Taka Peninsular is identified in Schedule C3 and C4
Lambton Harbour	The former Te Aro Pā in Lambton Harbour is identified in Schedule C4
All Hutt Catchments	Te Awa Kairanga/Hutt River mouth is identified in Schedule C3 and C4. Schedule C4 also identifies Maraenuku pā and Motutawa pā on the Hutt River and the Petone Foreshore
Hutt –Speedy's	The confluence of Speedy's Stream with the Hutt River is identified in Schedule C4
Kakaho, Horokiwi, Pauatahanui, Duck, Porirua	The following locations around the Porirua Harbour are identified in Schedule C3: Takapuwhāhia, Te Punga o Matahoaua, Whititanga, Pauatahanui Reserve, Porirua Stream mouth
Horokiwi	Horokiwi Stream is identified in Schedule C3
Taupo	Taupo Stream mouth and Taupo Pā are identified in Schedule C3
Duck	Duck Creek is identified in Schedule C3
Owhiro	Tapu te Ranga – Owhiro – Haewai is identified Schedules C3 and C4
Island and Houghton Bays; Lyall Bay	Te Raekaihau Point Reef is identified in Schedule C4
Porirua Coast	Whitireia is identified in Schedule C3
Korokoro	Korokoro Stream (and stream mouth) is identified in Schedules C3 and C4
Eastbourne	East Harbour Coast is identified in Schedule C4
Wainuiomata	Wainuiomata river mouth and foreshore are identified in Schedule C4
Waiwhetu	Waiwhetu stream – Owhiti Pā is identified in Schedule C4

Schedule D – Statutory acknowledgements

Taranaki Whānui ki Te Upoko o Te Ika's Statement of Association includes Kaiwharawhara Stream, Hutt River, Waiwhetu Stream and the Wellington Harbour.

Ngāti Toa Rangatira's Statements of Association includes the Red Rocks Scientific Reserve, Hutt River and tributaries, Te Awarua o Porirua Harbour, Wellington Harbour (Port Nicholson), Kapukapuariki Rocks, Toka-a Papa reef, and Tawhitikuri/Goat Point.

Schedule F - Ecosystems and habitats with significant indigenous biodiversity values

The ecosystems and habitats with significant indigenous biodiversity values identified in Schedule F are summarised in Appendix E.

Schedule H - Contact recreation and Māori customary use

Schedule H1 identifies rivers and lakes considered to be regionally significant primary contact recreation bodies. The waterbodies within the scope of this application are identified in Table 10 below.

Table 10: Waterbodies identified in Schedule H1 of the PNRP

Catchment	Waterbody
Hutt River- mainstem	Hutt River
Hutt – Pakuratahi	Pakuratahi River
Hutt – Atakarawa	Akatarawa River
Wainuiomata	Wainuiomata River

Schedule H2 identifies waterbodies that need to be prioritised for improving fresh and coastal water quality for contact recreation and Māori customary use. These are both important considerations with regard to stormwater discharges. The relevant waterbodies within the scope of this application are identified in Table 11 below.

Table 11: Waterbodies identified in Schedule H2 of the PNRP

Catchment	Waterbody
Fresh waterbodies for secondary contact | *Fresh water bodies at or below the National Objectives Framework compulsory bottom line for the health of people and communities from secondary contact with water.*	
Karori catchment	Karori Stream
Fresh waterbodies for primary contact | *Regionally significant primary contact recreation rivers at or below the National Objectives Framework minimum acceptable state for primary contact with freshwater at flows below three times median flows, and at one or more sites.*	
Hutt River – Mainstem	Hutt River
Wainuiomata	Wainuiomata River
Coastal water priorities for improvement for contact recreation | *Areas of coastal water with recognised recreation values at or below the Table 3.3 of the PNRP outcome for faecal contamination during the bathing season (November-March)*	

Catchment	Waterbody
Island / Houghton Bays	Island Bay at Derwent Street, at Reef St Recreation Ground, and at the Surf Club
Owhiro Bay	Owhiro Bay
Porirua	Te Awarua-o-Porirua Harbour (Onepoto Arm) at the Rowing Club
Taupo	South Beach at Plimmerton
Porirua Coast	Titahi Bay at South Beach Access Road
Lambton Harbour	Wellington Harbour (Port Nicholson) at Harris Street, Hunter Street, and Tory Street

Schedule I - Important trout fishery rivers

The following waterbodies are important trout fishery rivers within the scope of the application, Akatarawara River, Hutt River, Mangaroa River, Pakuratahi River, Wainuiomata River, Waitohu Stream and the Whakatikei River.

5.4.2 Taputeranga Marine Reserve values

Of particular importance are the contact recreation, biodiversity and scientific values attributed to the Taputeranga Marine Reserve (TMR), located on Wellington's south coast, and managed by the Department of Conservation.

The TMR was established in 2008 under the Marine Reserves Act 1971, to conserve biodiversity and preserve the area in its natural state as habitat of marine life for scientific study.

The TMR covers approximately 854ha and its shoreline boundary is approximately 5km, from the old quarry west of Owhiro Bay in the west, to just west of Te Raekaihau Point in the east taking in Owhiro, Island and Houghton bays. The outer boundary of the reserve is 2.3km out to sea. The northern and southern limits of many fish, invertebrates and algal species occur within the reserve. The complex topography of the south coast and high energy of the coastal waters has created a wide variety of habitats within a relatively small area. Currently, the Island Bay culvert and the Houghton Bay culvert discharge stormwater into the TMR.

Whilst this is a 'no take' area, the marine reserve is highly valued for scientific study, education, eco-tourism and recreation (such as snorkeling, diving, swimming and exploring rock pools).

5.4.3 Mana whenua interests and values

The PNRP identifies the importance of recognising Māori use of waterways, including taking into account mahinga kai and Māori customary use. The PNRP also identifies the importance of considering kaitiakitanga and the role iwi have in managing the environment. The iwi within the scope of this application are Ngāti Toa Rangatira (Porirua, Wellington, Hutt Valley), and Taranaki Whānui (Wellington and Hutt Valley).

There are no protected customary rights groups or customary marine title groups within the scope of the consent, under the Marine and Coastal Area (Takutai Moana) Act 2011.

There are no Mataitai reserves or Taiapure, which are governed by the Fisheries Act 1996 and Maori Fisheries Act 2004, in the Wellington region. However there is a desire to establish mataitai in the future, as identified during consultation with the Port Nicholson Block Settlement Trust (PNBST) and the Wellington Tenths Trust.

5.4.4 Wider community values

Whaitua process values

There are two Whaitua within the geographical scope of this application – the Te Awarua-o-Porirua Whaitua (established December 2014) and the Wellington Harbour/Hutt Valley Whaitua (yet to be established).

The Porirua Whaitua committee have been established as community advisory group that include representatives from GWRC's Te Upoki Taio – Natural Resources Committee, iwi, local authorities, WWL, and people from the community who have an interest in water management and land use issues. The Whaitua process is a mechanism to enlist the support and engagement of local people to identify water values and make recommendations on how the water values will be managed and protected.

The terms of reference for the Te Awarua-o--Porirua Whaitua includes the management of stormwater and wastewater infrastructure as matters to be considered in the development of the Whaitua Implementation Programme.

Values from submissions on the PNRP

Submissions on the PNRP were reviewed to gain an understanding of any key values or concerns raised of relevance to stormwater discharges as a proxy for the wider community.

Key comments and concerns are identified below along with the submitter number:

- Progressive improvement of stormwater quality should be encouraged (S121, S146, S33);
- Preference for catchment based approach to stormwater management (P73);
- Importance of linking stormwater to receiving water quality and standards (S33);
- Concern about refuse entering the stormwater network (S4);
- Monitoring appropriate sites is important, including significant bodies of water and ecosystems (S398);
- Stormwater management plans should be developed in accordance with Whaitua objectives (S13); and
- Monitoring to identify the effects of stormwater discharges from the network on mahinga kai and Māori use is important (S398).

6 Regulatory context for stormwater discharges

6.1 Resource Management Act requirements

The RMA sets out the circumstances in which resource consents for activities are required.

Section 15 sets out the restrictions on the discharge of contaminants into the environment

(1) No person may discharge any—

(a) Contaminant or water into water; or

(b) Contaminant onto or into land in circumstances which may result in that contaminant…entering water.

…

unless the discharge is expressly allowed by a rule in a regional plan and in any relevant proposed regional plan, a resource consent, or regulations.

6.2 Operative Regional Plans

Rules for stormwater discharges under the operative Regional Plans are as follows:

Rule 2 of the operative Regional Freshwater Plan provides for the discharge of stormwater into surface water as a Permitted Activity when conditions (1) to (5) can be met. If these conditions cannot be met, the activity becomes Controlled (Rule 2 Stormwater Discharges) or Discretionary (Rule 5 All remaining discharges to water).

Rule 53 of the operative Regional Coastal Plan provides for the discharge of stormwater onto land or into water in the coastal marine area as a Permitted Activity when conditions (1) to (3) can be met. If these conditions cannot be met the activity becomes Discretionary (Rule 61) or Non-Complying (Rule 62) if the discharge is within an Area of Significant Conservation Value.

Rule 3 of the operative Discharges to Land Plan provides for the discharge of stormwater into or onto land as a Permitted Activity when conditions (1) – (3) can be met. If these conditions cannot be met, the activity becomes Discretionary (Rule 2 Discharges into or onto land that is not otherwise provided for by a rule in the Plan).

Prior to the establishment of WWL in September 2014, stormwater network discharges were managed on an individual council basis with some meeting permitted activities and others authorised via resource consents. Section 6.6 below identifies the existing stormwater discharge resource consents held by WWL's client councils.

6.3 Proposed Natural Resources Plan (PNRP)

The PNRP was publically notified by GWRC on 31 July 2015. GWRC has signaled through Rule R50 (and Rule R52) of the PNRP that local authority stormwater discharges must be considered and managed under a holistic 'global' framework, requiring all stormwater discharges from local authority networks to be consented, via a two stage consent process (refer to Figure 6 below).

Figure 6: Process for consenting local authority stormwater discharges under the PNRP

6.4 Reason for Consent

As all provisions in the PNRP have immediate legal effect from the date of notification, two global resource consents are sought as a **Controlled Activity** under Rule R50 of the PNRP. The global consents will authorise the continued discharge of stormwater from the WCC, UHCC, HCC and PCC stormwater networks to water, and onto or into land which may enter water (fresh water and coastal receiving environments).

Rule R50 states –

> The discharge of stormwater into water, or onto or into land where it may enter water, from a local authority stormwater network is a controlled activity, provided the following condition is met:
>
> (a) the resource consent application is received within two years of the date of public notification of the Proposed Natural Resources Plan (31.07.2015).

An assessment against the Rule R50 matters of control which GWRC are restricted to is provided in Table 12 below.

Table 12: Assessment against the Rule R50 matters of control

Matters of control	Assessment
Requirements to monitor and report on the quality of stormwater discharges to fresh and/or coastal water, including of stormwater discharges containing wastewater.	A draft SMP has been prepared, which details the proposed monitoring and modelling over the next five years.
Management of acute effects of stormwater on human health detected during monitoring	Section 9.6 of this report and section 7 of the draft SMP outline how acute effects on human health detected during monitoring will be managed.

Duration of consent up to a maximum of five years.	A consent duration of five years is requested.
Timeframes for the development of a stormwater management strategy in accordance with Schedule N (stormwater strategy).	The timeframe for developing a SMS is detailed in section 6.5 below.

The purpose of a Stage One global stormwater discharge consent application is to:

- Develop a SMP that is acceptable to WWL and GWRC, which is practical and cost-effective. The SMP will direct stormwater monitoring in Porirua, Hutt City, Upper Hutt and Wellington City over the next five years;
- Require WWL to undertake stormwater discharge monitoring to identify adverse quality and quantity effects from the stormwater network, to enable the development of a prioritised programme for improvements in a Stage Two SMS;
- Set out a framework for managing acute effects on human health detected during monitoring; and
- Set out a timeline for the development of a SMS.

GWRC has determined that unless there are effects on the environment that need to be managed in the short term, local authorities are not required to apply for new stormwater discharge permits in the period between preparing this consent application and its determination. Any new discharges arising during the consent processing phase will be deemed to be included in this consent application.

6.5 Timeframe for the development of a Stormwater Management Strategy

Rule R51 of the PNRP requires as part of the Stage Two global consent application, the development of a SMS, drawing on the monitoring undertaken during Stage One. A draft SMS is proposed to be developed four years from the date of grant of this Stage One consent. A proposed consent condition is provided in section 13 to this effect.

6.6 Existing local authority stormwater discharge consents

6.6.1 Wellington City Council

WCC holds four stormwater discharge permits, WGN090219 [27418, 27419, 30500 & 30501], granted by GWRC on 18 February 2011 to “continue to discharge stormwater and occasionally contaminated stormwater….directly into the coastal marine area”, from stormwater outfalls located on the coastline between Horokiwi in Wellington Harbour and Owhiro Bay on Wellington’s south coast.

These four discharge permits are subject to a number of conditions including the preparation of Integrated Catchment Management Plans (ICMPs) in two stages, and the monitoring of stormwater quality.

The Stage One ICMP covers stormwater sub-catchments from Owhiro Bay in the southwest to Horokiwi/Bellevue in the northeast. The Stage One ICMP includes descriptions of the stormwater catchment characteristics, receiving environment values, stormwater network issues, a high level assessment of effects of contaminants and stormwater management recommendations. The Stage One ICMP was completed in March 2014.

The progressive preparation and implementation of Stage Two ICMPs is required within seven years of the WCC permit being granted. The Stage Two ICMPs will include an assessment of management options, a statement of targets and standards for catchment performance monitoring, as well as priorities and timetables. These are anticipated to be completed by March 2018.

6.6.2 Hutt City Council

HCC holds discharge permit WGN070053 [25551], authorising the discharge of stormwater from the lower Gracefield catchment to the Waiwhetu Stream via a pump station. This consent was granted in March 2007 and will expire in March 2022. A condition of consent requires the development and implementation of a SMP to assess the quality of stormwater in the Gracefield catchment, and to mitigate the effects of contaminants entering the stormwater network. The Gracefield SMP has been completed and monitoring is being implemented in accordance with the conditions of consent.

6.6.3 Porirua City Council and Upper Hutt City Council

PCC and UHCC do not hold any local authority stormwater network discharge consents.

6.6.4 How this consent will affect current WCC and HCC consents

To allow for the continued development of the Stage Two ICMPs, the four WCC discharge permits will remain live until their expiry on 18 February 2021. Thereafter this global stormwater consent will 'pick up' the authorisation of WCC's stormwater network discharges to coastal receiving environments.

This global consent will also 'pick up' the authorisation of the continued discharge of stormwater discharge from the lower Gracefield catchment to the Waiwhetu Stream, on the expiry of HCC's discharge permit WGN070053 in March 2022.

7 Adequacy of information and major knowledge gaps

Extensive information collation has been undertaken to produce the EER and draft SMP. A list of the information sources is provided in Appendix A. Stormwater and receiving environment information was collated from a variety of sources, but primarily from WWL and its client councils. The available information collated varied between catchments, with the greatest available information for WCC catchments, primarily due to the commencement of monitoring under consent WGN090219 and the development of ICMPs.

Information collation was an important stage for preparing the EER and draft SMP and consent application for two primary reasons:

- It has provided a robust process to identify the major knowledge gaps in each catchment which has informed the proposed monitoring and modelling programme in the draft SMP; and

- It has informed the AEE in section 8 below. In particular, where there are known major knowledge gaps or information is not available, this has meant that the quantification of effects from stormwater discharges has not been able to be made.

Catchment data sheets have been prepared for each catchment and are provided in Appendix A of the draft SMP. These sheets provide a succinct summary of the known characteristics of the network and existing state of the environment. An adequacy of information assessment was undertaken and a score attributed to each characteristic, from 1 to 5 as per Figure 7 below to create a total score out of 75.

Figure 7: Adequacy of information scores

The outcome of this adequacy of information assessment was to identify the level of available information for each catchment and identify where major knowledge gaps exist. The major knowledge gaps for each catchment are detailed in Table 1-1 of the draft SMP (Appendix F).

8 Assessment of effects on the environment

Section 104(1)(a) of the RMA requires that when considering an application for resource consent the consent authority must, subject to Part 2, have regard to any actual and potential effects on the environment. The actual and potential effects of the proposal have been evaluated to a level appropriate to the scale and significance of effects as required by Section 88 and the Fourth Schedule of the RMA.

Due to the large number of catchments within the scope of this application and the varying level of available information on catchment characteristics, this AEE focuses on providing a high level assessment of the effects of the continued discharge of stormwater on the existing environment.

The review of existing monitoring data has not led to a conclusive determination or quantification of the level of adverse effect stormwater discharges in isolation are having on the receiving environments. Other catchment modifications including the loss of vegetation cover, channelisation, culverting of streams, increased area of impervious surfaces, discharges from agricultural land, industrial discharges and spills are some other common sources that contribute to adverse effects in receiving environments.

8.1 Overview of the effects of urban stormwater

Stormwater by its nature collects contaminants such as sediment, oils, fuel, polycyclic aromatic hydrocarbons (PAHs), persistent organic contaminants (POPs), pesticides, bacteria and other chemicals. These then accumulate in the receiving fresh water and coastal environments. In addition pollutants also enter the stormwater networks through illegal cross-connections between wastewater and stormwater drains and WNO. As a result of all of these inputs and the absence of formal treatment of stormwater prior to discharge (other than removal of coarse solids in road-side catch pits), it is inevitable that stormwater discharges can negatively impact upon the receiving environments. Not only can stormwater impact water quality such that aquatic ecosystems are compromised, there is also the potential for impacts on contact recreation, amenity, mahinga kai and Māori customary use.

The physical characteristics of receiving environments can determine how sensitive that environment will be to stormwater discharges. Receiving environments that are relatively constrained or low energy tend to accumulate stormwater contaminants, due to deposition of fine sediments and associated contaminants. As such, environments such as enclosed estuaries and harbours tend to accumulate contaminants. Therefore effects of stormwater are likely to be greater in Wellington and Porirua harbours, than the south coast. In terms of fresh water environments, small low gradient streams are more sensitive to stormwater discharges.

8.2 Effects on receiving water quality

The main effects from urban stormwater discharges on receiving water quality are:

- Increases in suspended solids;
- Increases in toxic substances in the water column;

- Changes in the nutrient regime;
- Increase in floating and deposited litter; and
- Microbiological contamination.

8.2.1 Increases in suspended solids

Exposure of soils during development of urban areas can lead to very high suspended solids (SS) concentrations in runoff from developing areas. Concentrations in stormwater can increase 100 to 1000-fold[13]. For example, after initial subdivision and development as the urban area fully matures, suspended solids concentrations and loads gradually decrease but this process can take many years, and in the intervening period SS can cause the smothering of benthic habitats, especially in small stony streams. Large quantities of fine sediments may also be deposited in estuaries, as evidenced by the gradual sediment accumulation in the Porirua and Wellington harbours.

Stormwater containing high concentrations of suspended solids discharged to a stream or river can reduce the visual clarity of the watercourse. Visible discharge plumes can form, extending downstream from the discharge point.

Information available on estimated sediment loads to Wellington Harbour indicate the catchments within WCC jurisdiction are highly urban. Therefore with relatively little ongoing development, these WCC catchments do not significantly contribute to sediment loads (as detailed in Table 13 below). The limited sampling WCC has undertaken in stormwater drains show that fine sediment concentrations are not particularly high[14] and typical of mature urban areas[15].

Table 13: Estimated sediment loads into Wellington Harbour (from Capacity 2014)

Catchment	Area (ha)	Annual sediment load (kt/year)	Catchment yield (tonnes/ha/year)
Hutt River	61,500	132	2.14
Kaiwharawhara Stream	1,680	1.30	0.77
Ngauranga Stream	920	0.60	0.65
Wellington Harbour urban areas (Lambton Harbour, Kaiwharawhara, North Coast, Evans Bay	5,650	2.20	0.39

The annual sediment load into the Porirua Harbour (from total area of 17,068ha) is 22.283 kt/year, resulting in a catchment yield of 1.31 tonnes/ha/year. The contribution of sediment loads from streams that discharge to the Pauatahanui and Onepoto arms of the Porirua Harbour are detailed in Table 14 below. As at January 2011, sedimentation rates in Porirua Harbour were rated as 'low to moderate'[16].

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[13] Williamson, 1993; Williamson, et al., 2001
[14] Capacity, 2014
[15] Williamson, 1993
[16] Oliver and Milne, 2012

Table 14: Estimated sediment loads into Porirua Harbour

Catchment	Area (ha)	Annual sediment load (kt/year)	Catchment yield (tonnes/ha/year)
Pauatahanui	10,692	16.648	1.56
Onepoto	6,376	5.735	0.90

The discharge of sediment laden water to the stormwater network is managed to some degree by rules in the operative Regional Plans, the PNRP, conditions of resource consents, and the GWRC Erosion and Sediment Control Guidelines (2002).

8.2.2 Increased levels of toxic substances in the water column

Urban stormwater in the Wellington City area almost invariably contains high concentrations of zinc (Zn), and moderate concentrations of copper (Cu) and polycyclic aromatic hydrocarbons (PAH)[17]. This is because sources of tyres and galvanised iron (Zn), brake wear and vehicle wear (Cu), and combustion of fuel and leaked oil (PAH), are ubiquitous in urban areas. Urban stormwater may contain other toxic susbstances from point sources within the catchment (e.g., spills, disposal of chemicals, ammonia from sewage leaks), or from diffuse sources (e.g., spraying weeds with hebicides).

Concentrations of Cu and Zn in stormwater runoff can be high compared with both acute and chronic water quality guidelines and sediment concentrations exceeded guidelines at many Wellington stream locations[18]. A study of urban stream sites in Auckland, Wellington and Christchurch, reported a relationship between dissolved Cu and Zn concentrations and urban land cover[19]. Higher concentrations of dissoved metals are associated with a higher proportion of urban land use in the catchment. In that study 50% of urban sites in Wellington exceeded the ANZECC (2000) guideline for dissolved Cu (0.0014 g/m^3) and 57% exceeded the guideline for dissolved Zn (0.008 g/m^3).

The urban stream environments are probably toxic to some aquatic organisms through contaminant levels in both water and sediments[20]. However many sensitive organisms may have already been affected by flow, temperature, and habitat changes. The adverse effects of urbanisation can occur with as little as 10-20% impervious cover[21]. Typically the pollution sensitive taxa disappear (often EPT invertebrate taxa - mayflies, stoneflies & caddisflies) and the remaining invertebrate taxa is dominated by pollution tolerant taxa (e.g., snails, crustacea, worms, midge larvae). In virtually all studies reported in the review of Walsh, *et al*, (2005), sensitive species were either absent or less abundant in streams draining urban areas. The causitive agents include scouring, channel instability, suspended sediment, and/or toxic substances.

Many toxicants are associated with the particulate fraction in stormwater which is generally not retained in streams but rapidly flushed through the system into downstream receiving environments. These contaminants therefore pose a risk to aquatic ecosystems in depositional coastal environments such as the Porirua and Wellington Harbours. Copper and zinc are the

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[17] MWH, 2003; Williamson, 2003; KML, 2005; Milne and Watts, 2008
[18] KML, 2005; Milne and Watts, 2008
[19] Gadd, 2016
[20] Williamson *et al.* 2001
[21] Suren and Elliot, 2004

contaminants of ongoing concern in these environments, but neither are predicted to to increase rapidly[22].

8.2.3 Changes in the nutrient regime

Nutrients in stormwater, such as nitrogen and phosphorus compounds, can either increase or decrease as a result of urbanisation, depending on site specific factors. Forest and native bush have low nutrient yields, so urbanisation increases nutrient loss from the land. Where there is high production pasture which receives fertiliser inputs, urbanisation leads to a reduction in nutrient loads, whereas for low production pasture, urbanisation probably leads to little change.

Of 54 urban sites in Auckland, Wellington and Christchurch, none exceeded the NPSFM national bottom line for nitrate-N or ammoniacal-N[23].

8.2.4 Increase in floating and deposited litter

Litter and floatables that enter stormwater networks can negatively impact visual amenity and habitat quality in the aquatic environment. An unpublished WCC investigation into litter loads discharged from Wellington's Overseas Passenger Terminal culvert suggests that floatables are well controlled by baffled street sumps exposed to typical storm events, and do not result in significant visual or aesthetic effects in receiving waters.

Non floatable litter, such as cigarette butts and other organic material, can pass through street sumps and discharge to fresh water and the CMA. While this material is less likely to cause visual or aesthetic effects, benthic ecology surveys have reported high levels of organic matter in seabed sediments in the immediate vicinity of the large stormwater outfalls at the Overseas Passenger Terminal and Aotea Quay[24].

Street sumps in Hutt City, Upper Hutt City and Porirua are typically unbaffled and floatables are able to pass directly through to the discharge point.

8.2.5 Microbiological contamination of receiving waters

Wastewater can gain access to the stormwater system from:

- Wastewater pipes illegally connected to stormwater drains; and
- Wet weather WNO from wet wells in wastewater pump stations and from the constructed WNO structures built in strategic locations along the wastewater network.

Leaks from the wastewater system via faults or WNO in wet weather can enter streams or coastal waters via the stormwater system, potentially increasing the risk of infection for recreational users of those waters. Even in areas without wastewater leaks or WNO, the microbiological quality of stormwater tends to be poor because of faecal material derived from birds, cats, dogs, rats and other animals present in an urban environment. Pathogens are frequently detected in urban stormwater, but compared with sewage, the occurrence of enteric pathogens is low[25].

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[22] Diffuse Sources Ltd, 2014
[23] Gadd, 2016
[24] Bolton-Ritchie, 2003
[25] Williamson, 1993

Moderate levels of pathogenic organisms that do not require ingestion to infect are also found. For contact recreation areas affected by stormwater runoff, there is an increased risk of skin, eye and ear infections.

As a result of the stormwater discharge permits to the CMA that WCC hold, information is available on the WCC catchments about the annual frequency and volumes of WNO events in WCC catchments. This data is available in Table L-1 of the EER. The most significant constructed WNO is located at Murphy Street and is discharged via the Davis Street culvert. The recorded average annual overflow volume is approximately 6000m^3.

The most significant WNO in the Hutt catchment is a consented discharge from the Silverstream Storm Tank which overflows to the river several times each year during periods of sustained wet weather when the capacity of the storage tank is exceeded (at which time the river is usually in flood).

There is no comprehensive WNO data available for the HCC, UHCC and PCC catchments. However, WWL is working to remedy this and will be investigating WNO for Porirua and the Hutt Valley through a separate process.

Coastal water and freshwater courses identified in the EER as being significantly affected by WNO, faults or leaks are:

- Plimmerton Beach (south);
- Porirua and Kenepuru Streams;
- Browns Bay Stream;
- Titahi Bay South Access Stream;
- Titahi Bay (south);
- Karori Stream;
- Owhiro Bay;
- Island Bay; and
- Hutt River at Melling.

The ongoing discharge of stormwater from the local authority networks affects the microbiological water quality of the ultimate receiving environments of the CMA, particularly when affected by WNO, faults or leaks in the wastewater network. Ideally these overflows, faults or leaks would not occur, or would be treated prior to reaching the CMA or waterways. However, in reality it is not possible to completely remedy the effects of WNO given that the purpose of the constructed overflow is to remedy the public health effects of the wastewater infrastructure becoming overloaded.

Occasional exceedances of the national microbiological water quality guidelines occur at many bathing beaches but these exceedances mostly coincide with rainfall events. The exceedances are likely the result of wet weather wastewater flows exceeding the capacity of the wastewater network, subsequent overflow to the stormwater network, and runoff from urban catchments (which includes animal wastes and decayed seaweed).

Overall, there is a plausible risk for infection because of the possibility of leaked wastewater into the stormwater system. However, there is little epidemiological evidence to support the idea of infection from urban stormwater alone[26].

These effects are considered to be temporary and acceptable provided the mitigation measures identified in section 8.10 are implemented. The potential adverse effects from stormwater discharges will be temporary, with most WNO occurring during high rainfall events.

8.3 Effects on ecology

Stormwater discharges to fresh and coastal waters can affect the health of the aquatic ecosystems in a variety of ways. Principally these impacts include decreasing water quality and, in low energy receiving environments such as estuaries and harbours, the deposition of sediments and associated contaminants in benthic habitats.

8.3.1 Aquatic ecosystems

The water quality effects of stormwater discharges described in section 8.2, particularly reduced water clarity, altered nutrient regime and elevated concentrations of copper and zinc, can directly affect the health of aquatic ecosystems. These analytes are monitored in many rivers and streams by GWRC's River State of the Environment (SoE) Monitoring Programme. A review of the results of the River SoE monitoring and other monitoring has identified slight to moderate effects on aquatic ecosystem health in all stream catchments that have more than 5% urban land-cover, and a loss of most sensitive macroinvertebrate taxa in stream catchments with more than 25% urban land-cover. It is recognised that the discharge of stormwater is one of many factors contributing to this effect.

Effects on aquatic ecology also arise from alterations to the flow regime within stormwater conduits which tend to increase the volume of peak flows in wet weather events and run dry during dry conditions.

A fundamental characteristic of urban catchments is their high proportion of impervious surfaces. Almost all impervious urban structures, such as roads, car-parks, buildings, transport depots and railways reduce the area where rainwater can infiltrate into the soil (Suren, 2000). Runoff rates from these surfaces are very high, far higher than from vegetated surfaces. This results in the stream having a much higher and faster response to rainfall events than non-urban catchments. It also results in less rainfall infiltration into the ground as a result of high runoff rates, and loss of groundwater recharge for many small streams, some of which occasionally dry up.

There are a number of potential consequences from the change in flow regime. Frequent scouring from higher flows in urban streams may result in the complete loss of some in-stream animal species. In an American study, Schueler, *et al*. (1999) suggested that deleterious effects of high stormwater runoff can occur in catchments with as little as 15% of their area in impervious material. Stream bank erosion is accelerated in newly urbanised areas as the stream morphology finds its equilibrium under a new (higher) flow regime, and habitat is lost because of longer periods of lower base flows.

Elevated stormwater run-off temperatures may also affect aquatic ecology.

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[26] Williamson *et al*, 2001

An acute effect on freshwater benthic ecology is defined by a Macroinvertebrate Community Index (MCI) score of less than 80, taking a three year average. Those catchments that have the presence of such acute effects on freshwater benthic ecology are identified in Table 1-1 of the draft SMP.

Overall, the understanding of aquatic ecology effects in some catchments (such as Owhiro Stream Korokoro Stream, Hutt-Speedy's), is limited. Therefore monitoring has been proposed to improve this knowledge, better quantify the nature and scale of effects that stormwater discharges may be having in these areas, and identify where the key sources of contaminants are. This will lead to the long-term enhancement of aquatic habitats and communities in receiving environments with the development of the SMS.

8.3.2 Sediment quality and benthic habitats in low energy receiving environments

Many contaminants associated with the particulate fraction in stormwater are generally not retained in streams but rapidly flushed through the system into downstream receiving environments. These contaminants therefore pose a risk to aquatic ecosystems in depositional coastal environments such as the Porirua and Wellington Harbours. Copper and Zinc are the contaminants of ongoing concern in these environments[27]

Sediment in Wellington Harbour is mostly muds and silts. The chemical contamination and ecological effects on the receiving environment have been assessed close to outfalls in Lambton Harbour and Evans Bay. Very high levels of heavy metals Zinc, Lead, and Copper have been found within 50m of these outfalls (Bolton-Ritchie, 2003; MWH, 2008). The relatively sheltered harbour allows disposition of discharged contaminants and dispersal processes (such as propeller disturbance and wave action around the wharves) are sufficiently slow to allow high levels to remain near the outfalls[28].

High concentrations of PAH and total petroleum hydrocarbons found close to Miramar Wharf may have been partly due to runoff or groundwater contamination from the former gasworks. High levels of PAH have also been attributed to the historical use of coal tar (a by-product of gasworks) for roading adhesive[29]. As this material became abraded by road use, it could also have been carried by stormwater to the bay. Spillage of petroleum products, perhaps associated with port activities, is also a potential issue[30].

GWRC's Wellington Harbour marine sediment quality investigations conducted in 2006 and 2011 found DDT, high molecular weight PAH, Pb, Hg, Cu and Zn all exceeded sediment quality guidelines in Lambton Harbour[31]. DDT, PAH, Pb and Hg are not currently being discharged in sufficient quantities in urban stormwater to produce these levels of contamination[32]. This is thought to be legacy contamination carried by stormwater in the past. There may also have been other sources such as industrial discharges (before connection to the sanitary system), spillage during port loading/off-loading, and leaching of heavy metals from antifouling paints and treated

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[27] .Diffuse Sources Ltd, 2014
[28] Diffuse Sources Ltd, 2014
[29] Ahrens *et al.* 2007; Depree, 2010
[30] Ahrens *et al*. 2007
[31] Stephenson *et al.* 2008; Oliver, 2014
[32] Diffuse Sources Ltd, 2014

timber. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly[33].

Ecological monitoring conducted in Wellington Harbour has shown that benthic communities near the wharves can be strongly disturbed. Further afield but within 4km of the wharves and quay, stormwater related effects are still evident but are classified as slight[34]. Small or no effects are only found out towards the middle of Wellington Harbour at considerable distances (4-6km) from Lambton Harbour.

For Porirua Harbour, the subtidal basins in each arm of the harbour are classified as being dominated by fine muds and providing a 'sink' in which contaminants accumulate[35]. To date GWRC has conducted four subtidal sediment quality monitoring surveys, in 2004, 2005, 2008 and 2010. In relation to the 2010 survey, concentrations of total Cu, Pb and Zn exceed 'early warning' sediment quality guidelines (i.e.ARC ERC or ANZRCC ISQG-Low) in subtidal sediments of the Onepoto Inlet. Mercury concentrations are approaching guideline levels but otherwise, along with the other five metals analysed, are below guideline levels in Onepoto Inlet. TOC-normalised total DDT and Dieldrin exceeded the ANZECC ISQG-Low trigger values at all sites. The general trend across the five sites over the last four surveys has been for Zn concentrations to increase steadily, for Pb concentrations to decrease and for Cu concentrations to be variable, showing both increases and decreases[36].

In relation to the Porirua Harbour studies "*there is currently no clear evidence that any of the subtidal sediment contamination has resulted in significant adverse effects on invertebrate communities, however, the combination of heavy metals, mud and organic carbon content at some sites, is linked with less diverse community structure. Adverse effects may eventuate as long as stormwater discharges continue in their present form and contaminants continue to accumulate in the harbour sediments*"[37].

Inevitably stormwater discharges which contribute to the contaminant load will affect sediment quality and contribute to reduced species diversity within benthic communities. The primary mitigation measure recommended in section 8.10 is a sediment quality and benthic ecology survey in the Wellington and Porirua harbours. This survey will enable the applicant to further assess the impacts of stormwater on sediment quality and benthic ecology. This will inform how to address (mitigate) stormwater contaminants on sediment quality and benthic habitat long-term by the development of the Stage Two SMS.

8.4 Effects on shellfish gathering and mahinga kai

Mahinga kai is the customary gathering of food and natural materials. It includes the food and resources themselves and the places where those resources are gathered. Monitoring the effects of stormwater discharges reflects the need to protect the diversity and abundance of species necessary for the cultural well-being of tangata whenua. Monitoring also recognises the need to safeguard the ability of tangata whenua to gather and use these resources, thus enabling the transference of cultural values and practices between generations.

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[33] Ibid
[34] Kelly, 2010
[35] Oliver, 2016
[36] Oliver and Conwell, 2014
[37] Ibid

Sites in Schedule C of the PNRP recognised as having mahinga kai values to Ngāti Toa Rangatira and Taranaki Whanui are listed in Table 15 below.

Table 15: Sites with mahinga kai values identified within Schedule C

Ngāti Toa Rangatira	Taranaki Whānui kit e Upoko o te Ika a Maui
Hue tē Taka (Wellington South Coast)	Hikoikoi and Pito-one pā (Petone foreshore)
Pauatahanui Reserve, within the Pauatahanui Inlet	Hue tē Taka (Wellington South Coast)
Takapuwhāhia, Te Punga o Matahoaua, Whititanga in the Te Awarua-o-Porirua Harbour	Korohiwa (East Harbour Coast)
Whitireia	Tapu te Ranga – Owhiro – Haewai
Tapu te Ranga – Owhiro – Haewai	Te Aro pā
Taupō Stream Mouth	Te Awa Kairanga/Hutt River – Maraenuku pā and Motutawa pā and the Hutt River mouth
	Te Korokoro o Te Mana (Korokoro Stream mouth)
	Te Raekaihau Point Reef
	Wainuiomata River mouth and foreshore
	Waiwhetu Stream – Owhiti pā

While the term mahinga kai is Māori, food gathering is relevant to all cultures. Regional Public Health (RPH) have noted that Pacific and Asian communities are also likely to gather shellfish.

While RPH educate and advise that no shellfish collection should occur adjacent to urban areas, local knowledge indicates that shellfish collection occurs none-the-less.

The limited shellfish monitoring undertaken to date by GWRC indicates that generally the sites monitored are compliant with the microbiological water quality levels for shellfish gathering, with the exception of the sites at the Porirua Harbour Rowing Club and Sorrento Bay during the 2015/16 summer months.

Results from other surveys have included:

- A GWRC survey of blue mussel quality in 2006:
  - Microbiological water quality was found to be fully compliant for shellfish gathering and consumption at Mahanga Bay[38].
  - There are low faecal coliform concentrations in shellfish at Mahanga and Scorching Bays, and at Pt. Dorset. Concentrations of heavy metals (Cd, Cr, Cu, Pb, Hg, Ni, and Zn) were all relatively low in mussels collected from these east coast locations compared to inner

[38] Morar and Greenfield, 2016

harbour sites. None of the metal concentrations exceeded the national food standards for edible tissue, where standards exist[39].

- Infaunal sampling conducted at Petone Beach in 2004 concluded that infauna was dominated by bivalve shellfish (pipi) and numerous polchaete worms[40].
- An intertidal zone ecological assessment undertaken by EOS Ecology[41] in August 2016 for a proposed seawall and shared path in the Eastern Bays. Mahinga kai invertebrate species recorded during the epifauna survey included blue mussels, greenshell mussels, pipis, black mussels and cockles. Some remains of the rock oyster were found on rocks and small empty paua shells but no live animals were found. Discarded remains of marine food species were also found, including kina, paua, greenshell mussels, cockles, catseye, turban shell and scallops. The majority of these species were found in the sub-tidal zone.

The ability of people to gather food and natural materials from the predominantly coastal environments is directly related to water quality in these environments. The mitigation measures identified in section 8.10 will assist with mitigating any potential adverse effects on mahinga kai.

It is important to note that monitoring of shellfish, seaweed tissue and other biota sensitive to faecal and chemical contaminations in recreationally fished species is not proposed by WWL due to the high costs and lack of national guidelines for assessing the ecological relevance of contaminant concentrations in biota. The variation between species, mobility of fish species, and their susceptibility to contaminants vary, making results from monitoring inconclusive.

8.5 Effects on human health and contact recreation

The high recreational values associated with the CMA adjacent to Porirua, Hutt City, and Wellington City are reflected in the PNRP.

Contact recreational activities within the scope of this application range from coastal beach based water sports such as surfing, kayaking, surf lifesaving, boating and swimming. Coastal waters along the southern and western coasts also provide for diving and fishing. Recreational activities such as swimming, surfing and boating can be compromised if water quality is below national standards.

The Porirua and Wellington harbours are frequently used by people fishing, sea kayaking and sailing. Wind surfers and surfers utilise Wellington's southern coast areas such as Lyall Bay. There are also a number of boat clubs and tourism operators that make use of the Wellington and Porirua harbours for recreational activities, including sea kayaking tours, waka ama, and paddle boarding.

Shellfish gathering, rock fishing, and spear fishing also occur at various locations.

Contact recreation in the receiving environments is not limited to the summer months. Many people use the near-shore coastal waters such as Oriental Bay and Scorching Bay year-round to train for swim events.

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[39] Milne, 2006
[40] Stevens, et al, 2004
[41] EOS Ecology. 2016.

The greatest potential for acute effects on contact recreation and human health is microbiological contamination from untreated wastewater discharges, and faecal material (from birds, cats, dogs, rats and other animals present in an urban environment).

When people are exposed to contaminated stormwater through recreational contact, it provides a pathway for people to contract a range of illnesses including gastroenteritis, eye, ear and skin infections, and respiratory infections. Contaminated shellfish collected from around stormwater outfalls and culverts can also potentially affect human health if they are consumed as pathogenic micro-organisms accumulated by shellfish are only slowly purged.

Adverse effects on the quality of recreational waters is most pronounced during and after heavy rain events when contaminants are flushed into water (in part via the stormwater network) and the wastewater system is more likely to be overloaded.

The National Policy Statement for Freshwater Management (NPSFM) provides a primary and secondary contact values for *E.coli* bacteria counts. The primary contact recreation value is optional however the secondary contact value is compulsory for all fresh water.

In June 2016, NIWA[42] published a report that focused on the state of and trends in water quality of urban streams to assist in national environmental reporting. Data were sought from three Councils with urban areas: Auckland Council, GWRC and Christchurch City Council. Water quality data were compiled for six variables: dissolved copper, dissolved zinc, nitrate-N, ammoniacal-N, dissolved reactive phosphorus (DRP) and E. coli. This research indicated that 43% of urban sites in Wellington exceeded the NPSFM national bottom line for E.coli. (annual median less than 1,000 cfu/100 ml)[43]. In some but not all cases microbiological contaminants delivered via the stormwater network have contributed to these poor results.

Five catchments are classified as 'poor' with in regard to contact recreation in coastal areas (Owhiro Bay, Island Bay, Plimmerton South, Porirua Rowing Club and Porirua Coast). This is defined as five year 95% *Enterococci* value greater than 500cfu/100mL in coastal waters.

A number of waterbodies are considered 'poor' with regard to freshwater contact recreation (Karori Stream, Ngauranga Stream, Hutt-Stokes Valley, Duck Creek/Browns Bay Stream, Porirua/Kenepuru streams, Titahi Bay South Access Stream, Hutt River at Melling and Wainuiomata River at Richard Prouse Park). This is defined as an annual median *E.coli* value less than 1,000 cfu/100ml. This definition coincides with the bottom line for secondary contact recreation for fresh water streams, as specified in the NPSFM.

The River SoE and coastal bathing beaches monitoring undertaken by GWRC suggests that recreation values are not currently being compromised by stormwater discharges, except immediately after a sustained wet weather event.

The adverse effects on human health and contact recreation associated with the discharge of stormwater can be appropriately managed by:

- Monitoring and management of acute effects on human health detected during monitoring;

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[42] Gadd, 2016
[43] Ibid

- Notifying key organisations as soon as is practicable following a wastewater discharge;
- Ongoing coastal bathing beach, River SOE and microbiological monitoring; and
- Providing education on shellfish gathering.

The potential adverse effects on contact recreation and human health associated with the continued discharge of stormwater are considered to be acceptable provided that coastal bathing beach, River SoE and microbiological monitoring programmes continue, so that WWL can utilise monitoring data to understand where acute effects are occurring.

8.6 Effects on visual, aesthetic, and amenity values

The discharge of stormwater to surface waterbodies, land, and the coastal environment has the potential to affect visual, aesthetic and amenity values.

Generally, stormwater discharges do not generate offensive odours unless wastewater contamination occurs. Other than occasional reports of odour in the Houghton Bay and Miramar outfalls, odour is not identified as a significant issue with stormwater discharges.

WWL will be managing and mitigating acute effects on human health during monitoring (which is intrinsically linked to water quality). Therefore adverse effects on existing amenity values are not anticipated as a direct result of the continued discharge of stormwater.

8.7 Effects on Māori customary use

Mana whenua have identified waterbodies of particular importance at both a catchment scale (Ngā Taonga Nui a Kiwa) and a site specific level (sites of significance). These sites are listed in Schedule B and Schedule C of the PNRP, respectively, and provide an insight into the values that mana whenua wish to protect.

Māori customary use is the interaction of Māori with fresh and coastal water for cultural purposes. This includes the cultural and spiritual relationship with water expressed through Māori practices, recreation and the harvest of natural materials.

The PNRP identifies Māori values at different scales. Mauri, often described as the intrinsic and regenerative life force inherent in everything, is an example of a primary value shared by all Māori of the region. The Mauri of fresh water, in particular, is regarded by mana whenua as the basis for all wellbeing. At a regional scale, the PNRP identifies Mauri as a principle and overarching objective by requiring that the mauri of all fresh and coastal water is maintained and improved.

Traditional uses of native plants and animals are important to maintain Maori culture and identity. Mahinga mataitati is explained in the PNRP as a customary seafood gathering site. Therefore with regard to stormwater discharges and Māori customary use, this is considered a particularly relevant value to consider. Of the sites identified in Schedule C of the PNRP, the following are listed as having mahinga mataitai value: Motukaraka (Pauatahanui Inlet), Takapuwhāhia, Te Punga o Matahoaua, Whititanga in Te Awarua-o-Porirua Harbour and Whitireia, all of which are in the Porirua area. This highlights the importance of considering effects of stormwater discharges in a cultural context.

These values are regarded by Māori as important indicators of the health or mauri of the natural world, and the PNRP supports the identification, measurement and protection of these values. The sites of significance to Maori relevant to this application have been identified in section 5.4 and Appendix E.

The significance of discharges on Māori customary use and their values is that contamination or degradation of water quality has the effect of diminishing the Mauri or life force of receiving waters. As recognised within the objectives and policies of the PNRP, a link exists from the mountains to the sea – ki uta ki tai.

Māori use waterways for customary purposes, including recreation, as well as for spiritual and cultural practices that rely on water quality. It is recognised that the relationship of Māori with water relates to concepts of kaitiakitanga and protecting Mauri, concepts which can be difficult to translate into western frameworks.

Consultation with the Wellington Tenths Trust, PNBST and Ngāti Toa has been undertaken to gain an understanding of their concerns with stormwater discharges. The key concerns expressed through consultation are outlined in section 11 of this report and primarily relate to:

- Water quality (microbiological and aesthetics such as visual amenity);
- Flooding;
- Fish species abundance; and
- Impacts on coastal environments for shellfish gathering and Māori customary use.

Iwi are naturally the best source of information with regards to customary use. During the consultation to date, iwi are continuing the development of cultural health indicators, but this has not progressed to a level where these have been shared with WWL at consultation meetings.

As part of the discussions held with iwi, WWL discussed the potential for the development of a Cultural Health Monitoring Plan in collaboration with iwi, which was received positively by iwi. After further consideration of this approach, WWL consider that the development of a specific Cultural Health Monitoring Plan to monitor the effects of stormwater discharges is just one narrow aspect of cultural health monitoring. Instead, WWL consider that GWRC's current development of the Regional Kaitiaki Monitoring Framework (RKMF) is a more appropriate process to provide a regional approach for monitoring cultural health. Further, this will avoid the duplication in efforts from iwi, GWRC and other key stakeholders to develop the framework and undertake cultural health monitoring. Efficiencies can be gained for developing the RKMF as WWL is committed to providing or engaging suitably qualified and experienced personnel to:

- Attend meetings or other forums;
- Provide information to the Wellington Regional Council;
- Review documentation; and
- Contribute to any other relevant matter.

Such activities are proposed to be discussed and agreed in writing with GWRC prior to the commencement of such activities. A proposed consent condition requiring WWL to contribute to the development of the RKMF is provided in section 13 of this report.

By working with iwi and GWRC to further develop the RKMF that is acceptable to iwi, WWL will be a step closer towards mitigating the effects of the stormwater discharges and improving the Mauri of water in the receiving environments, as there will be an overarching regional framework in place for cultural health monitoring to occur.

8.8 Effects on the values of areas with identified in Schedules A, C and F of the PNRP

The values of the areas identified in Schedules A, C and F of the PNRP have been identified in section 5.4 and will invariably be affected by stormwater discharges. A specific assessment on each area in these Schedules has not been undertaken. The primary reasons for this are:

- The current available information and monitoring data is highly variable and does not easily align with the scheduled areas;
- Significant analysis was not achievable within the time constraints of preparing this consent application to assess the data and align with the scheduled areas;
- Proposed monitoring and modelling over the next five years will enable knowledge gaps to be filled in and correlated with the scheduled areas. An assessment of effects on scheduled areas in conjunction with mapping is expected to form part of the Stage Two global consent application and SMS.

8.9 Positive effects

GWRC has recognised (through the requirement for local authorities to obtain a resource consent for stormwater network discharges), the need for a long term commitment to implementing mitigation measures across proposed and existing urban environments. This is sought to address any adverse quality and quantity effects from unmitigated stormwater discharges.

The most obvious positive effect associated with stormwater discharges is that it allows stormwater to be conveyed to a location where it does not cause a flooding hazard. The high percentage of impermeable surfaces in urban areas reduces the capacity for infiltration. Runoff is concentrated in low lying areas potentially causing damage to property and a safety risk.

By discharging stormwater to the CMA, flood hazards can be reduced to provide a level of certainty that allows the inhabitants of Poriura, Upper Hutt, Hutt City and Wellington City to invest in their economic and social wellbeing, as well as providing health and safety benefits. In addition to the reduced risk of damp buildings and high velocity flows, conveying stormwater away from these low lying areas also reduces the potential health risks associated with bodies of standing water that may contain contaminants.

Monitoring stormwater network discharges in accordance with a SMP will aim to identify acute and significant adverse effects of stormwater to develop long-term management strategies in the Stage Two SMS.

Enabling the continued discharge of stormwater and the proposed monitoring and modelling of it, will increase the knowledge base and contribute positively to improving stormwater discharges in the long-term by the development of a SMS. This will ensure any long-term management measures implemented are cost effective and address real rather than perceived issues, making it affordable to the community and WWL's client councils.

The positive effect of implementing stormwater mitigation will primarily be evident in the natural environment. The improved health of surface waterways and the coastal environment will also serve to improve the cultural, amenity and recreation values for local residents.

8.10 Proposed mitigation

An overview of the mitigation measures for each of the effects discussed in sections 8.2 – 8.8 above is provided below in Table 16 and Table 17 below.

Table 16 identifies the proposed mitigation measures for this Stage One consent application, being within the matters of control specified in Rule R50. Table 17 identifies the measures that WWL are already undertaking as part of their 'business as usual' approach to mitigating and managing the effects of stormwater discharges. These measures are not identified as matters of control under Rule R50.

The primary mitigation measure WWL will undertake within the Rule R50 matters of control is the proposed monitoring and modelling programme identified in the draft SMP to identify any adverse quality and quantity effects from stormwater discharges. The proposed monitoring programme covers microbiological, ecological, sediment and benthic ecology monitoring and modelling (refer to section 9 of this report and the draft SMP for full details). This monitoring and modelling will be supplemented by field observations as well as complaints from members of the public regarding obvious visual pollution or activities likely to lead to pollution of stormwater and receiving waters. Responses to incidents and spills or complaints are standard procedures WWL currently undertake on behalf of its client councils. Investigations to identify stormwater contaminant sources will be tailored according to the likely pollution source.

WWL will report the results of stormwater monitoring undertaken in accordance with the SMP annually, **by 1 September for the reporting period of 1 July to 30 June**. A proposed consent condition in section 13 identifies the requirements for an Annual Report and what it should include. The Annual Report is proposed to be circulated electronically to the SWP.

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Table 16: Proposed measures WWL will undertake to mitigate the effects of stormwater discharges (within the matters of control of Rule R50)

Proposed mitigation measure	Effects on:							
	Water Quality			*Aquatic ecosystem health*	*Sediment quality and benthic habitats in low energy receiving environments*	*Human health, contact recreation and mahinga kai*	*Visual, aesthetic and amenity values*	*Māori customary use*
	Faecal pollution of stormwater	*Wastewater network overflows to stormwater*	*Non-faecal stormwater contamination*					
Management actions								
Management of acute effects on human health detected during monitoring in accordance with the framework as detailed in section 9.6	✓	✓				✓	✓	✓
Utilisation of existing monitoring								
GWRC River State of Environment Monitoring	✓	✓		✓	✓	✓	✓	✓
GWRC coastal recreation bathing beaches monitoring programme	✓	✓				✓	✓	
WCC monitoring of major stormwater culverts in 20 locations	✓	✓		✓	✓	✓	✓	✓
PCC monitoring of major stormwater culverts in nine locations	✓	✓		✓	✓	✓	✓	✓
Proposed monitoring								
New temporary River State of Environment sites at Owhiro Stream, Stokes Valley Stream, Hulls Creek (Silverstream), Black Creek (Wainuiomata) and Taupo Stream (Plimmerton)	✓	✓		✓	✓	✓	✓	✓
Undertake or contribute to one marine sediment quality and benthic ecology survey in Wellington and Porirua Harbours	✓	✓		✓	✓	✓		✓
Monthly microbiological sampling from new major stormwater culverts in UHCC and HCC catchments, testing for E.Coli and Enterococci	✓	✓		✓	✓	✓	✓	✓
Visual monitoring and recording of field observations at time of grab water samples	✓		✓	✓		✓	✓	
Storm event monitoring including the establishment of autosamplers in three locations	✓	✓		✓	✓	✓	✓	✓

Aquatic ecology monitoring at the five temporary River State of Environment sites				✓	✓			✓
Contributing to the development of the Regional Kaitiaki Monitoring Framework by providing or engaging suitably qualified and experienced personnel to attend meetings/other forums, provide information to the GWRC, review documentation, and contribute to any other relevant matter in agreement between WWL and GWRC						✓		✓
Establish a Stormwater Working Party with representatives from key organisations to advise on monitoring results, remedial actions and develop the Stage Two SMS	✓	✓	✓	✓	✓	✓	✓	✓
Proposed modelling								
Contaminant load, water quality and sediment quality modelling	✓	✓	✓	✓	✓	✓	✓	✓

Table 17: Measures WWL will undertake to mitigate and manage the effects of stormwater discharges (not within the matters of control of Rule R50)

Measure	**Effects on:**							
	Water Quality							
	Faecal pollution of stormwater	*Wastewater network overflows to stormwater*	*Non-faecal stormwater contamination*	*Aquatic ecosystem health*	*Sediment quality and benthic habitats in low energy receiving environments*	*Human health, contact recreation and mahinga kai*	*Visual, aesthetic and amenity values*	*Māori customary use*
Routine and scheduled maintenance, as detailed in section 4.6 and in accordance with WWL Asset Management Plans	✓	✓	✓	✓	✓	✓	✓	✓
Repairing, renewing and upgrading the wastewater and stormwater networks where pollution causing faults are identified or to provide additional capacity to the network	✓	✓	✓	✓	✓	✓	✓	✓
Conducting cross connection surveys of the properties in the catchment and remedying any faults found	✓	✓		✓	✓	✓	✓	✓

Pump station works, including control and monitoring equipment upgrades and overflow reduction;	✓	✓		✓	✓	✓	✓	✓
Sealing off some of the constructed overflows between the wastewater and stormwater networks;	✓	✓		✓	✓	✓	✓	✓
Preparing resource consent applications under Rule R61 of the PNRP for Porirua and Hutt Valley wastewater overflows.	✓	✓		✓	✓	✓	✓	✓
Timely response to complaints, following the process as detailed in section 4.7 and Figure 3	✓	✓	✓	✓	✓	✓	✓	✓
Response to wastewater overflow incidents as detailed in section 4.7	✓	✓		✓	✓	✓	✓	✓
Pollution source investigations	✓	✓	✓	✓	✓	✓	✓	✓

8.11 Summary of effects and proposed mitigation

The discharge of stormwater has the potential to create acute and longer term adverse effects on water quality, ecology, human health, contact recreation, amenity, mahinga kai, and Māori customary use. This is predominantly because of contaminants entrained in stormwater. Whilst these contaminant inputs can be managed to some degree, further monitoring is required to continue to understand the sources of contaminants and other contributing factors. The impacts of stormwater discharges are currently not fully understood in all areas due to:

- Major knowledge gaps;
- The variation in available information for all catchments; and
- No strong indication that stormwater discharges in isolation are the sole cause of the effect or whether there are other sources of pollution or natural variations in the environment.

Overall:

- WWL seek to manage the stormwater network during the term of this consent that is respectful of the environment, including investment in maintenance and upgrade of the wastewater and stormwater networks.
- As part of this Stage One consent, the main mitigation measures WWL propose are:
  - Undertaking a monitoring and modelling programme to identify where stormwater discharges are having adverse environmental effects on the receiving environments, utilising existing monitoring programmes and new monitoring/modelling as per Table 16 above;
  - Establishing a Stormwater Working Party with representatives from key organisations to advise on monitoring results, remedial actions and develop the Stage Two SMS; and
  - Managing and mitigating the acute effects on human health detected during monitoring in accordance with the framework identified in section 9.6;
- Cultural values have been taken into account through consultation with Ngāti Toa, PNBST and the Wellington Tenths Trust. WWL is committed to contributing to the development of the RKMF by providing or engaging appropriately qualified and experienced personnel to attend meetings, reviewing documentation, providing any information WWL holds that GWRC may require, and contributing to any other relevant matter. The scope of the activities that WWL will undertake is proposed to be agreed with GWRC prior to the commencement of such activities.
- Proposed consent conditions are set out in section 13 which identify the proposed monitoring and further investigations, reporting and management measures to mitigate acute effects on human health detected during monitoring of this existing activity.
- Stormwater networks continue to make a positive contribution to the social and economic well-being of the community, as 'regionally significant infrastructure' for the Wellington region.

9 Proposed Stormwater Monitoring Programme and Investigations

9.1 Developing the Stormwater Monitoring Plan

A draft SMP has been developed following a collaborative process with the TRG and sub-group. This has resulted in a robust recommended monitoring and modelling programme to be undertaken over the term of the consent.

The process undertaken to develop the SMP is summarised in Figure 8 below.

Figure 8: Stormwater Monitoring Plan development framework

It is important to note that the SMP provided with this consent application is a draft as the recommended monitoring and modelling programme relies on a number of existing GWRC, WCC and PCC monitoring sites to continue being monitored. Should any of the sites WWL wish to utilise for monitoring data change, further discussions between WWL and GWRC is required regarding monitoring site selection.

A consent condition is proposed (refer to section 14 of this report) requiring WWL to submit a final SMP to GWRC for approval. The main reason for the six month timeframe is to allow for GWRC's review of the River SoE monitoring programme and sites and the WWL/GWRC discussions regarding rationalising/making existing monitoring more efficient.

9.2 Purpose of monitoring under this consent

Monitoring involves the collection of information (quantitative and qualitative) related to stormwater within the stormwater network and in the receiving environments.

The main purpose of monitoring during the Stage One consent is to identify the adverse quality and quantity effects of discharges from the stormwater network on:

- Aquatic ecosystem health;
- Mahinga kai;
- Contact recreation;
- Maori customary use; and
- Outstanding or significant values identified in Schedule A, C and F.

This will enable WWL to develop a prioritised programme for improving areas within the stormwater network that will form the basis of a SMS.

9.3 Monitoring objectives

Monitoring provides a system for further investigation and/or remedial works to take place to ensure that all reasonable and practicable steps are being taken to work towards achievement of the monitoring objectives.

The monitoring objectives identified in the draft SMP are:

1. To undertake focused, cost effective and efficient monitoring and modelling of stormwater quality, stormwater flows and contaminant loads.
2. To continuously improve confidence in stormwater data, and to facilitate the modelling of contaminant accumulation in depositional environments;
3. To monitor ecosystem health, using suitable indicators in order to assess the effects of stormwater discharges on the freshwater and coastal receiving environments;
4. To identify catchments, contaminant sources and stormwater discharges of priority concern;
5. To identify any acute effects of stormwater on human health detected during monitoring in order to better manage activities contributing to these acute effects;
6. To undertake targeted investigations and performance monitoring in order to better manage activities contributing to these acute effects; and
7. To share stormwater discharge monitoring data with other agencies to provide a sound understanding of the effects of discharges from the stormwater network.

9.4 Proposed Monitoring and Investigations

The proposed monitoring, modelling and mitigation actions are summarised in Table 1-1 of the draft SMP and set out in more detail in sections 4 – 6 of the draft SMP. For the reasons described in section 9.1 above, final sampling locations and details will be confirmed in consultation with GWRC within six months of the grant of consent.

In summary, the monitoring and modelling WWL propose to undertake is identified in Table 18 below.

Table 18: Summary of proposed monitoring and modelling under this consent

Type of monitoring or modelling	Description

Routine microbiological monitoring	• Undertake grab samples on a monthly basis from major stormwater culverts being:
	  ○ 20 existing WCC locations specified by WGN090219
	  ○ Nine existing PCC locations routinely monitored
	  ○ New HCC and UHCC sampling locations identified in consultation with GWRC and confirmed in a final SMP
	• Test for E.coli (freshwater sites) or Enterococci (seawater or coastal sites)
	• Undertake field observations at time of sample collection

Storm event monitoring	• Use of automated stormwater quality and flow monitoring stations at a downstream location within each of the following catchments, but upstream of any tidal influence, targeting 10-12 storm events within 24 months:
	  ○ Lambton catchment – Waring Taylor culvert proposed
	  ○ Waiwhetu catchment – Gracefield, at or near Site 1A proposed
	  ○ Poriura – Porirua Stream or major culvert 9 proposed
	• Analytes to be tested will be:
	  ○ Suspended solids concentrate or total suspended solids
	  ○ pH and conductivity
	  ○ Total and dissolved copper, cadmium, chromium, lead, nickel and zinc
	  ○ E.coli
	  ○ Total nitrogen, total phosphorus, nitrate-N, ammoniacal-N and DRP

Contaminant load, water quality and sediment quality modelling	These models are being developed as part of the Porirua Whaitua process. WWL anticipates adopting a collaborative approach to enable a single modelling exercise which covers the Wellington Harbour/Hutt Valley areas as well. Details and recommendations of how this will be achieved will be provided in a final SMP.

River and stream monitoring	• Utilise GWRC's existing River SoE monitoring programme to assess ecosystem health and identify acute effects on human health.
	• Physico-chemical and microbiological analytes to be tested are dissolved oxygen, temperature, pH, conductivity, visual clarity, turbidity, suspended solids, faecal indicator bacteria, total organic carbon, and dissolved and total nutrients.
	• Monitor temporary River SoE sites monthly in five significant urban streams that receive discharges from stormwater networks:
	  ○ Owhiro Stream
	  ○ Stokes Valley Stream
	  ○ Hulls Creek (Silverstream),
	  ○ Black Creek (Wainuiomata), and

	○ Taupo Stream (Plimmerton). The standard suite of River SoE water quality monitoring analytes, plus copper and zinc, for a period no less than 24 months.
Freshwater recreational water quality microbiological monitoring	Utilise existing weekly freshwater recreational microbiological monitoring which includes weekly monitoring of indicator bacteria (E.coli) in accordance with Ministry for the Environment (MfE) and Ministry of Health (MoH) microbiological water quality guidelines for recreational areas.
Aquatic ecology monitoring	Assessment of the ecological condition of the temporary River SoE sites: • Monthly semi-quantitative assessments of macroinvertebrate communities and periphyton biomass during stable/low flows in summer or autumn; and • Annual habitat assessments during summer or autumn (at the time biological samples are collected). This assessment provides an indication of the condition of the physical habitat and its ability to support stream biota. It incorporates fine sediment cover, invertebrate habitat abundance and diversity, fish habitat abundance and diversity, hydraulic heterogeneity, bank stability, channel modification, and riparian buffer width, integrity and shade.
Coastal monitoring	• Utilise existing microbiological water quality monitoring of bathing beaches in the Wellington Harbour, Porirua Harbour and the southern and western coastline currently undertaken by contractors on behalf of GWRC and local authorities. • These sites are sampled weekly for 20 weeks between mid- November and the end of March. Observations of weather, the state of the tide and visual estimates of seaweed cover are also made at each site to assist with interpretation of the monitoring results. • Indicator bacteria is monitored in accordance with the microbiological water quality guidelines for recreational areas[44]

9.5 Reporting

WWL will report the results of monitoring and modelling undertaken in accordance with the SMP annually, **by 1 September for the reporting period of 1 July to 30 June**. A proposed consent condition in section 14 identifies the requirements for an Annual Report and what it should include. The Annual Report is proposed to be circulated electronically to a Stormwater Working Party.

9.6 Management of acute effects on human health detected during monitoring

Two 'trigger levels' of E.coli and Enterococci values have been developed to manage acute effects on human health detected during monitoring. The development of trigger levels has taken into account the PNRP freshwater secondary contact and NPSFM national 'bottom line' for secondary contact (annual median less than 1,000 cfu/100 ml), and the PNRP primary contact recreation criteria for coastal waters.

An acute effect on human health for the purpose of this consent is defined as:

[44] Ministry for the Environment and Ministry of Health, 2003

a) At any popular freshwater bathing site where the annual median E. coli value exceeds 1000 cfu/100ml; or

b) At any popular coastal bathing site where the five year 95 percentile Enterococci value exceeds 500 cfu/100m.

International epidemiological studies have shown that E. coli and Enterococci are more specific indicators of human health risk from recreational contact with fresh water and saline water than faecal coliforms.[45] Therefore concentrations of E.coli and Enterococci can be related to MfE/MoH guideline levels to provide an indication of human health risk (in the form of likely numbers of illnesses per number of recreational events).

It is however important to acknowledge that defining the actual risk to human health indicated by a particular count of E.coli or Enterococci is not possible. This is primarily because these micro-organisms are indicators of the pathogenicity of water and not direct measures of disease causing organisms.

In addition, the human response to pathogen concentrations and exposure varies from person to person and the relationship between risk and recreational events (e.g. swimmer numbers) is not necessarily a linear one. Hence the adoption of guidelines which define "acceptable" health risk limits is based upon international and New Zealand epidemiological studies of indicator pathogen relationships and average human responses.[46]

Based on the acute effect on human health triggers identified above, an assessment of existing monitoring data has been made against each catchment to determine whether an acute effect on human health in each catchment is present. These results are identified in Table 1-1 of the draft SMP.

A framework (refer to Figure 9 below) has been developed for WWL to manage the detection of acute effects on human health during monitoring. The purpose of the framework is to allow acute effects to be managed in a systematic and consistent manner that enables achievement of Policy P74 of the PNRP.

[45] Ministry for the Environment. 2009.
[46] Ibid.

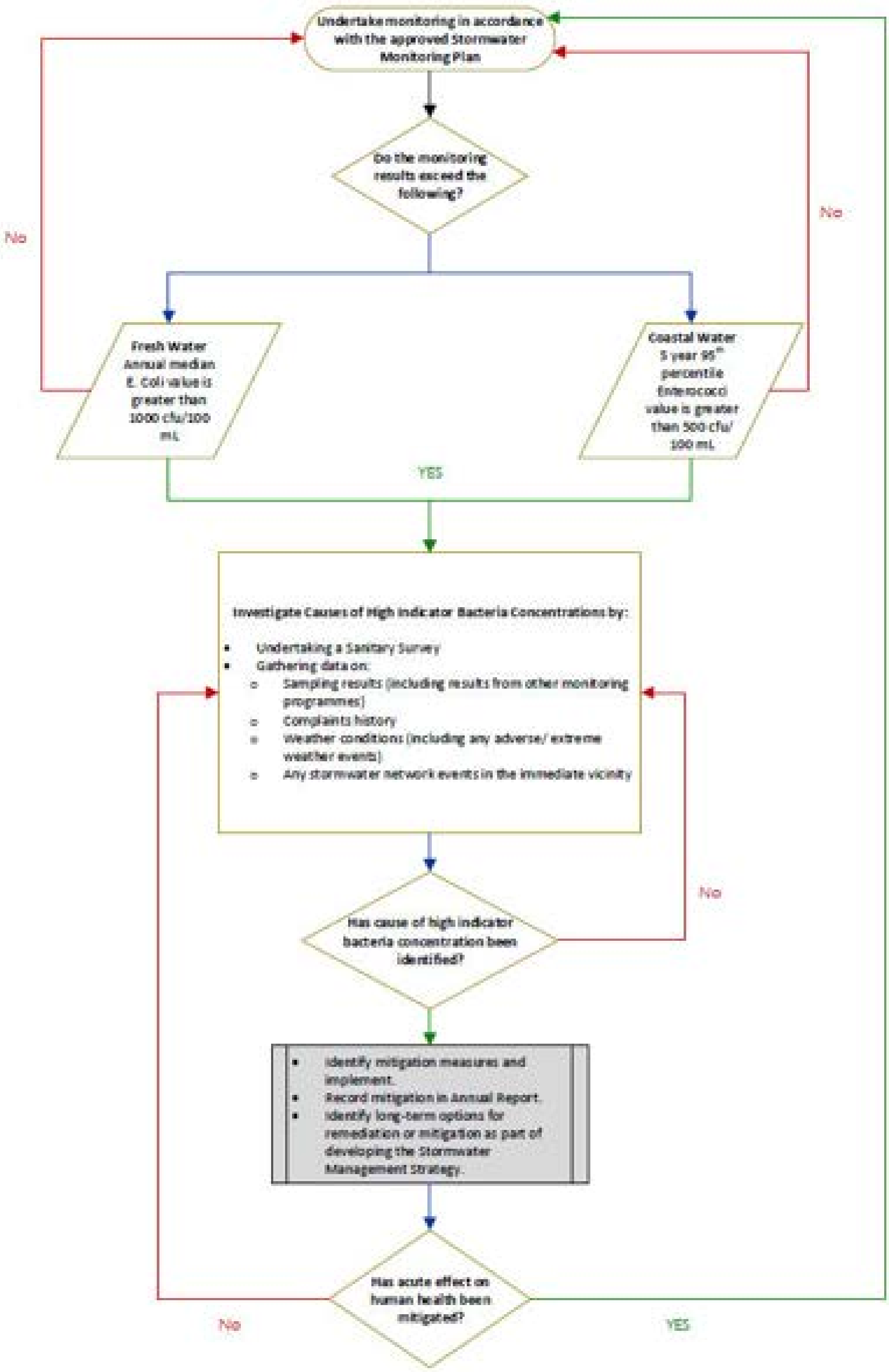

Figure 9: Management of acute effects on human health detected during monitoring

In addressing acute effects on human health, WWL (if E.coli and Enterococci trigger levels are exceeded), WWL will investigate causes of high bacteria indicator concentrations by:

- Undertaking a sanitary survey. Sanitary surveys include checking monitoring results, follow-up sampling if required, a visual inspection of the discharge (including lifting of manhole covers); and if required, closed circuit television monitoring. If necessary, this will be followed by the development of options for remedial works and their subsequent implementation;
- Gathering data on:
    - Sampling results (including results from other monitoring programmes);
    - Complaints history;
    - Weather conditions (including any adverse/ extreme weather events); and
    - Any stormwater or wastewater network events in the immediate vicinity;
- If the cause of high bacteria indicator concentration is identified, WWL will then:
    - Identify mitigation measures and implement;
    - Record mitigation measures or actions in the Annual Report; and
    - Identify long-term options for mitigation as part of developing the SMS.

10 Statutory Assessment

Pursuant to Section 104of the RMA, an assessment is provided against the relevant provisions of:

a) Part 2 and sections 104-107 of the RMA;

b) The Marine and Coastal Area (Takutai Moana) Act;

c) The New Zealand Coastal Policy Statement;

d) National Policy Statement for Freshwater Management;

e) Operative Wellington Regional Policy Statement;

f) Operative Regional Plans (Regional Coastal Plan, Regional Discharges to Land Plan , Regional Freshwater Plan); and

g) The Proposed Natural Resources Plan.

A detailed assessment of the relevant objectives and policies of the documents c) – g) is provided in Appendix G.

In summary, the planning documents generally enable the continued discharge of stormwater from urban areas as regionally significant infrastructure for communities, whilst seeking to avoid significant acute and adverse effects on the freshwater and coastal receiving environments.

10.1 Planning Framework

10.1.1 Part 2 of the RMA

In terms of Part 2 of the RMA the following provisions are considered to be relevant to this proposal.

Section 5 - Purpose

The purpose of the Act is to promote the sustainable management of natural and physical resources.

The proposed continued discharge of stormwater provides for the wellbeing of people and communities, while monitoring and mitigation measures will still ensure that the effects of stormwater discharges are avoided or mitigated.

The life-supporting capacity of water, soil and ecosystems can be safeguarded through the sustainable management of the discharges through the proposed monitoring, management of acute effects on human health, and WWL's responses to incidents/spill events. Therefore, it is considered that the proposal is consistent with the purpose of the Act.

Sections 6, 7 and 8

Section 6 sets out the matters of national importance in achieving the purpose of the RMA. The following section 6 provisions are relevant to this application:

> (a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development
>
> (e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga

Case law defines natural character as having two main components, one being natural elements (i.e. water) and the second being the experience of these elements. Stormwater discharges have the potential to impact on natural character by adversely effecting water and sediment quality, marine, benthic and freshwater ecology. This can also lead to the use of the receiving environments being degraded, particularly with regard to contact recreation, shellfish gathering and Maori customary use. The monitoring proposed in the draft SMP will enable WWL to identify acute and adverse effects and mitigate those acute effects on human health (which are intrinsically linked to natural character), as well as identify long-term options for managing stormwater discharges in a SMS to maintain or improve the natural character of the freshwater and coastal environment.

The relationship of Maori, their culture and traditions with ancestral lands, water, sites, waahi tapu, and other taonga has been recognised in this application through consultation with representatives of the Wellington Tenths Trust, PNBST and Ngāti Toa. More detail of this consultation is provided in section 11 of this report, including their key feedback.

Sites with significant mana whenua values have been recognised in this application. Efforts have been made to understand how cultural health monitoring can help to maintain and protect these values primarily through consultation with Ngāti Toa, the PNBST and the Wellington Tenths Trust. Iwi have responded positively to the progression of cultural health monitoring as a way of further developing their current progress of developing cultural health indicators. This expression of interest is directly relevant to WWL's proposed approach to contributing to the development the RKMF, to enable a consistent regional approach to cultural health monitoring.

WWL is committed to contributing to the development of the RKMF by providing personnel or engaging suitably qualified and experienced personnel to attend meetings/other forums, provide any information WWL holds to help GWRC, review documentation; and contribute to any other relevant matter. By enabling the RKMF to be further developed will enable cultural health indicators to be monitored during this Stage One consent, and contribute to the long-term management strategies to be developed in an SMS to mitigate any adverse effects on sites with significant mana whenua values. The cultural health monitoring of stormwater will help to preserve and improve the ability of mana whenua to retain their relationship with waterways, lakes, estuarine and coastline areas. It is considered that the relevant matters of Section 6 have been recognised and provided for.

Section 7 sets out other matters which GWRC shall have particular regard to. The following section 7 provisions are relevant to this application:

> *a) "Kaitiakitanga.*
>
> *[(aa) The ethic of stewardship]*
>
> *(b) The efficient use and development of natural and physical resources.*
>
> *(c) The maintenance and enhancement of amenity values.*
>
> *(d) Intrinsic values of ecosystems.*
>
> *(f) Maintenance and enhancement of the quality of the environment.*
>
> *(g) Any finite characteristics of natural and physical resources.*
>
> *(i) the effects of climate change."*

The matters of amenity values, ecosystems and water quality, have been given particular regard and assessed as not likely to be significantly adversely affected by the activity. The effects on amenity values, ecosystems and water quality, are expected to be temporary, and in some cases positive due to the requirement for WWL to manage any acute effects on human health detected during monitoring, compared to the existing situation where this is not required.

Kaitiakitanga and the ethic of stewardship has been given particular regard in the assessment of effects on cultural values and the consultation process undertaken as part of the development of this consent. Furthermore, WWL is committed to contributing to the development of the RKMF with GWRC, Ngāti Toa, PNBST, and the Wellington Tenths Trust as an ongoing partnership with iwi to enable a regional approach to cultural health monitoring to be undertaken. WWL propose to provide or engage suitably qualified and experienced personnel to attend meetings or other forums, provide information to GWRC, review documentation, and contribute to any other relevant matter.

Values of areas of significance to mana whenua are identified in section 5.2. The effects of the continued discharge of stormwater on Māori customary use was discussed in section 8.7. The values of scheduled waterbodies of significance to mana whenua, and the important relationship between water resources and iwi has been described in section 8.8.

The proposed continuation of stormwater disposal is considered to be an efficient use of natural and physical resources that will maintain, and in many ways, enhance amenity values, and the quality of the environment.

Particular regard is made to climate change in all of WWL's activities. In particular the effects of predicted sea level rise on potential flood risk. That risk exacerbates rainfall causing increased stormwater volumes that need to be appropriately managed to minimise the risk.

Given the above assessment, it is considered that particular regard has been made to the relevant matters of Section 7 of the RMA.

Section 8 of the RMA requires all persons exercising functions and powers under the RMA to have regard to the principles of the Treaty of Waitangi (Te Tiriti o Waitangi). To recognise these principles, consultation has been undertaken with iwi as detailed in section 12.

The ethic of stewardship has been recognised through:

- Consultation with and participation of iwi in meetings with WWL and their consultants through the preparation of this consent application and the draft SMP;
- Consultation with key stakeholders who have a specific interest in and/or who have exercised stewardship over water resources; and
- WWL's commitment to a continued partnership with iwi to achieve the monitoring of cultural health indicators based on a consistent regional approach. WWL's commitment to furthering cultural health monitoring will be provided through suitably qualified and experienced personnel being involved in the development of the RKHF, which is being led by GWRC. There will also be an opportunity for further consultation as iwi will be invited as a member of a Stormwater Working Party, established as a condition of consent to receive monitoring information, Annual Reports, advise on remedial works, and help develop the Stage Two SMS.

Due regard has been made to the principles of the Treaty of Waitangi in accordance with section 8 of the RMA.

Part 2 summary

Given the above assessment, the continued discharge of stormwater will promote sustainable management and is consistent with Part 2 of the RMA.

10.1.2 Sections 104 – 107 Consideration of applications

Section 104

Section 104(1) and (2) identify the matters that GWRC shall have regard to when assessing this application –

1. When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to–
   a. any actual and potential effects on the environment of allowing the activity; and
   b. any relevant provisions of—
      i. a national environmental standard:
      ii. other regulations:
      iii. a national policy statement:
      iv. a New Zealand coastal policy statement:
      v. a regional policy statement or proposed regional policy statement:
      vi. a plan or proposed plan; and
2. Any other matter the consent authority considers relevant and reasonably necessary to determine the application.

The actual and potential effects on the environment of the proposal are set out in section 8 of this report. Stormwater infrastructure provides an essential conventional function. Without stormwater networks, urban areas would be uninhabitable and communities would not be able to provide for their health and safety and economic wellbeing. The AEE confirms that in addition to the positive effects of the stormwater network conveying stormwater away from buildings and property, the discharges can also have adverse effects on the receiving freshwater and coastal environments.

Pursuant to Section 104(1)(b) of the RMA, a summary of the assessment made against the relevant provisions of the New Zealand Coastal Policy Statement (NZCPS), the operative Wellington Regional Policy Statement (RPS), Regional Coastal Plan (RCP), Regional Discharges to Land Plan (RDLP), Regional Freshwater Plan (RFP) and the PNRP is provided in section 11.2 below. A detailed assessment of the relevant clauses from all the aforementioned planning documents is contained within Appendix G.

In summary, the planning documents generally seek to enable the continued discharge of stormwater from urban areas, as an essential component of communities, and regionally significant infrastructure within the region, whilst avoiding significant adverse effects on important values and features in the freshwater and coastal receiving environments.

After considering an application for a resource consent for a controlled activity, a consent authority—

a. must grant the resource consent, unless it has insufficient information to determine whether or not the activity is a controlled activity; and
b. may impose conditions on the consent under section 108 only for those matters—
   i. over which control is reserved in national environmental standards or other regulations; or
   ii. over which it has reserved its control in its plan or proposed plan

Section 104A outlines the role of the consent authority in relation to making a determination on Controlled Activities.

Pursuant to Section 104A, GWRC must grant the resource consents sought. The assessment in section 6.4 of this report identified that the Rule R50 matters of control are satisfied.

GWRC may impose consent conditions, limited to the matters over which control is reserved in the PNRP. Proposed consent conditions are provided in section 14 of this report.

Section 105 of the RMA

Section 105(1) of the RMA sets out the matters that a consent authority must have regard to when considering a resource consent for a discharge permit. In addition to the matters set out in section 104, GWRC must have regard to –

a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and
b) the applicant's reasons for the proposed choice; and
c) any possible alternative methods of discharge, including discharge into any other receiving environment.

The nature of the stormwater discharges and the sensitivity of the receiving environment is summarised in this consent application and discussed in detail in the EER. The need to maintain the discharge of stormwater from the local authority networks and monitor as required by the PNRP has been discussed throughout this report. Alternative methods of treating stormwater discharges have been briefly identified in section 3.2.3, which has concluded that due to cost and topography constraints, it is not reasonable to look at alternative methods.

Section 107 of the RMA

Section 107 of the RMA places restrictions on the grant of certain discharge permits to water, if, after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving waters –

c) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:
d) any conspicuous change in the colour or visual clarity:
e) any emission of objectionable odour:
f) the rendering of fresh water unsuitable for consumption by farm animals:
g) any significant adverse effects on aquatic life.

WWL propose to record field observations in line with the Section 107(1) effects identified above during the monitoring of stormwater outlets.

The draft SMP identifies a zone of reasonable mixing of 50m for coastal receiving waters. This has been discussed with GWRC's technical specialists, who consider 50m to be reasonable.

Guidance from GWRC's technical specialists were sought on a zone of reasonable mixing for fresh water. These technical specialists were unable to determine a zone of reasonable mixing and has recommended that GWRC identifies an appropriate zone of reasonable mixing for freshwater. WWL seek further guidance from GWRC for an appropriate zone of reasonable mixing for fresh water in line with guidance from the PNRP policies P71 and P72, and that this be implemented through amendments to the SMP. The limitations with this approach is that it is not informed by science and the numerous stormwater outlets located in close proximity to each other create 'overlaps'.

Section 107(2) enables GWRC to grant a discharge permit or coastal permit that would otherwise contravene section 15 or section 15A of the RMA that may allow the effects identified in section 107(1) if it is satisfied that:

> a) that exceptional circumstances justify the granting of the permit; or
>
> b) that the discharge is of a temporary nature; or
>
> c) that the discharge is associated with necessary maintenance work—
>
> and that it is consistent with the purpose of this Act to do so.

WWL cannot guarantee that those effects identified in section 107(1) will not extend beyond a zone of reasonable mixing for fresh and coastal waters for the following reasons:

- Visual clarity effects invariably occur at the beginning of high rainfall events;
- High rainfall events and land use activities such as contaminant spills which generate or contribute to receiving water effects are outside WWL's control;
- At this stage, a scientifically informed zone of reasonable mixing zone for fresh water is unable to be determined; and
- In addition the activity, which includes Section 107(1) effects, must be approved, as it is a Controlled Activity.

Section 107(2)a) is applicable as there are exceptional circumstances that justify the granting of the permit, primarily that the continued discharge of stormwater is necessary to:

- Convey stormwater to a location where it does not cause a flooding hazard;
- Reduce the risk of damp buildings and high velocity flows;
- Provide a level of certainty that allows the inhabitants of Porirua, Upper Hutt, Hutt City and Wellington City to invest in their economic and social wellbeing, as well as providing health and safety benefits;
- Reduce the potential health risks associated with bodies of standing water that may contain contaminants; and
- Enable the proposed monitoring and modelling of stormwater, to increase WWL and GWRC's knowledge base and contribute positively to improving stormwater discharges in the long-term by the development of a SMS. This will ensure any long-term management measures implemented are cost effective and address real rather than perceived issues, making it affordable to the community and WWL's client councils.

Section 107(3) of the RMA enables conditions to be imposed on a discharge or coastal permit. Proposed consent conditions are provided in section 13 of this report.

Overall, stormwater quality will be the same or better as a result of the required management of acute effects on human health detected during monitoring under this consent.

10.2 Marine and Coastal Area (Takutai Moana) Act 2011

The purpose of this Act is to establish:

- A durable scheme to protect the legitimate interests of all New Zealanders in the marine and coastal area of New Zealand;

- Recognise the mana tuku iho exercised in the marine and coastal area by iwi, hapū, and whānau as tangata whenua;

- Provide for the exercise of customary interests in the common marine and coastal area; and

- Acknowledge the Treaty of Waitangi.

Essentially this Act replaced the Foreshore and Seabed Act 2004 and establishes an opportunity for groups to apply for Customary Marine Rights or Customary Marine Title over the CMA. Customary Marine Title recognises the relationship of an iwi, hapū or whānau with a part of the Common Marine and Coastal Area, and establishes various rights over this area.

The deadline for applications was 3 April 2017, with approximately 380 applications for Crown engagement received. Approximately 20 applications for Crown engagement were lodged for the Wellington region. Of these, two applications are geographically located within the scope of this global stormwater discharge application. These applications are still being processed.

WWL's initial legal advice is that:

- There is no obligation under the RMA to consult with any person, including iwi, under section 36A of the RMA. The Marine and Coastal (Takutai Moana) Area Act does not change that position.

- When an applicant is successful and becomes a customary marine title group or customary rights group then the application will need to be notified to that group.

- Notwithstanding the lack of any duty to consult, the applicant may consult with whoever it wishes and WWL is committed to continuing to work with iwi on developing the Regional Kaitiaki Monitoring Framework to enable cultural monitoring to occur.

WWL acknowledges the potential relevance of this legislation, given that two applications lodged with the Crown are located within the geographical scope of this global stormwater consent application.

However, WWL will not be undertaking further consultation with the applicants of the customary marine title applications as no customary marine titles have been granted in Wellington (i.e. applications are still being processed), the proposed activity is the continuation of existing regionally significant infrastructure which is not changing, and initial legal advice received indicates that consultation is not required.

10.3 Objective and Policy Assessment

10.3.1 National Policy Statement for Freshwater Management 2014 (NPSFM)

The NPSFM took effect on 1 August 2014 and provides national direction for the management of fresh water, recognising that this resource is essential to economic, environmental, cultural and social wellbeing. The NPSFM is applicable as stormwater discharges into freshwater environments.

The requirements to set freshwater objectives and limits for water quality under the NPSFM are not implemented in the PNRP. Instead, they will be implemented through GWRC's whaitua process which WWL is involved in. The whaitua process will lead to subsequent Whaitua-specific plan changes to the PNRP over the next 10 years, which will include incorporation of the requirements of the NPSFM National Objectives Framework.

This application is consistent with the objectives of the NPSFM, particularly with regard to monitoring of freshwater, as detailed in the assessment table in Appendix G.

10.3.2 New Zealand Coastal Policy Statement 2010 (NZCPS)

The NZCPS took effect on 3 December 2010 and provides national direction for the management of coastal resources and the coastal environment in New Zealand. The NZCPS is applicable as stormwater discharges into the coastal environment.

The relevant objectives and policies in the NZCPS, relating to wider coastal environment management, are identified and assessed in Appendix G. The following measures contribute to the management of the CMA and coastal environments and the outcomes sought in the NZCPS:

- WWL's current approach to managing stormwater discharges;
- The proposed monitoring and modelling programme over the next five years;
- The proposed consent conditions that provide a framework requiring WWL to undertake monitoring; and
- Management of acute effects on human health detected during monitoring.

10.3.3 Regional Policy Statement for the Wellington Region 2013 (RPS)

The second generation RPS for the Wellington Region was made operative on 24 April 2013. The RPS identifies regionally significant issues relating to the management of the regions natural and physical resources and sets out what needs to be achieved (objectives) and the way in which the objectives will be achieved (policies and methods).

The RPS highlights the flow on effects of contaminants from areas with increasing development that enter the stormwater that is then discharged into water, or onto or into land that may enter water.

The RPS seeks to recognise and protect the benefits of regionally significant infrastructure, this includes stormwater networks, while also maintaining or enhancing the quality of coastal waters and freshwater to a level suitable for the health and vitality of ecosystems. The relevant objectives and policies of the RPS are identified and assessed in Appendix G.

Overall, taking into account the monitoring and management measures proposed in consent conditions, the continued discharge of stormwater is consistent with the relevant objectives and policies of the RPS.

10.3.4 Operative Regional Coastal Plan 2000 (RCP)

The RCP became operative in 2000 and applies to activities and the use of resources within the CMA, within the remit of the RMA.

The RCP identifies a number of coastal areas and sites that receive stormwater and are therefore important to the consideration of this proposal. This consent application for continued stormwater discharge to coastal environments appropriately responds to the values of coastal environments identified in the RCP. WWL is committed to contributing to coastal bathing beach monitoring and mitigating acute effects on human health detected during monitoring.

Taking into the account other factors such as consultation with RPH regarding human health concerns and proposed mitigation measures for the management of acute effects on human health, the proposal to continue the discharge of stormwater and monitor this over the next five years aligns with the relevant objectives and policies of the RCP, as identified in Appendix G.

10.3.5 Operative Regional Freshwater Plan 1999 (RFP)

The RFP became operative on 17 December 1999. Since then six plan changes have been made operative, the most notable being Plan Change 6 which took effect on 1 August 2014, which amended Policy 5.2.10(a) to give effect to policy A4 of the NPSFM.

The general objectives and policies of the RFP relate to the relationship of tangata whenua with freshwater, natural values, amenity values, flood mitigation and use and development. The objectives and policies specific to discharges to freshwater are discussed in Appendix G**.** Of particular note is Policy 4.2.23 which states that particular regard is to be had to the benefits arising from any proposal for the use and development of a water body.

Overall, the proposed monitoring and management measures together with the proposed consent conditions have had appropriate regard to the relevant objectives and policies of the RFP.

10.3.6 Operative Regional Discharges to Land Plan 1999 (RDLP)

The RDLP applies to the whole of the Wellington region, except the CMA. The RDLP identifies issues to be addressed so that the receiving environment of discharges to land is sustainably managed.

As the scope of the stormwater discharges include stormwater discharges to land which may enter fresh water and coastal receiving environments, the relevant objectives and policies of the RDLP are identified and assessed in Appendix G. This application is consistent with these objectives and policies which allow discharges to land which are not likely to have adverse effects on soil and water quality.

10.3.7 Proposed Natural Resources Plan

The PNRP marks a shift in GWRC's approach to managing the effects of local authority stormwater networks and provides a clear framework for how stormwater is to be managed. The PNRP recognises that the discharge of stormwater can result in adverse effects on water quality and the health of rivers, streams, lakes and the coast and requires that stormwater discharges from local authority networks be improved over time. This is to be achieved through a two-stage consent process, which links to the water quality limits to be set through each Whaitua process. Objective O48 and Policy P74 of the PNRP are directly relevant to Rule R50, under which consent is required.

Objective O48 looks to manage the adverse quality and quantity effects of discharges from networks so that they are improved over time. Policy P74 signals that the purpose of this five year consent is to undertake monitoring to identify adverse effects from the stormwater network, in order to develop a prioritised programme for improvement and provides specific guidance for Stage One, as follows –

Policy P74

a. The adverse effects of discharges from a local authority stormwater network during a controlled activity consent granted under Rule R50 shall be managed by:

b. managing the stormwater network on a comprehensive basis whereby discharges from local authority stormwater devices are aggregated on a catchment or sub-catchment basis and authorised via a single 'global' consent, and

   i. undertaking monitoring to identify the adverse quality and quantity effects of discharges from the stormwater network on:

   ii. aquatic ecosystem health and mahinga kai, and

   iii. contact recreation and Māori customary use, and

   iv. the values of areas with identified outstanding or significant values identified in Schedule A (outstanding water bodies), Schedule C (mana whenua), Schedule F (indigenous biodiversity), and

   v. water and sediment quality in the receiving environment, and the benthic habitat of low energy receiving environments

   in order to develop a prioritised programme for improvement of areas within the stormwater network that will form the basis of a stormwater management strategy, and

c. managing any acute adverse effects of discharges from the stormwater network detected during the monitoring under (b), including significant adverse effects on primary and secondary contact with water, by

   i. implementing mitigation as soon as practicable after the effect is determined, and

   ii. identifying long-term options for remediation or mitigation, and

d. limiting resource consents granted under Rule R50 to a maximum of five years, and

e. Including conditions in the resource consent to set timeframes for the development of a stormwater management strategy in accordance with Schedule N (stormwater strategy).

The Rule R50 matters of control are:

- Requirements to monitor and report on the quality of stormwater discharges to fresh and/or coastal water, including of stormwater discharges containing wastewater;
- Management of acute effects of stormwater on human health detected during monitoring;
- Duration of consent up to a maximum of five year; and
- Timeframes for the development of a stormwater management strategy in accordance with Schedule N (stormwater strategy).

There is a significant discrepancy between the matters identified in Policy P74 and the Rule R50 matters of control. The management of acute effects of stormwater on human health detected during monitoring is a very specific matter of control under Rule R50, whereas Policy P74(c) identifies a wider scope of the management of acute effects detected during monitoring for matters, as well as primary and secondary contact with water.

The monitoring and modelling programme WWL propose to undertake is identified in the draft SMP. Regarding cultural health monitoring, WWL propose to contribute to the development of the RKMF by providing or engaging suitably qualified and experienced personnel to aid the development of the regional framework for a consistent approach to cultural health monitoring. The aforementioned will cover the monitoring of matters listed in Policy P74(b).

It is important to recognise that WWL will only be managing and mitigating acute effects on human health detected during monitoring as this is one of the matters of control under Rule R50. There are other 'business as usual' management and mitigation measures outside the Rule R50 matters of control requirements of this consent that WWL will continue to undertake as part of their programmes of work.

There a large number of other objectives and policies relating to the receiving environments and are assessed in Appendix G. Overall, the application for continued stormwater discharge from local authority stormwater networks is consistent with the relevant objectives and policies of the PNRP.

10.3.8 Statutory assessment conclusion

The AEE concludes that the continued discharge of stormwater as sought in this application, subject to the proposed conditions of consent, can be carried out without adversely affecting the water and sediment quality of the fresh water and coastal receiving environments, benthic habitats, mahinga kai, contact recreation and Māori customary use.

WWL has accounted for the potential for actual acute effects on human health arising from the continued discharge of stormwater during the term of the Stage One consent. When an acute effect is identified, appropriate management and mitigation actions will be undertaken to avoid, remedy or mitigate these to the greatest extent that is practicable.

Furthermore, the proposed monitoring regime will contribute to the long-term management and improvements to the quality of stormwater discharges through the development of a SMS in Stage Two.

Overall, when the benefits of the continued discharge of stormwater are considered alongside the proposed mitigation measures, it is considered that continued discharge of stormwater will continue to promote the sustainable management of natural and physical resources. The continued discharge of stormwater activity is consistent with the purpose and principles of the RMA, and the objectives and policies embodied in the NZCPS, NPSFM, RPS, operative Regional Plans and the PNRP.

11 Consultation

11.1 Overview

Although there is no specific statutory requirement for consultation under the RMA, it was useful to conduct targeted consultation to inform the development of the draft SMP and consent application. WWL considers consultation is an important part of this project. Environmental quality, public health, Māori cultural values, asset management, funding and regulatory processes are of significant interest to key stakeholders and the general public.

The approach has been to engage with key stakeholders at an early stage in the preparation of this application. The key focus was understanding key stakeholder issues, concerns and input considerations for the draft SMP.

Due to time constraints and because the Stage One consent is limited in duration (and the Controlled Activity status), targeted consultation with key stakeholders, iwi and GWRC has been undertaken rather than general public consultation. This was to ensure those with a primary interest in stormwater discharges and effects on receiving environments were involved.

Consultation for this project has included the establishment of a Technical Reference Group (TRG) and a sub-group.

11.2 Key consultation activities

11.2.1 Development of a Communications Plan

At the commencement of this project, WWL developed a Communications Plan to outline targeted consultation activities. The Communications Plan identified key consultation objectives, key messages, key stakeholders, iwi to be consulted, and the consultation activities to be undertaken (timing, frequency and purpose).

WWL adopted four key communication objectives:

1. Key stakeholders are engaged with and their concerns are identified as early as possible to inform inputs into the SMP and consenting requirements.
2. Key stakeholders are aware of the project and know what is happening and when.
3. Timely and responsive communication is undertaken. Key stakeholders are kept informed and know who to contact with any concerns or feedback.
4. Understand iwi affiliations and values of PNRP scheduled sites and waterbodies, mahinga kai, and Māori customary use. Address iwi concerns as early as possible.

11.2.2 Development of Project Information Sheet

A Project Information Sheet was developed (refer to Appendix H) to provide background and project details for the Stage One global stormwater consent.

The Information Sheet was sent with the first email correspondence to iwi and key stakeholders and a face-to-face meeting was sought. Specifically the Information Sheet was sent to:

- The Wellington Tenths Trust and PNBST;

- Ngāti Toa Rangatira;
- Department of Conservation;
- Regional Public Health;
- Fish and Game; and
- A representative of the WCC Stormwater Consultative Committee.

Key questions identified on the Information Sheet to prompt discussion and provide a steer on the feedback WWL wished to obtain were:

1. What specific areas of Wellington Water's stormwater network and/or the stormwater receiving environment (coastal and freshwater) are a concern to you?
2. Are there specific aspects or areas of Wellington Water's stormwater network and/or the stormwater receiving environment (coastal and freshwater) that would benefit from being monitored?
3. What would you like the Stormwater Monitoring Plan to achieve?
4. Would you like to be involved in a Stormwater Working Party?

11.2.3 Iwi consultation

Several face-to-face meetings were undertaken with Morrie Love, representing Wellington Tenths Trust and PNBST and Turi Hippolite from Ngāti Toa Rangatira.

The development of a specific Cultural Health Monitoring Plan was discussed with iwi and overall all are keen to be involved with developing such a plan, as it will tie in with their development of cultural health indicators. However, after further consideration, WWL consider the development of a separate specific Cultural Health Monitoring Plan to be a duplication of efforts for the current development of the RKMF that GWRC are currently leading. Instead of developing a specific Cultural Health Monitoring Plan, WWL are committed to contributing to the development of the RKMF through providing suitably qualified and experienced personnel to help develop the RKMF to provide a consistent regional approach. WWL considers the initial willingness of iwi to be involved with the development of a Cultural Health Monitoring Plan is best channeled to the development of the RKMF, so that efforts are not duplicated.

Iwi have also indicated keenness to be involved in a proposed Stormwater Working Party to be established as a condition of consent (refer to section 13).

A summary of the feedback received from iwi is provided in Table 19 below.

Table 19: Summary of feedback from iwi

Iwi	Summary of feedback
Ngāti Toa Rangatira (Ngāti Toa) [redacted], Resource	• Flooding in Porirua continues to be a major problem • Ngāti Toa are currently working on developing cultural health indicators. Rawiri Faulkner (consultant) is leading this project

Management Advisor	• Ngāti Toa are keen to collaborate with WWL to explore which cultural health indicators can be used to monitor • Are interested in being involved with physical monitoring • Identified areas that would benefit from monitoring including customary gathering sites, Porirua Harbour and around the Porirua coastline, and Porirua Stream • Interested in being a member of the Stormwater Working Party
Wellington Tenths Trust and Port Nicholson Block Settlement Trust [redacted]	• The water quality of open streams is a key concern. A list of waterbodies identified as having particular cultural significance to PNBST was provided to WWL • The PNBST are currently developing cultural health indicators • Mahinga kai and Māori customary use in the coastal environments are important • PNBST and the Wellington Tenths Trust seek the following outcomes from the Stage One global stormwater consent: ○ Improvements to problem areas, particularly the health of shellfish ○ Maintaining Wellington Harbour water quality, visual clarity and no odour ○ Native fish populations being maintained or improved ○ Water quality being maintained or improved • Interested in being a member of the Stormwater Working Party

11.2.4 Greater Wellington Regional Council officer consultation

At the outset, WWL wanted to undertake a collaborative 'no surprises' approach with GWRC in developing this consent application and the SMP. Key objectives identified in the Communications Plan for working with GWRC Officers were:

- Undertaking a 'no surprises' approach and to resolve any differences in opinion before lodging the applications;
- Providing the scope of the applications, catchments and monitoring plan to GWRC at an early stage to confirm as a basis to develop in more detail;
- Providing a draft application and SMP to GWRC Environmental Regulation for pre-lodgement feedback;
- Providing up front key dates to GWRC Officers, such as those for regular meetings, pre-lodgement completeness checks and processing of the application to maximise preparedness and efficiency; and

- Working with Environmental Regulation on a set of practical and affordable conditions prior to the issue of a decision.

The key GWRC officers consulted with and the main topics of discussion are identified in Table 20 below.

Table 20: GWRC officers consulted with

GWRC Department	GWRC officers consulted with (those in bold were regularly involved with the TRG and sub-group):	Main consultation activities/topics discussed
Environmental Science	[redacted] – Environmental Scientist – Coast, Aquatic Ecosystems and Quality Team [redacted] – Manager [redacted] – Freshwater Ecologist	• Updates on key timeframes and progress on the project
Environmental Policy	[redacted] – Team Leader	• Updates on key timeframes and progress on the project
Environmental Regulation	[redacted] – Team Leader [redacted] – Resource Advisor [redacted] – Resource Advisor	• Updates on key timeframes and progress on the project • Guidance on information to be provided in the consent application and consideration of application as a Controlled Activity • Discussion on draft conditions. • Pre-lodgment completeness check
Other	[redacted] – Whaitua Project Manager	• Stormwater investigations and modelling undertaken by the Porirua Whaitua • Timeframes for the establishment of the Wellington Harbour/Hutt Valley Whaitua committee • Content for the SMP
	[redacted] – Project Advisor	• Feedback on stormwater from the public on community engagement projects
	[redacted] - Science Coordinator - Kaitiaki	• Progress of the Regional Kaitiaki Monitoring Framework.

11.2.5 Other key stakeholders

A combination of email correspondence, phone calls, video conference and face-to-face meetings, has been undertaken with the following key stakeholders:

- Department of Conservation;
- Fish and Game;
- Regional Public Health; and
- A representative of the WCC Stormwater Consultative Committee.

A summary of their feedback is provided in Table 21 below.

Table 21: Summary of key stakeholder feedback

Key Stakeholder	Summary of feedback
Department of Conservation [redacted] and [redacted]	• Key discharge points that would benefit from being monitored are in the Marine Reserve (Houghton Bay, Island Bay, Owhiro Bay), Waiwhetu Stream Porirua Stream, Kenepuru Stream, Duck Creek, Horokiri Stream and South Karori Stream • Would like to see monitoring of significant waterways that are not already being monitored • Receiving environments of concern are the Marine Reserve, Wellington and Porirua harbors and Schedule F2 waterbodies • Would like to see fish species and chemicals/metals monitored as part of the SMP • Would like the monitoring to provide a better understanding of what is going on i.e. are there changes in flow, is the quality of stormwater changing? • Interested in being a member of the Stormwater Working Party

Regional Public Health
 	
[redacted]s and [redacted]
	• The main effects RPH are concerned about in relation to stormwater discharges are:
	    • The level of exposure in terms of public health
	    • The degree of contamination e.g. wastewater, level of dilution, treatment vs non-treatment, areas of discharge in low socio-economic areas and susceptibility of the general public
	    • Microbiological risks to the public from wastewater contamination
	    • Potential effects of climate change and urban growth on stormwater and public health
	• Stormwater education is important. Educating the general public about risks associated with stormwater discharges, wastewater overflows and not gathering shellfish at least 48 hours after an overflow event. Education needs to be more than about contact recreation with a greater focus on when not to collect shellfish

	• The SMP should cover shellfish monitoring, maintenance of recreational site monitoring (particularly sites with a D grade), new monitoring sites where contact recreation is year round, streams of concern • An appropriate acute effects on human health response/feedback loop is required to be maintained between relevant agencies and interested parties during a stormwater event • Interested in being a member of the Stormwater Working Party and being involved in the development of the RKMF
Fish and Game [redacted]	• Greatest concern is any effects on rivers and streams listed as important trout fishery rivers or spawning reaches in the Regional Plans • The following analytes would benefit from being monitored: Dissolved Inorganic Nitrogen, Dissolved Reactive Phosphorus, key heavy metals (e.g. lead, mercury), hormones (e.g. estrogen), organochlorine compounds (e.g. DDT), any other potential toxins that may influence human health via consumption, and total water flows (so contaminant loads can be calculated)
A representative of the WCC Stormwater Consultative Committee [redacted]	• Monitoring to date has been focused on water quality as opposed to contaminant loads or volumes. Monitoring should look at macro, benthic and ecological species • Need to gain a better idea of long term impacts, frequency of discharges, quality and quantity impacts. Auto loggers are a good way to achieve this • Good modelling will reduce the amount of monitoring required • Contaminant load modelling and qualitative sampling would be good

11.2.6 Establishment of a Technical Reference Group

A Technical Reference Group (TRG) was set up in April 2017 comprising of representatives from WWL, GWRC Environmental Science, GWRC Environmental Regulation, GWRC technical consultants and WWL consultants involved with preparing this consent application and SMP.

The TRG is a task-based advisory group that is proactive and responsive, focused on developing a comprehensive, fit for purpose and cost effective SMP.

The TRG met twice on 5 and 18 April 2017. Email updates about the project and progress were subsequently provided in lieu of a face-to-face meeting.

11.2.7 Establishment of a TRG sub-group

A TRG sub-group was established involving [redacted] (MWH), [redacted] (GWRC Team Leader) and GWRC technical consultants [redacted] (Aquanet Consulting Ltd), [redacted] (NIWA) and [redacted] (NIWA).

The purpose of the sub-group was to contribute specific technical advice to [redacted] tasked with developing the SMP.

The TRG sub-group met three times, on 10 April 2017, 10 May 2017 and 12 June 2017.

11.2.8 Draft AEE consultation

A draft copy of this AEE report was provided to Ngāti Toa, the Wellington Tenths Trust, PNBST, DoC and RPH as per their request during consultation.

11.3 Conclusion

The issues identified from targeted consultation undertaken during the preparation of the consent application and draft SMP predominantly related to microbiological water quality, which in turn influences other key adverse effects, such as human health, ecology, Māori customary use, and sediment quality.

The majority of the key stakeholders recognised that the limited duration of the Stage One consent meant that fit for purpose and targeted monitoring was mainly going to be undertaken, along with the management of acute effects on human health detected during monitoring. WWL has made it clear to key stakeholders and iwi that wholesale improvements to the stormwater network and options for treatment prior to discharge would be not be investigated until Stage Two.

Those consulted with were positive and many have indicated that if a SWP is established, they would like to be involved. A proposed consent condition in section 14 of this report outlines the establishment of a SWP.

Overall, there was positive feedback from key stakeholders and iwi that a fit for purpose and targeted monitoring programme for the next five years is a move in the right direction for long-term management and improvement of stormwater discharges.

12 Notification Assessment

When considering the adverse effects of a Controlled Activity, pursuant to section 95D(c) and 95E (2)(b) of the RMA, any adverse effect of the activity that does not relate to a matter for which a rule reserves control must be disregarded.

With regard to Rule R50, applications for resource consent are precluded from public notification unless special circumstances exist. Special circumstances are those that are:

- Exceptional or unusual, but something less than extraordinary;
- Outside the common run of applications of this nature; or
- Circumstances which makes notification desirable, notwithstanding the conclusion that the adverse effects will be no more than minor.

With respect to this application, the applicant considers that no special circumstances exist as there is nothing exceptional or unusual about this application, beyond what is anticipated by the requirements of Rule R50 (a global consent for local authority network stormwater discharges).

Applications for resource consent under Rule R50 are also precluded from limited notification.

Accordingly, it is requested that this resource consent application is processed on a **non-notified** basis.

13 Proposed consent conditions

General condition

1. The consent holder shall operate the stormwater discharges in general accordance with the consent application and associated documents lodged with the Wellington Regional Council on X July 2017 and further information received on:
    - [insert date]

    Where there may be contradictions or inconsistencies between the application and further information provided by the applicant, the most recent information applies. In addition, where there may be inconsistencies between information provided by the applicant and conditions of the consent, the conditions apply.

Stormwater Monitoring Plan

2. The consent holder shall within six months of the grant of consent, or within such longer time as may be agreed in consultation with the Manager, Environmental Regulation, Wellington Regional Council, finalise and submit for approval by the Manager, Environmental Regulation, Wellington Regional Council, a Stormwater Monitoring Plan (SMP).

    The SMP shall be approved, to confirm that the SMP:
    a) Is generally consistent with the draft SMP submitted with the consent application; and
    b) Addresses all the matters listed in condition 3 below.

3. The purpose of the SMP is to set out the sampling locations, frequency and methods to be adopted by the consent holder to monitor water quality, sediment quality, benthic habitat, and any other information necessary to inform the long term Stormwater Management Strategy required by condition 14 of this consent.

    The SMP shall include, but not be limited to, providing the following detail:
    a) Monitoring objectives;
    b) Sampling locations, frequency and methodology;
    c) Water quality monitoring;
    d) Sediment quality monitoring;
    e) Benthic habitat monitoring;
    f) Investigations and modelling;
    g) Management of acute effects of stormwater discharges on human health detected during monitoring;
    h) The expiry of other existing local authority stormwater discharge consents;
    i) Reporting; and
    j) A monitoring review process.

    Note: A 20 working day turnaround time is intended for the SMP approval process.

4. Monitoring shall not proceed until the SMP described in condition 3 of this consent has been approved.

5. Any amendments to the detail required by condition 3 in the approved SMP shall be confirmed in consultation with the Stormwater Working Party (SWP) (established under condition 13 of this consent) and detailed in an Annual Report (required by condition 14 of this consent).

6. The consent holder shall undertake all stormwater monitoring, and the management of acute effects of stormwater discharges on human health detected during monitoring in accordance with the approved SMP (or subsequent amendments).

7. All sampling techniques, including sample preservation and dispatch to the analysing laboratory, employed in respect of the conditions of this consent shall be carried out by suitably trained and experienced persons in accordance with best practice and in accordance with the requirements of the analysing laboratory. All water and sediment analyses undertaken in connection with this consent shall be performed by an Internationally Accredited (IANZ) registered laboratory.

Sanitary Surveys

8. The consent holder shall notify the Manager, Environmental Regulation, Wellington Regional Council in writing as soon as practicable or within 24 hours of receipt of the analytical results, of any incidences of E.Coli bacteria counts obtained from undertaking stormwater discharge monitoring as identified in the SMP, exceeding 10, 000 cfu/100mL.

This notification shall include relevant sample collection details (including the date and time of sample collection, rainfall in the 24 hours prior to sampling, and weather and tidal conditions at the time of sampling), and proposed further water sampling or investigations.

The consent holder shall undertake a sanitary survey in a catchment(s) in the event that:

a) Any routine water sample collected under this consent has an E.Coli bacteria count exceeding 10,000 cfu/100mL and the E.Coli bacteria count in a follow-up water sample taken from the same location within 24 hours of receipt of the routine sample result also exceeds 10,000 cfu/100 mL; or
b) The rolling 12-month median E.Coli bacteria count obtained from undertaking monthly routine stormwater discharge monitoring as identified in the SMP exceeds 1,000 cfu/100 mL.

If required, the consent holder shall implement remedial works to overcome the causes of E.Coli bacteria contamination identified in the sanitary survey.

The outcomes of any sanitary surveys undertaken shall be detailed in a monthly report to the Manager, Environmental Regulation, Wellington Regional Council, and the Annual Report as required by condition 10 of this consent.

Note: A sanitary survey includes an initial comparison of the results to previous stormwater sampling results, follow up sampling if required, visual inspections of discharge including lifting of man hole covers, and closed circuit television monitoring (CCTV) if required.

Incident notification and spills

9. The consent holder shall keep a permanent record of any known incident(s) involving major spillages or illegal discharges of chemicals, fuels, or other contaminant sources into the stormwater network that results, or could result, in an adverse effect on the freshwater and coastal marine area environments. The consent holder shall make the incident register available to Wellington Regional Council officers on request.

The consent holder shall notify the Manager, Environmental Regulation, Wellington Regional Council, of any such incident the next working day following the incident being brought to its attention.

The consent holder shall forward an incident report to the Manager, Environmental Regulation, Wellington Regional Council within seven (7) working days of the incident occurring, unless otherwise agreed with the Manager, Environmental Regulation, Wellington Regional Council. The report shall describe the manner and cause of the incident, measures taken to mitigate/control the incident (and/or illegal discharge), and measures to prevent recurrence.

Note: The consent holder shall advise Wellington Regional Council on the day of the incident being brought to its attention by calling the Environmental Hotline on 0800 496 734.

Annual Report

10. The consent holder shall prepare and submit an Annual Report to the Manager, Environmental Regulation, Wellington Regional Council **by 1 September each year following the commencement of monitoring**.

The Annual Report shall include as a minimum (but not be limited to) the following:

a) A summary of physical capital and maintenance works to the stormwater network carried out in the preceding year;
b) Stormwater outfall discharge water quality monitoring results, including an evaluation of the results, an analysis of the dry and wet weather sampling results and differences, and an analysis of any differences or trends from previous results;
c) Observations and photographs from the visual inspections undertaken during stormwater outfall discharge water quality monitoring;
d) A summary of sanitary survey results, remedial works or management actions in relation to acute adverse effects on human health detected during monitoring;
e) Sediment quality and benthic habitat monitoring results where applicable, including an assessment of these by an appropriately qualified and experienced scientist, and an analysis of any trends;
f) Results where applicable from Wellington Regional Council's Wellington Harbour and Porirua Harbour subtidal sediment and biota monitoring programmes, Wellington Regional Council's Hilltop Database on water quality and sediment quality, and marine and freshwater recreational water quality monitoring programmes;
g) A discussion of the key findings of the monitoring undertaken in relation to environmental impacts and network performance;
h) Recommendations for amendments to monitoring procedures or locations including a summary of the consultation on these changes with the SWP;
i) A summary of the meetings held with the SWP;
j) Any other matters the consent holder considers relevant, including any follow-up actions resulting from the preceding year's operation.

Note: The Annual Report shall report on the year 1 July to 30 June inclusive.

11. The consent holder shall provide electronic copies of the Annual Report to the Stormwater Working Party (established by condition 13 of this consent).

Regional Kaitiaki Monitoring Framework

12. The consent holder shall for the term of this consent, contribute to the development of the Regional Kaitiaki Monitoring Framework by providing or engaging suitably qualified and experienced personnel to:

a) Attend meetings or other forums;
b) Provide information to the Wellington Regional Council;

c) Review documentation; and
d) Contribute to any other relevant matter.

The scope of the activities identified in clauses a) to d) shall be agreed in writing between the consent holder and the Manager, Environmental Regulation, Wellington Regional Council, prior to the commencement of such activities.

Stormwater Working Party (SWP)

13. The consent holder shall in consultation with the Manager, Environmental Regulation, Wellington Regional Council, establish a **Stormwater Working Party (SWP)** and invite members of the party to a meeting at least every 6 months for the duration of this consent, or another timeframe as agreed to by the SWP.

The members of the SWP shall be representatives of key stakeholder organisations to be confirmed with the Manager, Environmental Regulation, Wellington Regional Council, and shall be sufficient for the purposes of:

a) Reviewing monitoring results and the Annual Report;
b) Advising on the appropriateness of the remediation actions for acute adverse effects on human health detected during monitoring;
c) Advising on development of the long term Stormwater Management Strategy (as required by condition 14 of this consent); and
d) Any other relevant matters relating to the exercise of this consent.

For the purpose of this consent, the SWP shall have the following terms of reference:

i. A meeting shall be called by the consent holder with no less than 20 working days' notice and at least 6-monthly;
ii. The agenda for the meetings and any relevant reports shall be circulated to all SWP members a minimum of 10 working days prior to the meeting; and
iii. Records of each meeting shall be kept and circulated to members within 20 working days month of each meeting being held. The records should include, but not be limited to, issues discussed, actions agreed upon and any follow-up on agreed actions from previous meetings.

Stormwater Management Strategy (SMS)

14. The consent holder shall prepare and submit to the Wellington Regional Council by *[insert date, being 4 years from date of grant of consent],* a long term Stormwater Management Strategy (SMS).

The purpose of the SMS shall be to:

a) Provide a strategy for how sub-catchments within the local authority stormwater network will be managed in accordance with any relevant objectives identified in the Proposed Natural Resources Plan (or subsequent amendment), including any relevant whaitua-specific objectives at the time of developing the strategy; and
b) Describe how the stormwater network will be managed in accordance with good management practice and progressively through time, to minimise the adverse acute, chronic and cumulative effects of stormwater discharges on fresh and coastal water.

The SMS shall be prepared in accordance with Schedule N of the Proposed Natural Resources Plan (or subsequent amendment).

Review condition

15. The Wellington Regional Council may review any or all conditions of this consent by giving notice of its intention to do so pursuant to section 128 of the Resource Management Act 1991, at any time within one month of the first and third anniversary of granting consent for the following purposes:

a) To review the adequacy of any report and/or monitoring requirements, and if necessary, amend these requirements;
b) To deal with any adverse effects on the environment which may arise from the exercise of this consent, and which is appropriate to deal with at a later stage; and
c) To enable consistency with any relevant operative Regional Plans or National Environmental Standards, or Regulations.

The review of conditions shall allow for the deletion or amendment of conditions of this consent, and the addition of such new conditions as are shown to be necessary to avoid, remedy or mitigate any significant adverse effects on the environment.

14 Conclusion

WWL is seeking a coastal permit and discharge permit to authorise the continued discharge of stormwater from WCC, PCC, HCC, UHCC, and WCC stormwater networks into or onto land which may enter water, and directly to water. A term of five years is sought for the two consents, which is the maximum term available for this activity under Rule R50 of the PNRP.

This application seeks to formalise existing stormwater discharges. The local authority stormwater networks are an essential infrastructure service conveying stormwater away from urban environments.

The effects of stormwater discharges from the local authority networks to the CMA, coastal and freshwater environments have been outlined and evaluated in section 8 of this report. The information available from monitoring and assessments indicates that discharges of stormwater to Porirua Harbour, Wellington Harbour and coastal environments with urban settlements have the potential to affect water quality at bathing beaches, and to temporarily increase the health risks for bathers and those engaged in other contact recreational activities at such times. This is predominantly due to wastewater overflowing to the stormwater network.

Stormwater networks are essential for communities and this Stage One global stormwater consent application demonstrates WWL's commitment to managing the effects of these discharges on human health detected during monitoring, by implementing mitigation measures along with comprehensive monitoring.

A draft SMP is provided with the application, which identifies the monitoring and modelling programme proposed over the next five years. WWL proposes to utilise existing monitoring programmes as well as undertake additional stormwater discharge, contribute to the development of the RKMF to enable a consistent regional approach to cultural health monitoring, storm event auto sampling, establish five temporary River SoE sampling sites, ecological condition, and marine sediment and benthic ecology monitoring. Final confirmation of existing and new monitoring sites need to be informed by discussions between GWRC, WWL and other relevant agencies to 'rationalise' existing stormwater discharge monitoring in the region. Final details will be provided in a final SMP to GWRC for approval within six months of the grant of consent.

The continued discharge of stormwater from the local authority networks is consistent with the relevant policy framework of the statutory plans developed under the RMA. The continuation of an established, existing activity represents sustainable management as defined in Part 2 of the RMA. No Section 6, 7 or 8 RMA matters will be adversely affected by the granting of the consents sought.

Consultation has been undertaken with iwi, key stakeholders and the TRG to develop the draft SMP.

There are considered to be no significant adverse effects that are significant that would prevent the granting of a five year consent, on a non-notified basis, subject to appropriate conditions of consent in accordance with the matters of control set out under Rule R50.

The applicant requests the provision of draft conditions for review prior to issue, to ensure the practical implications of the condition requirements are understood.

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Appendices

Appendix A: Information Sources List

No.	Data Description	Area	Data Type	Source	Status
1	Stormwater network	All	GIS lines	WWL	Obtained
2	Stormwater outlets/manholes	All	GIS points	WWL	Obtained
3	Sewer network	All	GIS lines	WWL	Obtained
4	Constructed sewer overflows	All	GIS points	WWL	Obtained
5	Impervious surface	All	GIS polygon	WWL	Obtained
6	Landuse categories	All	GIS polygon	LRIS	Obtained
7	Groundwater classification	All	GIS polygon	WWL/GWRC/LRIS	Not needed
8	Soil classification	All	GIS polygon	WWL/GWRC/LRIS	Not needed
9	Contaminated land mapping	All	GIS polygon	GWRC SLUR	Obtained
10	Stream/river networks	All	GIS lines	REC	Obtained
11	Stream – open channel lengths	All	GIS polygon	WWL	Obtained
12	Culvert extent (%, km)	All	GIS lines	WWL	Not avail.
13	Stormwater monitoring sites	All	GIS points	WWL	Obtained
14	River SOE monitoring sites	All	GIS points	GWRC	Obtained
15	Recreational water quality sites - Fresh	All	GIS points	GWRC	Obtained
16	Recreational water quality sites - Coastal	All	GIS points	GWRC	Obtained
17	Aerial Imagery	ALL	Raster	Amanda	Obtained
18	boundary of costal marine area	CMA	GIS line	GWRC	Not needed
19	Property ownership	All	GIS polygon	LINZ	Obtained
20	Stormwater monitoring data	All	spreadsheet	TLAs	WCC/HCC/PCC
21	River SOE water quality data summary	All	report	Morar, et al 2016	Obtained
22	River SOE invertebrate data summary	All	report	Morar, et al 2016	Obtained
23	Recreation water quality data freshwater	All	report	Morar, et al 2016	Obtained
24	Recreation water quality data coastal	All	report	Morar, et al 2016	Obtained
25	Marine sediment quality summary	WCC	report	Oliver, 2013	Obtained
27	Marine benthic biota summary	WCC	report	Oliver, 2013	Obtained
28	Marine sediment quality summary	PCC	report	Oliver et al 2014	Obtained
29	Marine benthic biota summary	PCC	report	Oliver et al 2014	Obtained
30	Coastal Water Quality and Ecology monitoring Programme. Annual data report, 2015/16		report	Oliver 2016	Obtained
31	WCC Stormwater discharge resource consent application - Complete document (Print version)		report	WWL (MWH, 2008)	Obtained
32	WGN090219 - Report to the Hearing Panel	WCC	report	WWL	Obtained
33	WGN090219 Hearing Panel Decision Report	WCC	report	WWL	Obtained
34	2015 11 04 Cultural Values Report Lambton Harbour	WCC	report	Port Nicholson Block Settlement Trust/Wellington Tenths Trust	Obtained
35	Cultural Impact Report Lambton Harbour Catchment – Ngāti Toa Rangatira	WCC	report	Ngāti Toa Rangatira	Obtained
36	WCC Stormwater discharge resource consent application - Complete document (Print version)	WCC	report	WWL (MWH, 2008)	Obtained
37	Stormwater discharge resource consent application - RMA s92(1) request for additional information (GWRC)	WCC	report	WWL	Obtained
38	SW Discharge Consent Environmental Objectives (Submitted Version) - 10 12 2012	WCC	report	WWL	Obtained
39	WCC ICMP Stage 1	WCC			
-	WCC ICMP Stage 1 report	WCC	report	WWL	Obtained
-	WCC ICMP Stage 1 summary	WCC	report	WWL	Obtained

-	WCC ICMP Stage 1 Appendix J - overflow location details and assessments	WCC	report	WWL	Obtained
-	Stormwater Impacts in the Marine Environment around Wellington City	WCC	report	WWL	Obtained
-	Stormwater Discharge Consent Annual Report 14-15	WCC	report	WWL	Obtained
-	Stormwater Discharge Consent Annual Report 15-16	WCC	report	WWL	Obtained
-	Overflow data up to 2015-16	WCC	report	WWL	Obtained
-	Stormwater catchment characteristics	WCC	report	WWL	Obtained
-	EOS Report – Ecological assessment of streams in Lambton Harbour	WCC	report	WWL	Obtained
-	EOS Proposal – Ecological Assessment: ICMP Stage 2 Lambton Harbour	WCC	report	WWL	Obtained
-	Consented Culverts WQ Data July 2012 - Jan 2017	WCC	report	WWL	Obtained
-	Consented Culverts and Signs Sampling Guide	WCC	report	WWL	Obtained
-	2013_14 SW Discharge Consent Annual Report – July 2014	WCC	report	WWL	Obtained
40	Sump cleaning regime	All	spreadsheet	WWL	required
41	Culvert inlet clearing regime	All	spreadsheet	WWL	required
42	Street Sweeping	All	spreadsheet	WWL	required
43	Network renewal programme	All	spreadsheet	WWL	required
44	Stormwater flows (2yr, 20yr ARI)	All	spreadsheet	MWH	Obtained
45	Wellington Harbour dispersion model	-	report	GWRC	Not available
46	Porirua Harbour dispersion model	-	report	GWRC	Not available
47	Existing stormwater treatment devices	All	spreadsheet	WWL	Obtained
48	Cultural health index for streams and waterways technical report – April 2006	-			Obtained
49	<u>Dunedin City Council</u>				
-	Assessment of Environmental Effects Dunedin City Council Marine Stormwater Discharges	-	report	DCC	Obtained
-	Dunedin City Council - Consent Application - Appendix D - Proposed Monitoring Framework	-	report	DCC	Obtained
50	<u>Wellington International Airport Extension Project</u>	-			
-	Technical Report 14 - Prelim Shoreline Assessment	WCC	report	WIAL	Obtained
-	Technical Report 16 - Marine Sediments and Contaminants - Lyall Bay	WCC	report	WIAL	Obtained
-	Technical Report 17 - Assessment of coastal hydrodynamics and sediment processes in Lyall Bay	WCC	report	WIAL	Obtained
-	Technical Report 19 - Assessment of Ecological Effects	WCC	report	WIAL	Obtained
-	Technical Report 20 - Assessment of Submerged Wave Focusing Structure	WCC	report	WIAL	Obtained
51	Intertidal zone ecological assessment of Environmental Effects: Eastern Bays Shared Path – EOS ecology	HCC	report	McMurtrie & Brennan 2016	Obtained
52	<u>Transmission Gully</u>				
-	Technical Report 9 - Freshwater habitat and species: Description and values	PCC	report	NZTA	Obtained
-	Technical Report 10 - Estuarine habitat and species: Description and values	PCC	report	NZTA	Obtained

-	Technical Report 11 - Ecological impact assessment	PCC	report	NZTA	Obtained
-	Ecological impact assessment - Appendices	PCC	report	NZTA	Obtained
-	Technical Report 14 - Assessment of hydrology and stormwater effects	PCC	report	NZTA	Obtained
-	Assessment of hydrology and stormwater effects - Appendices	PCC	report	NZTA	Obtained
-	Technical Report 14 - Assessment of water quality effects	PCC	report	NZTA	Obtained
53	Design of Stormwater Monitoring Programmes – Technical Report. Feb 2014. NIWA	-	report	GWRC	Obtained
54	Stormwater toxicants: Summary of Greater Wellington's Expert Panel Workshop, 2 May 2011	-	report	GWRC	Obtained
55	Effects of urban stormwater in the Wellington Region	All	report	Williamson et al 2001	Obtained
56	Assessment of urban stormwater quality in Greater Wellington region	All	report	KML 2005	Obtained
57	Stormwater contaminants in urban stream in Wellington: A synthesis	All	report	Milne & Watts, 2008	Obtained
58	Stormwater monitoring in Porirua Streams	PCC	report	Milne & Morar 2017	Obtained
59	Gracefield stormwater consent – annual monitoring report 2016	HCC	report	WWL 2016	Obtained
60	Ecological restoration priorities for the Porirua Stream	PCC	report	Blaschke et al 2009	Obtained
61	The Porirua Harbour and its catchment	PCC	report	Blaschke et al 2010	Obtained
62	Kapiti , Southwest , South Coasts and Wellington Harbour Risk Assessment and Monitoring Recommendations	All	Report	Wriggle Ltd	Obtained
63	Porirua Harbour broad scale habitat	PCC	Report	Wriggle Ltd	Obtained
64	Wellington Harbour broad scale habitat	WCC	Report	Wriggle Ltd	Obtained
65	Hutt Estuary broad scale habitat	WCC	Report	Wriggle Ltd	Obtained
66	Development of EMC based pollutant models for five urbanised catchments in the Wellington Region (No 2). August 2004. Ref 956A/Revision 0	?	Report	Connell Wagner	Required
67	Development of EMC based pollutant models for five urbanised catchments in the Wellington Region. July 2002. Ref 7722440/Revision 2	?	Report	Connell Wagner	Required
68	Technical guidance document: Aquatic ecosystem health and contact recreation outcomes in the Proposed Natural Resources Plan	All		GWRC (Greenfield et al, 2015)	Obtained
69	Macroinvertebrate outcomes for aquatic ecosystem health in rivers and streams: Technical report to support the draft Natural Resources Plan	All		Greenfield, 2017	Obtained
70	Urban Streams Water Quality State and Trends. Prepared for Ministry for the Environment	All	Report	Gadd, (NIWA) 2016	Obtained
71	Inanga spawning habitat	All		Taylor et al	Obtained

Appendix B: Existing Environment Report

Wellington Water

Wellington Water Ltd Stage One Global Stormwater Discharge Consent

Existing Environment Report

Our water, our future.

Prepared by MWH, now part of Stantec
for
Wellington Water Ltd
July 2017

Prepared by ____[redacted]

[redacted] and [redacted]

Reviewed by ____ [redacted]

[redacted]

Approved by ____ [redacted]

[redacted]

Executive Summary

A Stage One stormwater discharge consent is required by Rule R50 of the Proposed Natural Resources Plan for the Wellington Region (PNRP). This report forms part of the Stage One stormwater consent application.

At a high level there are two major catchments or Whaitua which drain to the two major harbours in the western region, Wellington Harbour and Porirua Harbour. For the purpose of this assessment these areas have been divided into 28 sub-catchments which mostly correspond with stream catchments. Flat coastal areas without significant streams were combined into 'coastal' catchments.

The stormwater networks located within these catchments have been identified and mapped. Catchment characteristics including total area, percentage impervious, open channel stream length, and area of contaminated land, were summarised and significant sources of stormwater contamination identified. The latter includes wastewater overflows, landfills, quarries, transport networks, industrial areas, and other areas with a high proportion of impervious surface.

Information associated with the monitoring or investigations into stormwater quality, receiving water quality, surface water quantity, sediment quality and condition of biological communities was collated and summarised for each sub-catchment. That information was used to identify the values, pressures and current state of freshwater and coastal waters into which urban stormwater is discharged.

This description of the existing environment is the first step in the development of a stormwater monitoring plan, which is presented in separate document.

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1 Introduction

1.1 Purpose

A Stage 1 stormwater discharge consent is required by Rule R50 of the Proposed Natural Resources Plan for the Wellington Region (PNRP). A primary purpose of the consent is the development of a stormwater monitoring plan that will guide the collection of information to assist with the assessment of stormwater related effects, and to address any acute effects on human health. The Stage 1 consent application will cover all discharges of stormwater to freshwater and coastal water from the stormwater networks managed by Wellington Water Limited (WWL) on behalf of Wellington, Hutt, Upper Hutt and Porirua city councils. This includes the stormwater catchments that contribute to Porirua Harbour, Wellington Harbour and the Porirua - Wellington coastline where there are significant settlements discharging urban stormwater.

This report forms part of the Stage 1 stormwater consent application. Its purpose is to:

a) Describe the stormwater networks managed by WWL;

b) Describe the current state of catchments within which the stormwater networks are located, and the water bodies into which the stormwater is discharged, and

c) Identify the locations of relevant existing monitoring sites including those established for monitoring stormwater quality, receiving water quality, surface water quantity, sediment quality and condition of biological communities within the stormwater catchments.

Information contained in this report was used to prepare a stormwater monitoring plan (SMP) for the Wellington, Hutt Valley, Upper Hutt and Porirua areas over the next five years (WWL, 2017).

1.2 Definition of urban stormwater

In this report we have followed the stormwater definition proposed by Williamson, *et al.* (2001):

> "*Urban stormwater is the rain water runoff that is collected from roads, paths, roofs and other impervious surfaces, and conveyed through a stormwater reticulation system to be discharged to receiving waters. The stormwater system may also carry flow in dry weather, from interception of groundwater (and sometimes illegal sewage connections).*"

Impacts can occur during both rain runoff and during dry weather (especially microbiological quality). A third impact occurs when the receiving water system is effectively part of the stormwater system and has been modified to act in that way (e.g., the drainage system has been hydraulically improved). Receiving waters can be modified in other ways as well, such as being conveyed through culverts under roads.

One of the challenges faced in preparing of this report is deciding what is 'stormwater' and what are point source discharges or spills into stormwater drains or waterways. Another difficulty is defining where stormwater conduits end and natural waterways (i.e., the receiving waters) begin. Again, we have followed the approach taken by Williamson *et al.* (2001) where they defined stormwater as rainfall runoff plus diffuse (i.e., non-point source) discharges of contaminants to that rainfall runoff. Discharges of sewage, landfill leachate, industrial/commercial wastewater and spills are considered point source discharges to stormwater conduits. Stormwater conduits have generally been defined as man-made conduits, usually pipes. Streams, even when re-aligned and or highly modified, are generally regarded as the receiving environment.

1.3 Consented stormwater discharges

Wellington City Council (WCC) holds four discharge permits, WGN090219 [27418, 27419, 30500 & 30501], authorising the discharge of stormwater runoff from urban Wellington City catchments to the coastal marine area of Wellington Harbour and the South Coast between Horokiwi and Owhiro Bay. These consents were granted in February 2011 and will expire in February 2021. The consents were granted with a number of conditions including those requiring the preparation of Integrated Catchment Management Plans (ICMP), as well as monitoring of stormwater quality:

- Condition 12 (of WGN090219 [27418]): Stormwater outfall discharge monitoring of faecal coliforms once per month at the 20 specified monitoring locations. A series of field observations are recorded for each sample collection including those relating to wind, rain and tidal conditions, etc.
- Condition 13 (of WGN090219 [30501]) requires the consent holder to prepare and submit to GWRC a wastewater overflow monitoring and analysis plan.
- Condition 14 requires the consent holder to notify GWRC of any incidences of faecal coliforms from monthly monitoring exceeding 10,000 cfu/100 ml, and to collect a follow-up sample within 24 hours of receipt of the routine sample. In the event that the follow-up sample also exceeds 10,000 cfu/100 ml, a sanitary survey is required to be undertaken. A sanitary survey is also required if the rolling 12-month median value from monthly monitoring exceeds 1,500 cfu/100 ml. The sanitary survey is to be followed by remedial works which address the cause.
- Condition 15 requires the consent holder to collect seawater samples once per week between November to March and once per month between April and October at specified coastal bathing beach locations. This, in effect, requires WCC to collaborate with GWRC in running the coastal recreational water quality monitoring programme.
- Condition 16 requires the consent holder to submit for approval a detailed sampling and analysis plan for monitoring Wellington Harbour sediment quality and benthic fauna community health. This, in effect, requires WCC to collaborate with GWRC in running the Wellington Harbour marine sediment quality investigation.

Hutt City Council (HCC) holds a discharge permit, WGN070053[25551] authorising the discharge of stormwater from the lower Gracefield catchment to the Waiwhetu Stream via a pump station. This consent was granted in March 2007 and will expire in March 2022. The consent was granted with a number of conditions including the development and implementation of a stormwater monitoring plan to assess the quality of stormwater in the Gracefield catchment, as well as project to mitigate the effects of contaminants entering the stormwater system.

Upper Hutt City Council and Porirua City Council do not currently hold stormwater discharges consents for their local authority stormwater discharges.

1.4 Integrated catchment management plans

Wellington Water (formerly Capacity), acting for WCC, have completed Stage 1 ICMP for urban catchments of Wellington City in March 2014 (Capacity, 2014). They are scheduled to complete the Stage 2 ICMP's in March 2018.

Condition 7 of the resource consent requires stage 1 ICMP's to:

- Describe the stormwater catchment characteristics;
- Refer to the environmental objectives already submitted for approval by GWRC;
- Identify and assess stormwater network issues (including wastewater inputs to the stormwater network) and contaminants;
- Set out methods and a timetable to manage the issues which are to be addressed;
- Identify and prioritise areas for issue management;
- Set out a timetable for the catchment specific plans to be prepared in Stage 2 of the ICMP.

WCC's Stage 1 ICMP covers stormwater sub catchments from Owhiro Bay in the southwest to Horokiwi/Bellevue in the northeast. The Stage 1 ICMP development includes descriptions of the stormwater catchment characteristics, receiving environment values, stormwater network issues, a high level assessment of effects of contaminants and stormwater management recommendations.

The Stage 2 ICMPs, when they become available, will include an assessment of management options, a statement of targets and standards for catchment performance monitoring, as well as priorities and timetables. It is noted that ICMP currently under development cover only the Wellington urban area and that the same level of information will not be available for the Porirua, Hutt Valley or Wainuiomata areas.

1.5 Overview of the stormwater networks

The proximity of the coast, harbours and streams result in a system of numerous localised stormwater networks. Rural areas are generally served by open streams and water courses, while runoff in urban areas is mostly directed through piped systems. Most developed areas of the Wellington region are serviced by reticulated stormwater networks which are intended to provide for the effective disposal of stormwater from residential properties and the business community.

The stormwater networks comprise pipes and channels which discharge into open drains, watercourses, harbours, and the ocean at many locations across the region. The network lengths and components for the four cities are summarised in Tables 1-1 and 1-2 below.

Table 1-1: Stormwater network lengths by local authority (WWL asset data)

Council	Network Length (km)
Hutt City	526
Porirua City	275
Upper Hutt City	151
Wellington City	688
Total	1,640

Table 1-2: Components of the HCC, UPCC, PCC and WCC stormwater networks (WWL asset data)

Asset Descriptions	Quantity
Pipes[1] (km)	1,640
Number of network fittings	56,619
Number of pump stations	21
Length of channels (km)	38.5
Number of detention dams	7
Length of tunnels (km)	1.69

[1]Total public stormwater pipe length

Most pipelines in the stormwater networks operate by gravity drainage and are not intended to operate under pressure. Pump stations provide drainage from localised areas which are too low lying for gravity drainage to be effective. Intakes to the stormwater system often incorporate debris traps to intercept solid material. Beyond this, stormwater is generally not treated to remove contaminants. This means that many contaminants entering the stormwater system are subsequently discharged to receiving water bodies.

The stormwater networks are designed to accommodate stormwater runoff resulting from rainfall of defined intensities (expressed in terms of the average exceedance probability or average return period [ARI] of the rainfall). It is inevitable that stormwater pipelines will be overloaded whenever rainfall exceeds the design standard. New or upgraded stormwater pipelines are designed to higher standards that reflect the flood risk in different situations and take account of predicted climate change.

1.6 Overview of the stormwater catchments

The region's topography contains many well defined watersheds and individual catchments. At a high level, there are two major catchments or Whaitua which drain to the two major harbours in the western region, Wellington Harbour and Porirua Harbour. The Wellington Harbour and Hutt Valley Whaitua is defined by the western and southern coastal areas, and the ranges to the north and east which bound the Kapiti and Ruamahanga (Wairarapa) catchments. Te Awarua o Porirua Whaitua covers an area that drains into the Porirua Harbour and includes developed areas between Johnsonville and Pukerua Bay.

In this report the Wellington/Hutt Valley and Porirua catchments are addressed separately. The Wellington Harbour/Hutt Valley area is described within 21 sub-catchments, 9 in Wellington and 12 in the Hutt Valley. The Porirua Harbour catchment is described within 7 sub-catchments (Figure 1-1). The 28 sub-catchments mostly correspond with stream catchments, except for larger rivers which may be broken into smaller sub-catchments, and flat coastal areas without significant streams which are combined into 'coastal' catchments. The characteristics of these sub-catchments are summarised in Tables 1-3, 1-4 and 1-5.

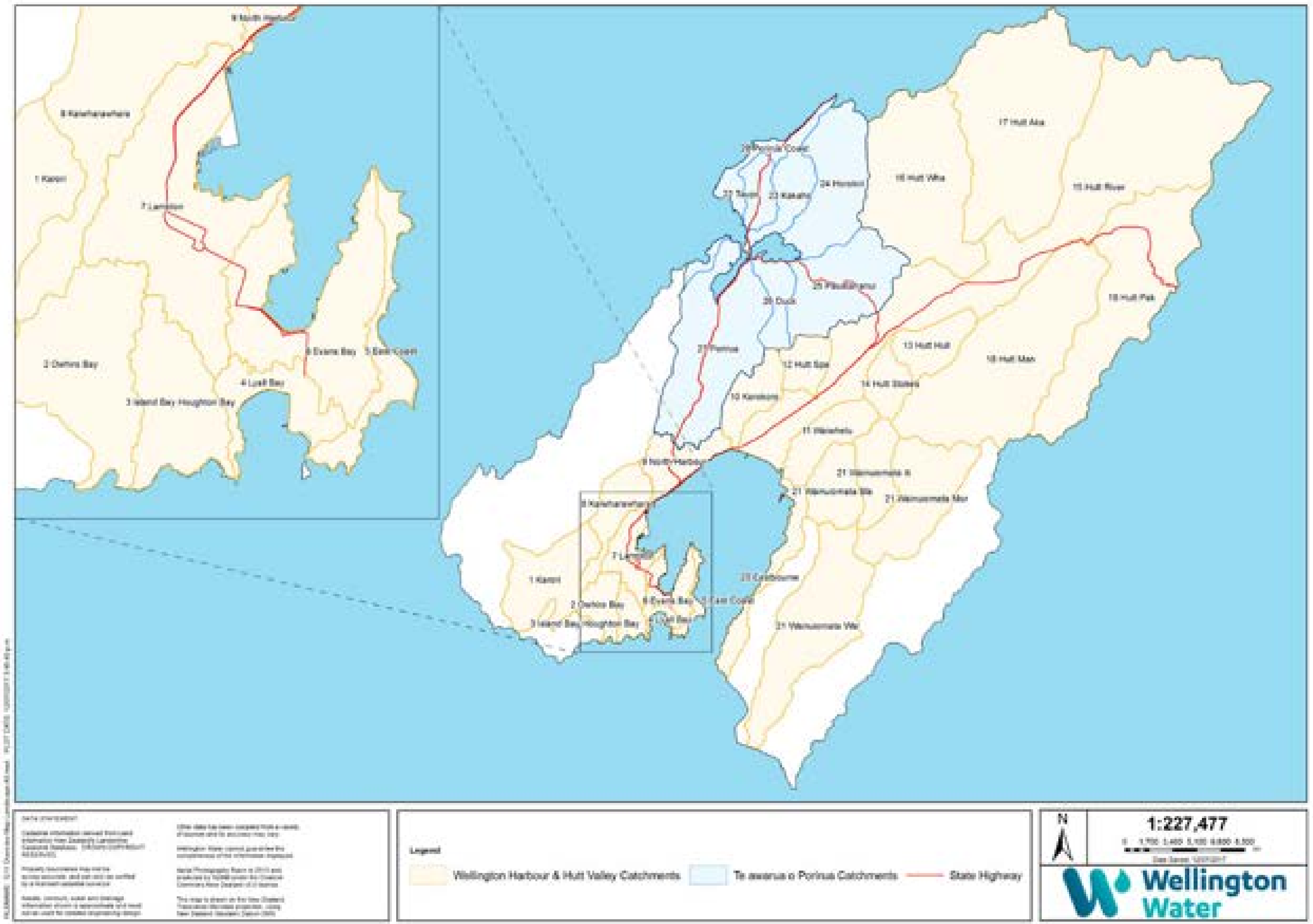

Figure 1-1: Porirua Harbour and Wellington Harbour stormwater catchments

Table 1-3: Summary of Wellington catchment characteristics

Catchment	Sub catchment	Total catchment area (km^2)	Peak flow 2 year ARI	Stormwater catchment		Impervious surface		Open stream channel length (km)	Stream type	No. of Outfalls to CMA (>600mm dia)	No. of wastewater overflow structures		Area of contam. land (km^2)	Contamination 'hot spots'
				Area (km^2)	% of total	Area (km^2)	% of total				PS	CSO		
1. Karori	Karori	30.93	36.3	4.29	13.88	1.70	5.50	32.9	Modified mostly open	Stream outlet	To be determined	8	0.25	Closed landfills (x2)
2. Owhiro Bay	Owhiro Stream	9.71	20.1	4.93	50.78	1.02	10.52	26.3	Modified, partly open	Stream outlet	2	1	2.09	Closed landfills (x3) Current landfills (x3: Southern, T&T, C&D)
3. Island/ Houghton bays	Island Bay	5.12	14.4	4.16	81.28	1.71	33.49	6.00	Minor headwater fragments	3	2	3	0.31	Closed landfills (x6)
	Houghton Bay	0.88	3.2	0.47	54.07	0.13	14.84	0.10	Minor headwater fragments	1	1	0	0.12	Houghton Bay landfill, closed 1971. Currently a source of leachate to Houghton Bay
4. Lyall Bay	Lyall Bay	2.84	8.5	2.64	93.17	1.36	47.94	1.00	Minor headwater fragments	15	6	1	0.27	Closed landfill (x2)
5. East Coast	Southeast coast Seatoun/ Karaka Crawford	2.93	No data	1.29	43.9	0.65	22.24	2.82	Minor stream fragments	2+ many minor	7	2	0.03	Moa Point emergency wastewater outfall; Closed landfill (x1)
6. Evans Bay	Miramar/ Strathmore	4.40	12.8	4.05	92.02	1.94	44.14	4.52	Minor headwater fragments	1	3	4	0.26	Closed landfill (x2)
	Kilbirnie/ Rongotai	1.75	No data	1.62	92.26	0.99	56.36	0	No open streams	8	2	0	0.19	Closed landfill (x1); former gasworks; oils in marine sediments near Miramar Wharf
	Hataitai	1.39	5.2	1.15	82.77	0.55	39.41	0	No open streams	1	1	2	0.01	None anticipated.
	Grafton-Rata	0.84	No data	0.69	82.1	0.33	39.00	0	No open streams	?	3	0	?	None anticipated.
7. Lambton & Oriental	Oriental Bay	0.49	No data	1.34	96.57	0.59	42.32	1.00	Minor stream fragments	5	1	0	0.00	Railway yards and workshops, Port yards; Urban motorway; Closed landfills (x3)
	Southern CBD	8.23	No data	6.77	82.21	4.00	48.59	12.18	No open stream	5	4	15	0.46	
	Northern CBD	4.94	No data	4.26	86.38	2.30	46.57	5.34	Minor stream fragments	14	6	3	0.72	
8. Kaiwhara-whara	Kaiwharawhara	16.60	29.9	9.28	55.92	2.96	17.85	24.11	Significant open stream	Stream outlet	1	1	0.97	Motorway; Closed landfills (x5)
9. North harbour	Onslow Ngauranga Horokiwi	15.84	23.7	10.65	67	3.78	23.8	32.9	Stream fragments	Stream outlets	2	2	1.27	Light industry, quarries (x2) Closed landfills (x5)

Table 1-4: Summary of Hutt Valley and Wainuiomata catchment characteristics

Catchment	Sub-catchment	Total catchment area (km²)	Peak flow 2 year ARI	Stormwater catchment		Impervious surface		Stream length REC (km)	Stream type	No. of Major Outfalls to CMA (>600mm dia)	No. of wastewater overflow structures		Area of 6ontaminate land (km²)	Contamination 'hot spots'
				Area (km²)	% of total	Area (km²)	% of total				PS	CSO		
10. Korokoro	Korokoro	15.70	No data	0.41	2.59	0.73	4.68	23.24	Modified mostly open	Stream outlet	2	0	0.10	None anticipated.
11. Waiwhetu	Waiwhetu	18.65	No data	11.05	59.28	10.17	54.53	26.99	Heavily modified mostly open	Steam outlet	1	9	1.38	Gracefield industrial areas; Railway workshops; Main trunk railway; Oil storage facility
12. Hutt – Spe	Speedys	11.61	No data	1.41	12.11	0.92	7.90	19.35	Modified mostly open	0	0	0	1.13	None anticipated.
13. Hutt – Hull	Hulls Creek	16.58	No data	7.18	43.31	0.04	0.23	24.84	Heavily modified, partly open	0	1	0	2.57	Silverstream Landfill, Trentham Racecourse, Trentham Riffle Range
14. Hutt – Sto	Stokes Valley	11.96	No data	4.71	39.43	4.47	37.36	16.76	Heavily modified partly open	0	0	0	0.12	None anticipated.
15. Hutt – Hutt	Hutt – Lower Hutt – Upper Hutt – Headwater	199.16	No data	51.04	25.63	21.24	10.67	316.81	Modified, all open river	River mouth	28	2	6.79	Silverstream landfill Motorway Main trunk railway Gracefield industrial area.
16. Hutt – Wha	Whakatiki	81.84	No data	0.39	0.47	0.00	0.00	128.72	Modified open river	0	0	0	0.00	None anticipated.
17. Hutt – Aka	Akatarawa	116.42	No data	0.07	0.06	0.00	0.00	181.32	Unmodified open river	0	0	0	0.80	None anticipated.
18. Hutt – Man	Mangaroa	104.10	No data	0.93	0.89	0.00	0.00	167.17	Modified, open river	0	0	0	1.80	None anticipated.
19. Hutt – Pak	Pakuratahi	81.38	No data	0.00	0.00	0.00	0.00	124.6	Modified, open river	0	0	0	0.35	None anticipated.
20. Eastbourne	Eastbourne	19.37	No data	3.42	17.65	3.05	15.77	16.18	Days Bay Stream	+++minor	12	0	0.34	None anticipated.
21. Wainui-omata River	Black Creek	18.44	No data	8.07	43.75	6.07	32.89	26.49	Heavily modified, partly open	0	8	5	0.34	None anticipated.
	Wainuiomata-iti	17.38	No data	0.00	0.00	0.29	1.64	24.63	Modified, all open	0	0	0	0.0	None anticipated.
	Wainuiomata	57.85	No data	1.84	3.19	1.28	2.21	91.89	Modified, all open	river	0	1	1.81	Wainuiomata Landfill
	Morton	40.06	No data	0.21	0.52	0.18	0.45	57.76	Unmodified open river	0	0	0	0.00	None anticipated.

Table 1-5: Summary of Porirua catchment characteristics

Catchment	Sub-Catchment	Total catchment area (km²)	Peak flow 2 year ARI	Stormwater catchment		Impervious surface		Stream length REC (km)	Stream type	No. of Major Outfalls to CMA	No. of wastewater overflow structures		Area of contaminated land (km²)	Contamination 'hot spots'
				Area (km²)	% of total	Area (km²)	% of total				PS	CSO		
22. Taupo	Taupo	10.58	No data	0.79	7.44	1.29	12.23	17.60	Modified, all open	stream	2	0	0.23	None anticipated.
23. Kakaho	Kakaho	17.76	No data	0.41	9.65	1.17	7.95	18.81	Modified, all open	stream	1	0	0.04	None anticipated.
24. Horokiri	Horokiri	41.02	No data	0.00	0.00	0.23	0.55	61.76	Modified, all open	stream	0	0	0.24	None anticipated.
25. Pauatahanui	Pauatahanui	41.56	No data	1.17	2.83	1.98	4.78	67.75	Modified, all open	stream	0	0	0.94	None anticipated.
26. Duck	Duck	10.03	No data	3.28	32.74	2.46	24.47	16.87	Modified, mostly open	stream	1	0	0.00	None anticipated.
27. Porirua	Aotea/Harbour	10.71	No data	7.22	67.4	4.82	45	11.8	Modified, fragments only	++minor	2	0	0.01	Spicers landfill; Closed landfills (x3); Light industrial areas of Tawa, Lindon and Porirua; Main trunk railway; Motorway
	Porirua	31.59	No data	18.74	59.32	11.67	36.93	49.55	Heavily modified, partly open	stream	~20	1	20.9	
	Paparangi	8.99	No data	1.10	12.20	0.48	5.29	15.07	Heavily modified, partly open	++minor	0	0	0.22	
	Churton	15.25	No data	9.31	61.03	2.29	15.03	22.02	Heavily modified, partly open	++minor	0	0	0.21	
28. Porirua coast	Porirua coast	14.4	No data	2.25	15.6	2.91	20.19	9.7	Modified, fragments only	++minor	4	0	0.68	None anticipated.

2 Stormwater monitoring overview

2.1 Historic stormwater monitoring

This section provides an overview of the historic stormwater monitoring that has occurred. Key sources of information are listed in Table 2-1. The water quality guidelines used in this report are tabulated in Appendix A.

Table 2-1: Information sources used in this report

Source	Water body	Information	Sites referenced
Cameron & Laurenson (2008)	Wellington Harbour and South Coast	Wellington urban stormwater discharge to the CMA, consent applications & AEE	20 stormwater network
Cameron (2015)	Wainuiomata River & Black Creek	Habitat quality, periphyton & invertebrates.	4 sites on Wainuiomata River and 1 on Black Creek
Cameron (2016)	Hutt River	Habitat quality, periphyton & invertebrates,	5 sites on the upper and middle reaches
Cameron (2017)	Owhiro Stream	Habitat quality, invertebrates, water quality	5 Sites near T&T Landfill
Capacity (2011)	Wellington S/W & wastewater	Overflow monitoring and analyses plan	multiple
Capacity (2013)	Wellington urban catchments	Wellington stormwater catchment and network characteristics	n.a.
Diffuse Sources (2014)	Wellington urban catchments	Impacts of stormwater discharges to CMA	multiple
Diffuse Sources	Wellington urban catchments	Contaminant load data	18 sub-catchments
(Greenfield, et al., 2015)	Wellington Region	Technical guidance for aquatic ecosystem health and contact recreation in fresh and coastal waters	Generic
Heath & Greenfield (2016)	Hutt River	Cyanobacteria blooms in Wellington Rivers	multiple
HCC data	HCC urban streams/culverts	Monthly microbiological monitoring	15 sites
James (2015)	Lambton harbour stream fragments	Ecological assessment based on existing data	multiple
KML (2005)	Urban streams	Aquatic ecology, invertebrate management groups	Kapiti, Porirua, Wellington & Hutt
KML (2005a)	Urban streams	Stormwater quality monitoring in residential and industrial catchments	Wellington (4), Hutt (3), Porirua (4)
Markland et al (2005)	Te Mome Stream	Water and sediment quality in Te Mome Stream	4 stream sites
Milne & Watts (2008)	Urban streams	Sediment, stormwater and streams	29 sites regionally
Milne (2010)	Wellington Harbour	Supplementary report	17 sub tidal sites
Milne & Morar (2017)	Porirua urban streams	Water quality and stormwater quality (2011- 2012)	Porirua, Mitchell, Kenepuru, Duck, Browns, Horokiri and Pauatahanui
Morar & Perrie (2013)	Rivers & streams	Regional RsoE annual report 2012/13	multiple
Morar & Greenfield (2016)	Coastal & freshwater	Regional Recreational water quality	multiple
Morar *et al* (2016)	Rivers and streams	Regional RsoE 2015/16	multiple
Oliver (2014)	Wellington Harbour	Marine sediment quality & benthic ecology (2011)	16 sub tidal sites
Oliver & Conwell (2014)	Porirua Harbour	Marine sediment quality (2010 survey)	Onepoto Arm (2), Pauatahanui Arm (3)
Perrie (2008)	Karori Stream	Habitat quality, invertebrates	2 sites
Perrie et al (2012)	Rivers & streams	Regional State & Trends	multiple
PCC data (2015-2016)	Porirua minor streams	Monthly microbiological monitoring in minor streams	9 sites
PCC (2016)	Porirua stormwater network	Stormwater network characteristic	N.A.
Sorenson & Milne (2009)	Porirua Harbour, & Porirua, Kenepuru and Onepoto streams	Sediment quality sampling	Multiple sites

Source	Water body	Information	Sites referenced
Stephenson & Mills (2006)	Porirua Harbour	Marine sediment quality & benthic ecology (2005 survey)	
Stephenson *et al* (2008)	Wellington Harbour	Marine sediment quality & benthic ecology	17 sub tidal marine sites
Stevens et al (2016)	Hutt Estuary	Broad scale habitat assessment	Multiple sites
Stevens et al (2004)	Wellington coast	Broad scale habitat assessment	Multiple sites
UHCC (2016)	S/W network	Description of stormwater network	n.a.
UHCC data	Minor streams	Monthly microbiological monitoring in minor urban streams	Multiple sites
WCC data	Minor streams	Quarterly microbiological monitoring in minor urban streams	27 sites
Wellington Water (2016)	Gracefield sub-catchment	Wet and dry weather stormwater samples from the Gracefield stormwater	13 S/W network sites
Williamson et al (2001)	Coastal and freshwater	Effects of urban stormwater: Synthesis of existing information	Multiple.
Warr (2007)	Hulls Creek	Water quality and aquatic ecology	10 stream sites

2.1.1 Greater Wellington Regional Council

Since 2001 GWRC has conducted a series of investigations into the effects of urban stormwater discharges on aquatic environments within the Wellington region (e.g., Williamson *et al.* 2001; KML 2005; KML 2005b; Markland *et al* 2005; Stephenson & Mills 2006; Stevenson *et al.* 2008, Milne & Watts 2008; Sorenson & Milne; 2009, Milne 2010; Oliver & Conwell 2014; and Milne & Morar, 2017). These investigations show that stormwater entering urban streams and the coastal environment contains a wide range of contaminants, some of which, through long term accumulation, could eventually have (or already have had) significant adverse effects on some freshwater and coastal aquatic ecosystems.

GWRC also conducts extensive receiving environment monitoring across the region (in some cases in conjunction with the relevant local authorities) including:

- Freshwater and coastal recreational water quality (Morar & Greenfield, 2016) summarised in Appendices B and C,
- Rivers state of the environment monitoring (e.g., Perrie *et* al 2012, Morar & Perrie 2013, Morar *et al* 2016) summarised in Appendices D and E.
- Marine sediment quality and benthic ecology surveys (Stephenson & Mills 2006; Stevenson *et al.* 2008; Milne & Watts 2008; Sorenson & Milne,2009; Milne 2010; and Oliver & Conwell 2014).
- Marine sediment quality and benthic ecology samples were collected from Wellington Harbour during November and December 2016. While sediment chemistry results are available (Olsen, *et al.*, 2017; Olsen, 2017), the full GWRC survey report is not expected to be available until late 2017.

2.1.2 Local authorities

All of the local authorities have conducted additional microbiological monitoring in small urban streems that are significantly affected by urban stormwater. The results of monthly indicator bacteria monitoring in minor streams by WCC, HCC, and PCC, in addition to the sources listed above, is summarised in Appendices G, H and I, respectively.

2.1.2.1 Wellington City Council

WCC is required by conditions of its stormwater consent to:

- Conduct regular monthly monitoring of faecal coliforms in stormwater at 20 locations (3 stream outlets and 15 stormwater culverts, refer Appendix F). The results collected to date show all that 20 sites have exceeded the consent single sample trigger value of 10,000 cfu/100 ml on at least one occasion, and a number of sites have also exceeded the 12 month rolling median value trigger of 1,500 cfu/100 ml. The latter includes stormwater culverts at Island Bay, Bowen Street, Overseas Terminal, Taranaki Street, and Tory Street.
- In addition general water quality and trace metals were monitored twice yearly from 2000 to 2010 (at least once each year in wet weather) in stormwater at the Evans Bay Culvert (Hataitai), Waring

Taylor Culvert, Overseas Passenger Terminal Culvert, Houghton Bay Culvert and the Island Bay Culvert.

- Prepare a wastewater overflow and monitoring plan, conduct ongoing monitoring in accordance with the plan (refer Appendix L), and contribute to the GWRC coastal recreational water quality monitoring programme and the marine sediment quality and benthic ecology surveys for Wellington Harbour outlined above.
- Commission a series of technical reports as part of the ICMP development including a Wellington City wastewater overflow monitoring and analysis plan (Capacity, 2011), an assessment of stormwater impacts in the Marine Environment around Wellington City (Diffuse Sources Ltd, 2014), and ecological assessment of terrestrial and freshwater ecosystems within the Lambton Harbour catchment (James, 2015).

2.1.2.2 Hutt City Council

HCC conducts stormwater monitoring in accordance with its discharge permit authorising the discharge of stormwater from the lower Gracefield catchment to the Waiwhetu Stream via a pump station (WWL, 2016). The results for the Gracefield sub catchment are summarised in Appendix K.

2.1.2.3 Upper Hutt City Council

HCC conducts microbiological monitoring at various locations in minor streams and drains within the Hutt River flood plain but to date this monitoring has not been developed into an ongoing monitoring programme.

2.1.2.4 Porirua City Council

PCC has conducted routine monthly monitoring at the nine sites on minor streams and drains. Water samples are tested for the indicator bacteria *E. coli* to monitor the level of microbiological contamination in these watercourses. Summary statistics for the period January 2015 to August 2016 are included in Appendix I. Wastewater overflow investigations are outlined in Appendix M.

2.2 Urban stormwater quality

The results of twice yearly monitoring of stormwater at the Evans Bay Culvert (Hataitai), Waring Taylor Culvert, Overseas Passenger Terminal Culvert, Houghton Bay Culvert and the Island Bay Culvert (MWH, 2008) show that total suspended solids and biological oxygen demand (BOD_5) concentrations are generally low in Wellington urban stormwater (Table 2-2). The highest total suspended solids concentrations were recorded at the Houghton Bay Culvert, which drains a steep catchment that includes the closed Houghton Bay Landfill. Nutrient concentrations are moderately elevated, but these and BOD_5 are of less concern in streams at high flow or for exposed coastal receiving environments. Of the metals tested in Wellington stormwater only Cu and Zn were frequently elevated above ANZECC (2000) water quality guidelines (Jayaratne, et al., 2015). Results of quarterly wet weather monitoring in the Gracefield industrial area also included in Table 2-2 generally show higher Pb and Zn concentrations than at the Wellington sites.

Table 2-2: Median stormwater quality monitoring results from consent monitoring at Wellington (WCC data, 2002 to 2008) and Gracefield (WW data, 2016) stormwater culverts

	GWRC & ANZECC 95% TVs	NZ National Industrial (URQIS)	Waring Taylor Culvert (Lambton)	OPT Culvert (Lambton)	Hataitai Culvert (Evans Bay)	Island Bay	Houghton Bay	Site 1A Gracefield (Waiwhetu)
TSS (mg/L)	N.A.	21	12	17	35	34	41	23
BOD5	N.A	–	<2	<2	<2	2	5	–
TKN	–	2.0	0.50	0.60	0.80	0.50	2.55	–
TP	<0.033	0.42	0.065	0.120	0.100	0.05	0.114	–
Faecal coliforms (cfu/100ml)	<1000	2800	1000	4,100	370	2200	600	3400
Dissolved copper (mg/L)	<0.0014	0.006	–	–	–	–	–	0.015
Dissolved lead (mg/L)	<0.0034	0.00038	–	–	–	–	–	0.008
Dissolved zinc (mg/L)	<0.008	0.380	–	–	–	–	–	0.421
Total copper (mg/L)	N.A	0.015	<0.03	<0.03	<0.03	<0.03	<0.03	0.026
Total lead (mg/L)	N.A	0.003	<0.005	<0.005	<0.005	<0.005	0.009	0.035
Total zinc (mg/L)	N.A	0.470	<0.05	0.067	<0.05	<0.05	<0.05	0.421

WCC monitoring of faecal coliforms and enterococci in 20 major discharge locations has been used to identify faults in the wastewater and stormwater networks and examine the systems response to remediation work (e.g. fixing cross connections, leaks, and overflows). These data have been further analysed to assess trends over time in stormwater microbiological quality (see Appendix F).

A GWRC stormwater investigation reported by Kingett Mitchell (KML 2005) included limited monitoring of organic compounds, which detected elevated levels of PCBs and DDT metabolites (the latter and organochlorine pesticide) both dissolved in stormwater and attached to particulate material carried by stormwater. Since neither PCBs nor DDT has been used in New Zealand since around the 1980s, this contamination is thought to be historical and concentrations are expected to gradually decrease over time. Chlorophenol compounds (historically used in timber preservation) were found only at low concentrations. PAHs were detected at most sampling locations. While concentrations in stormwater were mostly lower than ANZECC receiving water trigger levels, the concentrations in particulate material carried by stormwater frequently exceeded ANZECC (2000) sediment quality trigger levels. The identified PAH profile appeared to reflect emission of PAHs from motor vehicles.

2.3 Sediment loads in stormwater

Estimated sediment loads from Wellington City to the Harbour and coastline are relatively low, especially compared with the load from the Hutt River catchment (Table 2-3). There is relatively little ongoing green-field development in Wellington and hence bare soil, which is the major source of fine sediments in urban areas (Jayaratne *et al.*, 2015). Limited sampling of Wellington stormwater drains showed fine sediment concentrations were not particularly high, and typical of mature urban areas (Capacity 2014).

The Hutt River catchment provides the largest sediment load to Wellington Harbour. If this load were to be equally distributed and settled over the whole harbour, it would give a deposition rate of about 1mm/year (for 85 km^2 harbour). However it is likely that a high proportion of the Hutt River load leaves the harbour during northerly winds (Capacity, 2014).

Table 2-3: Estimated sediment loads to Wellington Harbour (from Capacity 2014)

Catchment	Area (ha)	Annual sediment load (kt/year)	Catchment yield (tonnes/ha/year)
Hutt River	61,500	132	2.14
Kaiwharawhara Stream	1,680	1.30	0.77
Ngauranga Stream	920	0.60	0.65
Wellington Harbour urban areas (Lambton Harbour, Kaiwharawhara, North Coast, Evans Bay	5,650	2.20	0.39

The results of a modelling study conducted by Coastal Management Consultancy Ltd (2011) show that sediment loads and calculated yields from the urban areas of Porirua City to Porirua Harbour are also low compared to the less urbanised catchments such as Horokiri and Pauatahanui (Table 2-4). Oliver & Milne (2012) reported that as at January 2011, sedimentation rates in Porirua Harbour were rated as 'low to moderate'.

Table 2-4: Estimated sediment loads and calculated yields by sub catchment for the Porirua Harbour catchment (based on unmodified CLUES modelling, from Coastal Management Consultancy Ltd, 2011)

Catchment	Area (ha)	Annual sediment load (kt/year)	Catchment yield (t/ha/year)
Camborne Stream	25	0.014	0.56
Kakaho Stream	1246	2.320	1.86
No. 2 Stream	39	0.038	0.97
Horokiri Stream	3,306	6.880	2.08
Ration Stream	680	0.442	0.65
Collins Stream	63	0.030	0.48
Pauatahanui Stream	4,168	5.519	1.32
Duck Creek	1030	1.354	1.32
Browns Creek	135	0.051	0.38
Subtotal Pauatahanui	*10,692*	*16.648*	*1.56*

Catchment	Area (ha)	Annual sediment load (kt/year)	Catchment yield (t/ha/year)
Papakowhai north	63	0.025	0.40
Papakowhai south	28	0.013	0.47
Aotea Lagoon	42	0.022	0.52
Okowai Road	52	0.036	0.70
Kenepuru Stream	1,266	1.089	0.86
Porirua Stream	4,108	4.164	1.01
Semple Street Stream	160	0.064	0.40
Takauwhaia Stream	347	0.205	0.59
No 13 Stream Titahi	101	0.034	0.34
No 14 Stream Onepoto	111	0.023	0.21
No 15 Stream Te Onepoto	98	0.061	0.62
Subtotal Onepoto	*6,376*	*5.735*	*0.90*
Overall Total	**17,068**	**22.383**	**1.31**

2.4 Heavy metal and PAH loads in stormwater

Stormwater loads of Zn, Cu, Pb and PAH have been calculated for each of the Wellington urban stormwater catchments from event mean concentrations and estimated annual stormwater runoff volumes as part of Wellington's Stage 1 ICMP programme (Diffuse Sources, 2014; Capacity, 2014; and Jayaratne *et al.* 2015). The results are summarised in Table 2-5.

Table 2-5: Calculated contaminant loads in stormwater runoff from Wellington urban catchments (data from Diffuse Sources Ltd)

Area	Sub-catchment	Area (km^2)	PAH (g/yr)	Pb (kg/yr)	Cu (kg/yr)	Zn (kg/yr)
Owhiro	Owhiro Bay	9.71	7.1	19.4	27.1	235
Island/ Houghton	Island Bay	5.12	11.0	30.4	40.7	385
	Houghton Bay	0.88	0.9	2.6	3.4	32
Lyall Bay	Lyall Bay	2.84	8.1	14.1	27.1	224
East Coast	South East Coast	10.9	0.7	2.0	2.6	25
	Seatoun/Karaka	1.85	3.8	10.7	14.3	137
Evans Bay	Crawford	1.00				
	Miramar/Strathmore	4.40	11.7	30.4	43.4	404
	Kilbirnie Rongotai	1.75	6.1	15.0	23.3	193
	Hataitai	1.39	2.4	6.5	8.8	86
	Grafton/Rata	0.84				
Lambton	Oriental Bay	0.49	4.0	11.0	15.1	138
	Southern CBD	8.23	39.0	98.5	141.8	1201
	Northern CBD	4.94	23.3	58.9	81.3	716
Kaiwhara	Kaiwharawhara	16.6	16.0	46.6	57.9	597
North Harbour	Onslow	1.44	3.6	9.5	13.1	121
	Ngauranga	9.66	22.0	61.7	85.2	769
	Horokiwi Bellevue	4.73	1.8	4.2	6.3	47
	Total	**86.8**	**162**	**422**	**592**	**5309**

Contaminant load modelling is currently being undertaken for the Porirua Harbour catchments as part of the Whaitua process, but modelling results were not available at the time of finalising this report.

3 Current state of receiving environments in Wellington and Hutt Valley

3.1 Catchment overview

Wellington City's stormwater network extends from Karori to the west, Owhiro, Island, Houghton and Lyall bays to the south, through Seatoun, Miramar, Lambton Harbour, Kaiwharawhara, Ngauranga and Korokoro to the north east. These catchments drain either to Wellington's very exposed south coast or to the relatively sheltered waters on the western side of Wellington Harbour. The Hutt Valley stormwater network include those in Petone, Lower Hutt and Upper Hutt, all of which drain into the Hutt River system which enters the north-eastern side of Wellington Harbour. The Wainuiomata catchment drains to the south coast near Baring Head.

Overview maps of the Wellington Harbour and Hutt Valley catchments areas, catchment boundaries, rainfall and river flow monitoring stations, land use categories, contaminated land are shown in Figures 3-1 to 3-8. Detailed maps showing the location of stormwater infrastructure, stormwater monitoring locations, sewer mains, constructed sewer overflows and pump station overflows are included in Appendix N.

The following sections describe the current state of receiving water habitats, both freshwater and estuarine/coastal habitats, which are potentially affected by urban stormwater discharges.

3.2 Freshwater habitats

3.2.1 Karori Stream

Catchment characteristics

The Karori Stream catchment lies to the west of Wellington City centre, extending from Messines Road in north-eastern Karori to the stream mouth between Karori Rock and Sinclair Head on Wellington's south coast. The principal headwater tributary of Karori Stream arises within urban Karori and is fed by run-off from a residential catchment. A second major headwater tributary (Silver Stream) drains "Long Gully" which is in pasture and scrub and is relatively unaffected by urban development. The middle and lower stream runs through pasture, scrub and plantation forestry. The stream has a dry weather base flow of approximately 100 L/s, a 2-year average return interval (ARI) storm flow of 36,300 L/s and a 20-year ARI storm flow of 57,100 L/s.

The catchment covers a total area of 30.9 km^2 of which an estimated 6% is impervious surface (under roofs, roads, car-parks, etc.). The contributing catchment to the RsoE monitoring site at Makara Peak Mountain Bike Park is in 50.7% urban land-cover (Table 3-1).

Table 3-1: GWRC RsoE %Land-cover types in contributing catchment – Karori

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS18	Karori S at Makara Peak	Impacted	fair	45.7	0.6	0.0	2.4	50.7	0.6

An extensive stormwater network has been developed in urban Karori, largely replacing natural headwater streams in the upper catchment. The urbanised area of Karori is predominantly residential, but with significant commercial and community infrastructure (supermarkets, shops, schools, swimming pool, service stations, restaurants and bars, etc.). Closed landfills are located at Futuna Retreat (Friend Street) and Ben Burn Park, but none are currently operating. The Western Wastewater Treatment Plant is located downstream of the urban area on South Karori Road. The treated wastewater is piped to Wellington's South coast near the Karori Stream mouth. A total of 8 wastewater overflow locations are identified in the catchment which intermittently overflow in wet weather conditions either directly into Karori Stream or into the stormwater network which discharges into the stream.

The main transport route into and through Karori (Karori Road) carries moderately high traffic volumes. Typically upwards of 40% of the pollution load carried in urban runoff can be attributed to runoff from roads and vehicle emissions, particularly PAH's, Zn, Cu and Pb (Babich & Lewis, 2001).

The rural lower reach of Karori Stream has been repeatedly burnt and extensively grazed but maintains moderate instream habitat quality and a moderately diverse native fish population (KML, 2005).

Water quality

A GWRC RsoE site is located on the Karori Stream at the Makara Peak Mountain Bike Park immediately downstream of urban Karori, at which point the contributing catchment is 51% urban. This site received a 'fair' WQI grade for the 2015/16 year and was ranked 46th out of 53 sites in the Wellington Region. Water quality at this location normally meets recommended guidelines for dissolved oxygen, visual clarity and ammoniacal nitrogen but typically fails to meet guidelines for *E. coli.*, nitrate/nitrite nitrogen and dissolved reactive phosphorus.

Water quality summary statistics included in Appendix D show the median and maximum *E. coli.* Values for the 2015/16 monitoring years were 1,359 and 4,300 cfu/100 ml, respectively (data from Morar *et al*., 2016). The median value exceeded the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100 ml). Faecal source tracking conducted on samples collected at this site during 2013 and 2014 indicate a predominantly human source but the dog, ruminant and waterfowl also contributed to the faecal contamination (Milne & Morar, 2017 [in prep].)

The Karori Stream site is one of seven urban RsoE sites where water samples are routinely tested for dissolved Cu and Zn. The results show that these metals consistently exceed ANZECC (2000) trigger values in the water column (Appendix D).

Streambed sediments sampled at Karori Stream (Makara Peak) in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Zn in both years, and exceeded the trigger value for Total PAH, Total DDT and Dieldrin in at least one of the two years (Milne & Watts, 2008). No exceedance of ISQC-High trigger values were recorded for any constituent. The water quality and sediment results indicate that the stream environment at this location may be toxic to some of the more sensitive aquatic organisms.

Aquatic ecology

Based on a review of annual macroinvertebrate surveys from 2002 to 2007 at the Karori Stream RsoE site, Perrie (2008) observed that the invertebrate communities were in a fairly degraded state with MCI and %EPT metric scores consistently below 90 and 25, respectively. Recent RsoE results reported by Morar *et al*. (2016) indicate that the invertebrate community at that location remains in poor condition; the community includes a relatively low number of EPT taxa (mayflies, stoneflies, caddisflies), and is dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). This type of invertebrate community composition appears to be typical of urban stream with more than 20% impervious area (i.e., Walsh *et al*. 2005). Invertebrate metric score summaries for RsoE sites are shown in Appendix E.

Schedule F1 of the PNRP identifies Karori Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in Karori Stream include banded kokopu, inanga, koaro, lamprey, longfin eel, shortfin eel and upland bully.

3.2.2 Owhiro Stream

Catchment characteristics

The Owhiro Stream catchment lies to the south of Wellington City centre, extending from Brooklyn in the north to the stream mouth at Owhiro Bay. The catchment is bounded by Hawkins Hill, Polhill, Todman Street, The Ridgeway, Frobisher Street and Severn Street. It covers an area of 953 ha of which an estimated 10% is impervious. The Owhiro Stream has an estimated dry weather flow rate of 0.1m^3/s, a 2-year design storm flow of 20 m^3/s and a 20-year design storm flow of 32 m^3/s.

The Owhiro Stream drainage area is predominantly open space with scrubland and gorse land south of Polhill and east of Hawkins Hill, surrounding Southern Landfill. The eastern part of the catchment is largely residential. Industrial activity is clustered around Landfill Road while business properties are concentrated on Owhiro Road and Cleveland Road at Brooklyn.

Owhiro Stream has three main tributaries draining Carey's Gully (occupied by Southern Landfill and C&D Landfill), Kowhai Park Gully (occupied by T&T Landfill) and urban Brooklyn (which is largely culverted). The majority of the catchment (around 85%) is in gorse scrubland, with 7% urban, 4% pastoral, and 4% bare ground and landfill. All three tributaries are affected by urban development, with few if any headwater tributaries unaffected by urban undeveloped.

The urbanised areas of Brooklyn, Mornington and Kingston are a significant source of road and vehicle-related pollution, particularly PAH's, Zn and Cu. WCC's Southern Landfill and adjacent private landfills also contribute to contaminants to the stream.

Water quality

Focused stormwater studies conducted by KML (2005) and Milne & Watts (2008) have both included a monitoring site on the lower reach of Owhiro Stream, and both reported that dissolved Cu and Zn exceeded ANZECC trigger values in storm flows. Milne & Watts (2008) also found that Cu exceeded the trigger value in base flows.

Routine quarterly base flow monitoring has been conducted in Owhiro Stream since 2010 as part of a T&T Landfills monitoring program (see Cameron, 2017). Water quality results for a T&T reference site on the main-stem of Owhiro Stream, upstream of the influence of the landfills, but immediately downstream of urban Brooklyn, show dissolved Cu and Zn concentrations consistenly exceeded ANZECC (2000) trigger values (refer Appendix J).

Streambed sediments sampled at Owhiro Stream in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Zn in both years, and exceeded the Pb trigger value in 2005 but not in 2006 (Milne & Watts, 2008). The ISQC-Low trigger values for Total DDT and Dieldrin were exceeded in both years. The ISQC-High trigger value for Dieldrin was exceeded on one occasion. The water quality and sediment results indicate that the stream environment at this location may be toxic to some aquatic organisms.

Routine monthly microbiological monitoring is conducted by WCC at the stream outlet to the sea in accordance with the city's stormwater consent. The results summary in Appendix F show that annual median faecal coliform value has seldom exceeded 1000 cfu/100 ml but that maximum values above 10,000 cfu/100 ml have occurred in most years. These results may suggest that intermittent overflows from the wastewater system may occur.

Aquatic ecology

Macroinvertebrate surveys conducted in 2004, 2010 and 2016 (KML 2005, Cameron, 2010, and Cameron, 2017) show that the invertebrate community in Owhiro Stream immediately downstream urban Brooklyn is in a consistently poor condition with metric scores in the following ranges: MCI (78 to 84), QMCI (2.57 to 3.12) and %EPT taxa (5 to 25). These communities are characterised by a low number of pollution sensitive EPT taxa (mayflies, stoneflies, caddisflies), and are dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae).

Schedule F1 of the PNRP identifies Owhiro Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reach is identified as potential inanga spawning habitat. Fish species recorded in Owhiro Stream include banded kokopu, common bully, giant kokopu, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.

3.2.3 Kaiwharawhara Stream

Catchment characteristics

Kaiwharawhara Stream arises in the Zealandia Wildlife Sanctuary. Its catchment includes parts of urban Karori (including Karori Cemetery), Wilton, Wadestown, Ngaio and Khandallah, as well as an industrial/commercial area near the stream mouth at Kaiwharawhara. In total it covers an area of 1770 ha, of which nearly 39% is in urban land-cover and an estimated 18% is impervious surfaces (Table 3-2). The stream passes through two water supply reservoirs and is then piped under disused landfills at Ian Galloway Park and Appleton Park. Additional disused landfills are located at Anderson Park, Otari Plant Museum and Creswick Terrace Park. Kaiwharawhara Stream has an estimated dry weather flow of 0.1 m^3/s, a 2-year ARI storm flow of 29.8 m^3/s and a 20-year ARI storm flow of 46.9 m^3/s.

Table 3-2: GWRC RsoE %Land-cover types in contributing catchment – Kaiwharawhara

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS19	Kaiwharawhara S. @Ngaio Gorge	impacted	fair	47.6	6.5	0.0	7.0	38.6	0.3

Water quality

A GWRC RsoE site located at Ngaio Gorge on the Kaiwharawhara Stream received a 'fair' WQI grade for the 2015/16 year, and was ranked 44th out of 53 sites in the Wellington Region. At that location the contributing catchment is 39% urban. Water quality at this location normally meets recommended guidelines of dissolved oxygen, visual clarity and ammoniacal nitrogen but typically fails to meet guidelines for *E. coli.* Nitrate/nitrite nitrogen and dissolved reactive phosphorus.

Water quality summary statistics included in Appendix D show the median and maximum *E. coli.* Values for the 2015/16 monitoring year were 600 and 4,700 cfu/100 ml, respectively. The median value did not exceed the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100 ml). Faecal source tracking conducted on samples collected at this site during 2013 and 2014 indicate a predominantly human source, but dog and ruminant sources were also detected (Milne & Morar, 2017)

The Kaiwharawhara Stream site is one of seven urban RsoE sites where water samples are routinely tested for Cu and Zn. The results shown that dissolved Cu and Zn concentrations were elevated and commonly exceeded ANZECC (2000) trigger values at base flows (Appendix D).

Streambed sediments sampled at three sites in the Kaiwharawhara Stream in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger values for nickel (Ni), Pb, antimony (Sb), Zn, Dieldrin and Total DDT on at least one occasion (Milne & Watts, 2008). The ISQC-High trigger values for Zn, Pb and Total HMW PAH were also exceeded on at least one occasion. The water quality and sediment results indicate that the stream environment at this location may be toxic to some aquatic organisms.

Routine monthly microbiological monitoring is conducted by WCC at the stream outlet to the sea in accordance with the city's stormwater consent. The results summary in Appendix F show that annual median faecal coliform value at the Kaiwharawhara Stream outlet has not exceeded 1000 cfu/100 ml since 2008 but that maximum values above 10,000 cfu/100 ml have occurred in most year since 2008. These results suggest that intermittent overflows from the wastewater system may occur. Two wastewater overflow structures are located within the catchment (Table 4-14).

Aquatic ecology

Recent RsoE results indicate that the invertebrate community in the Kaiwharawhara Stream at Ngaio Gorge is in poor condition (QMCI = 2.52, %EPT taxa = 5, Taxa richness = 21), characterised by a relatively low number of pollution sensitive EPT taxa (mayflies, stoneflies, caddisflies), and dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). Invertebrate metric scores summaries for RsoE sites are presented in Appendix E.

KML (2005) reported invertebrate similarly poor metric scores at in Kaiwharawhara Stream at Ngaio Gorge, and in the middle reaches downstream of Ian Galloway Park (a closed landfill) but higher-up in the catchment metric scores indicate good invertebrate quality.

Schedule F1 of the PNRP identifies Kaiwharawhara Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in Kaiwharahwara Stream include banded kokopu, bluegill bully, common bully, giant bully, giant kokopu, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.

3.2.4 Wellington CBD streams

The urbanisation of the Lambton Harbour catchment has resulted in only 31% of the land area remaining as open space. The remaining 69% of the catchment is built-up and consists of the Wellington CBD and surrounding hill suburbs. The watercourses of the Lambton Harbour catchment have undergone significant modification as a result of urbanisation, with all streams having all or most of their lengths piped. No watercourses in the catchment flow freely to the ocean as open channels, and the remnant open sections typically occur in the remaining vegetated open space encompassed by the town belt, reserves, and the Botanic Gardens (James , 2015). A total of 139 remnant open channel sections from 48 separate watercourses have been identified in the Lambton Harbour catchment.

Many of the remnant open channels are ephemeral overland flow paths with no or limited habitat for aquatic fauna. However, there are some permanently flowing streams where banded kokopu and/or koura are known to be present. These include Papawai Stream, Moturoa Stream and Waimapihi Stream (James, 2015).

Routine monthly microbiological monitoring is conducted by WCC at major stormwater culvert outlets to the sea, most of which are at similar locations to former stream outlets to the sea. The results summary in Appendix F show that elevated faecal coliform levels (>10,000 cfu/100 ml) have occurred at all 20 monitoring locations from times to time.

3.2.5 Ngauranga Stream

Catchment characteristics

The Ngauranga Stream catchment lies north-west of Wellington City CBD, covering an area of 9.7 km^2 of which an estimated 31% is impervious. The catchment is heavily urbanised, predominantly in residential land use, but including commercial and light industry premises in Johnsonville, Newlands and Ngauranga, including the Kiwi Point Quarry and Taylor Preston Abattoir. No landfills are currently operating in the catchment but a significant landfill operated in the area now occupied by Raroa Park from 1961 to 1971. The catchment is bisected by the Wellington to Porirua motorway (State Highway 1) which has an average daily traffic count in excess of 50,000 vehicles and which is likely to be a significant source of Cu, Zn and PAH in stormwater runoff to Ngauranga Stream.

The Ngauranga Stream discharges to Wellington Harbour at Ngauranga after passing under the motorway. The stream has an estimated dry weather flow of 0.15 m^3/s, a 2-year ARI storm flow of 23.7 m^3/s and a 20-year ARI storm flow of 37.5 m^3/s.

Water Quality

A stormwater study conducted by Milne & Watts (2008) included a monitoring site on the lower reach of Ngauranga Stream. The results show very high concentrations of total Cu and Zn in first flush and composite samples, and although dissolved metals results were not obtained for storm flows, they would likely have exceeded ANZECC trigger values. Dissolved Zn concentrations exceeded the trigger value at base flow.

Streambed sediments sampled at three sites in the Ngauranga Stream in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger values for Zn on both occasions and Dieldrin on at least occasion (Milne & Watts, 2008). No exceedance of ISQC-High trigger values were recorded for any constituent. The water quality and sediment results indicate that the stream environment at this location may be toxic to some aquatic organisms.

Routine monthly microbiological monitoring is conducted by WCC at the stream outlet to the sea in accordance with the city's stormwater consent. The results summary in Appendix F show that annual median faecal coliform value at the Ngauranga Stream outlet has regularly exceeded 1000 cfu/100 ml over the last five years, and maximum values occasionally exceeded 30,000 cfu/100 ml. These results suggest that intermittent overflows from the wastewater system have occurred. Four wastewater overflow structures are located within the catchment.

Aquatic ecology

Results reported in an AEE report prepared for Wellington City Council's Kiwi Point Quarry (Young, et al, 2017) indicate that the invertebrate community in the Ngauranaga Stream at two locations beside Ngauranga Gorge is in poor condition (QMCI = 2.0 to 2.1 %EPT taxa = 0, Taxa richness = 3 to 12). The invertebrate community was characterised by a complete absence of pollution sensitive EPT taxa (mayflies, stoneflies, caddisflies), and is dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). KMA (2005) reported similarly poor metric scores, again with almost a complete absence of EPT taxa.

Schedule F1 of the PNRP does not identify Ngauranga Stream as a watercourse with significant indigenous ecosystems. Fish species recorded in Ngauranga Stream include short fin eel, common bully, koaro and banded kokopu.

3.2.6 Korokoro Stream

Catchment Characteristics

The Korokoro Stream drains a moderately small catchment with a total area of 15.7 km^2 of which an estimated 4.7% (in the lower reach) is impervious surface. The remainder of the catchment is in regenerating and mature indigenous forest and scrub, including the last significant stand of rimu-rata-tawa-kohekohe in the southwest of the Wellington Region. It is situated within Belmont Regional Park on the western hills of the Hutt Valley.

Water Quality

Routine monthly microbiological monitoring conducted by HCC indicate low levels of faecal contamination in Korokoro Stream. The minimum, median and maximum values from 42 monthly samples collected from 2013 to 2016, inclusive, are 8, 22 and 904 *E. coli.* Cfu per 100 ml, respectively (Appendix H). The results reflect the low level of urban development in the Korokoro catchment. The median value comfortably achieved the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100 ml). While two constructed wastewater overflow structures are located within the catchment they have not had an obvious effect on water quality in the lower stream.

Aquatic Ecology

KMA (2005) surveyed the invertebrate community at three locations on Korokoro Stream, in an upper reach, a lower reach and at the stream mouth. The stream mouth site is downstream of a culverted section that passes under the urban areas of Cornish Street and the Hutt Road. Metric scores show "excellent" invertebrate community quality at the upstream site, decreasing to "fair/good" in the lower reaches and "poor/fair" near the stream mouth.

Schedule F1 of the PNRP identifies Korokoro Stream as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in Kororkoro Stream include banded kokopu, bluegill bully, common bully, common smelt, giant kokopu, inanga, koaro, longfin eel, redfin bully and shortfin eel.

3.2.7 Speedy's Stream

Catchment Characteristics

Speedy's Stream drains a small steep forested catchment on the western side of the Hutt River valley adjacent to the suburb of Kelson, and joins the Hutt River on its true right bank immediately downstream of the Kennedy Good Bridge. The catchment has a total area of 11.6 km^2 of which an estimated 7.9% is impervious surface. The watercourse is well entrenched into the greywacke base rock, and confined at the bottom of steep sided valleys.

The riverbed substrate consists mostly of cobbles and coarse gravels, and occasional boulders, including introduced rock for bank protection. The bed contains little fine sediment and includes a variety of hydraulic components including small pools, riffles, runs and matted roots, which provide some good quality habitat for invertebrates and fish. However, the culvert under SH2 is likely to be a barrier to the upstream migration of fish species such as inanga and smelt, which are weak swimmers and have no climbing ability, and to trout which require a greater depth of water than is available in the culvert.

Water Quality

Routine monthly microbiological monitoring conducted by HCC indicate low levels of faecal contamination in Speedy's Stream (Appendix H). The results reflect the moderate level of urban development in the Speedy's catchment and no wastewater overflow structures located within the catchment.

Aquatic Ecology

KML (2005) surveyed the invertebrate community in the lower reach of Speedy's Stream, reporting invertebrate metric which indicate "excellent" quality (MCI = 128, QMCI = 8.6, %EPT taxa = 85.6, Taxa richness = 26).

Schedule F1 of the PNRP identifies Speedy's Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in Speedy's Stream included banded kokopu, bluegill bully, common bully, giant bully, giant kokopu, lamprey, longfin eel, redfin bully and shortfin eel.

3.2.8 Waiwhetu Stream

Catchment Characteristics

The Waiwhetu Stream is a small low elevation watercourse which flows from the bush covered Eastern Hutt Hills, through urban areas of Naenae, Epuni, Waterloo, Waiwhetu and Gracefield, to its confluence with the Hutt River Estuary at Seaview. It has a total catchment area of about 18.6 km^2. The stream has a stony bed in its upper reaches and in part of the estuarine reach, but for most of its length the streambed substrate is soft and muddy. The catchment is heavily urbanised with over 52% urban land-cover (Table 3-3).

Table 3-3: GWRC RsoE %Land-cover types in contributing catchment – Waiwhetu

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS57	Waiwhetu S at Whites Line	Impacted		42.3	0.1	0.0	5.4	52.3	0.0

Consequently stream flows are strongly influenced by stormwater run-off during flood events, resulting in rapid flow fluctuations and highly variable water quality. The estuarine zone extends approximately 2km upstream of the Hutt River confluence, with saline conditions occasionally recorded upstream as far upstream as the Wainui Road Bridge. At the Whites Line East flow gauge station the stream has a mean annual low flow of 0.016 m^3/s, a mean flow of 0.312 m^3/s and a maximum recorded flow of 36.858 m^3/s (GWRC data).

Historically the lower estuarine reach was situated within a much wider area of salt-marsh and low lying wetland at the Hutt River mouth, although the Waiwhetu Stream Estuary would have had relatively small areas of intertidal flats and saltmarsh. However, over the last 100 years the stream corridor and estuary has been extensively modified by flood protection works, reclamation, and removal of the natural vegetated margin.

Over the same period the Waiwhetu Stream has received an extensive range of contaminant inputs from sewage overflows, stormwater and from industrial discharges. Surface sediment and water quality investigations (Deely *et al*. 1992; Sheppard & Goff, 2001 & 2002; Stevens and Robertson, 2009) indicate that the lower reaches of the stream have historically been highly contaminated with heavy metals and organic compounds.

Water Quality

The GWRC RsoE site located at While Line East on the Waiwhetu Stream had or 'poor' WQI grade for the 2015/16 year and was ranked 50 out of 53 sites in the Wellington Region. Water quality summary statistics included in Appendix D show the median and maximum *E. coli*. Values for the 2015/16 monitoring years were 700 and 3,600 cfu/100 ml, respectively, indicating a moderate degree of faecal contamination. The median value achieved the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100 ml). Faecal source tracking conducted on samples collected at this site during 2013 and 2014 indicate a predominantly human source, but dog, wildfowl and ruminant sources were also detected (Milne & Morar, 2017)

Additional routine monthly microbiological monitoring conducted at five Waiwhetu Stream sites by HCC shows elevated faecal coliforms historically in the upper reaches of the stream (median values above 2000 cfu/100 ml) although improvements are evident over the period 2013 to 2016 (Appendix H).

During the 2015/16 monitoring year 25% of RsoE samples exceeded the ANZECC (2000) trigger value for Cu and 67% exceeded the trigger value for Zn, indicating that the stream environment at this location may be toxic to sensitive aquatic organisms (Appendix D).

A stormwater study conducted by KML (2005) included monitoring sites at culverts discharging to Waiwhetu Stream at Hutt Park Road Parkside Road. The results show that stormwater runoff at both locations carried very high concentration of dissolved Cu and Zn, which would potentially cause and exceedance of trigger levels in the receiving waters of Waiwhetu Stream.

The results HCC/WW stormwater monitoring within the Gracefield sub-catchment to the Waiwhetu Stream show elevated concentrations of dissolved Cu, Pb, Zn, all of which are significantly in excess of ANZECC trigger values (see Appendix K). Faecal coliform concentration in stormwater runoff were typically around 3000 to 4000 cfu/100 ml. Baseflow contaminant levels were considerably lower, although Cu and Zn still exceeded trigger values.

During 2015 HCC established a monitoring site in the estuarine reach of Waiwhetu Stream at Seaview Road, downstream of the industrial area of Gracefield, which was sampled once each month for 12 months, on the outgoing tide (Cameron, 2016). The results show that ANZECC (2000) trigger values were consistently exceeded for Zn, occasionally exceeded for Cu, but not exceeded for Pb, mercury, cadmium, chromium, nickel or arsenic. The maximum *E. coli*. Concentration was 1300 cfu/100 ml.

Sediment Quality

An extensive programme of flood control and contaminated sediment remediation was undertaken in the lower reaches of the stream by GWRC and HCC during 2009. Robertson & Stevens (2012) reported on a before/after investigation of the tidal reach, observing that post remediation, stream sediments exceeded ANZECC (2000) ISQG-High trigger values for Zn and Pb at several locations, while ISQG-Low trigger values for arsenic, cadnium, Cu, mercury, nickel and PAHs were all exceeded at one or more locations. These results indicate an ongoing risk of toxicity for invertebrates living in stream sediments in the lower Waiwhetu Stream.

Aquatic Ecology

RsoE results indicate that the macroinvertebrate community in the lower stream is in poor condition. The community includes no sensitive EPT taxa (mayflies, stoneflies, caddisflies), and is dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). Invertebrate metric summary statistics are included in Appendix E.

KML (2005) surveyed invertebrate communities at eight locations in the Waiwhetu Stream and reported invertebrate metrics showing mostly “poor” or “fair” quality throughout the stream, although the most upstream site, near the urban edge, indicated “good” quality with QMCI of 5.0, an MCI of 117 and 48% EPT taxa.

Robertson & Stevens (2012) reported that while the remediation and flood control works within the estuary have resulted in some improvements to habitat, and a very significant removal of contaminted sediment, overall there has been limited improvement to the ecological quality of the estuary, which continues to be rated poorly in terms of eutrophication, sedimentation, toxicity and habitat loss.

Schedule F1 of the PNRP does not identify the Waiwhetu Stream as a watercourse with significant indigenous ecosystems. Nevertheless the tidal reach in known to provide inanga spawning habitat (Taylor & Marshall, 2016).

3.2.9 Stokes Valley Stream

Catchment characteristics

Stokes Valley Stream begins as a relatively natural watercourse in regenerating bush in the upper valley but once it enters the valley floor it becomes channelised, straightened and is enclosed by culverts at a number of locations, including the reach passing under the Stokes Valley Shopping centre. The stream re-surfaces downstream of the shopping centre at Bowers Street but is contained within a concrete lined channel. The Tui Glen tributary stream, also contained within a concrete lined channel, joins Stokes Valley Stream approximately 700 m downstream of Bowers Street, the confluence marking the upper extent of the application area. The stream runs a further 300m through the concrete channel to a stilling basin at the Stokes Valley Road Bridge. Beyond Stokes Valley Road the stream bed substrate takes on a more natural character of cobbles, gravels and fine sediment. It retains, however, a straightened ‘engineered’ channel with sloping grassed banks throughout the lower reach to its confluence with the Hutt River.

Water quality

Routine monthly microbiological monitoring conducted by HCC indicates elevated levels of faecal contamination in Stokes Valley Stream; the annual median *E. coli.* Value frequently exceeds the NPS-FM ‘national bottom line’ for secondary contact recreation (Appendix H). Although there are no known wastewater overflow structures located within the catchment the monitoring results indicate that some wastewater faults or leaks remain unresolved.

Streambed sediments sampled at Stokes Valley Stream in 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Total DDT (Milne & Watts, 2008). No other trigger values were exceeded at this site.

Aquatic ecology

The results of a habitat assessment conducted in the reach downstream of Stokes Valley Road during July 2015 (Cameron, 2015), show that the stream is in a degraded condition due to loss of forest cover, modifications to its channel and removal to riparian vegetation, loss of shade and cover over the streambed, loss of connectivity to the flood plain, loss of hydraulic complexity and loss of woody inputs to the stream. These factors contribute to a low abundance and diversity of habitat for invertebrates and fish.

KML (2005) surveyed the invertebrate communities at two sites on the Stokes Valley Stream (upper and lower). They reported invertebrate metrics indicating "excellent" quality on the upper stream above the urban edge (MCI = 153, QMCI = 8.8, %EPT taxa = 98, taxa richness = 19) with a sharp reduction to "poor" quality within the urban reach (MCI = 75, QMCI = 1.3, %EPT taxa = 0.1, taxa richness = 24).

Schedule F1 of the PNRP identifies the Stokes Valley Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish. Fish species recorded include the banded kokopu, common bully, giant kokopu, longfin eel and shortfin eel.

3.2.10 Hulls Creek

Catchment characteristics

The Hulls Creek catchment is made up of low lying hills in the Blue Mountains, Pinehaven, and Trentham/Wallaceville areas and low gradient areas around Heretaunga and Silverstream. The dominant land cover classes in the Hulls Creek catchment is scrub, urban and indigenous forest (Table 3-4).

Table 3-4: Landcover in the Hulls Creek catchment

Landcover class	Area (ha)	Proportion of catchment (%)
Scrub	417	25
Urban	366	22
Indigenous forest	299	18
Urban open space	201	12
Planted forest	185	11
Pastoral	152	9
Landfill	27	2
Bare ground	12	1
Total	1658	

Source: Land Cover Database, Version 2 – MfE, 2001

In its upper catchment, Hulls Creek receives runoff from scrub and indigenous forest as well as the Rimutaka Prison farm. Just below the prison farm a tributary draining the northern catchment, which includes the Trentham Racecourse, a golf course, the old General Motors factory and areas of pastoral farming, enters the stream. The mid catchment is drained by the Pinehaven Stream which is dominated by plantation forestry and scrub in its headwaters and urban residential areas in its middle and lower reaches. The lower catchment is drained by Tip Stream which includes the Silverstream Landfill in its headwaters and indigenous forest and scrub in its lower reaches (Warr, 2007).

Pastoral and urban landuse in the upper and middle reaches of the Hulls Creek catchment has resulted in significant channel modification in many places. Much of the northern tributary and part of the main Hulls Creek channel between the northern tributary confluence and the former Central Institute for Technology (CIT) site have been integrated into UHCC's stormwater network. These reaches have been straightened and are concrete lined over much of their length. In urban areas some parts of Hulls Creek and its tributaries have been piped entirely (Warr, 2007).

Water quality

Warr (2007) reviewed the available water quality data collected over the preceding decade and concluded that the stream is moderately degraded, but not any more than other urban streams in the region. The author observed that a number of factors have contributed to that degradation:

- Pastoral landuse and stock access to stream channels in the upper catchment around the Rimutaka Prison farm and parts of the northern tributary are likely to be a key contributor to high turbidity and faecal bacteria levels in the upper reaches of Hulls Creek.
- The lack of riparian shade in the upper reaches makes these reaches particularly susceptible to wide fluctuations in water temperature and dissolved oxygen concentrations.
- Streambed sediments were found to exceed the ANZECC (2000) ISQC-Low trigger value for dissolved Zn and Total DDT. No other trigger values were exceeded at this site. Contaminated runoff from urban areas around Pinehaven is likely to be the main source of zinc in Hulls Creek.
- Runoff from the Silverstream Landfill stormwater sediment retention ponds periodically contributes significant amounts of suspended sediment and faecal bacteria to the lower reaches of Hulls Creek.

- Several instances of unauthorised stream works have been recorded in the Heretaunga Drain and Alexander Road areas. These unauthorised works resulted in uncontrolled sediment discharges to Hulls Creek and its tributaries.
- A high proportion of stream reaches in urban areas of the Hulls Creek catchment is heavily modified through straightening, concrete lining and in some cases piping. This modification has resulted in significant degradation of invertebrate and fish habitat in these reaches.

Aquatic ecology

Invertebrate sampling results from Hulls Creek and Pinehaven Stream taken as part of Kingett Mitchell's (2005) study of urban stream ecology in the Wellington region are summarised in Table 3-5

Table 3-5: Invertebrate metric scores for Hulls Creek reported by Kingett Mitchell (2005)

	Hulls Creek upper*	Hulls Creek lower**	Upper Pinehaven Stream***
Total taxa	25	20	26
MCI	77	85	133
QMCI	2.1	3.3	7.6
EPT taxa	4	6	15
% EPT individuals	0.2	0.7	95.9

Schedule F1 of the PNRP does not identify Hulls Creek as a watercourse with significant indigenous ecosystem values. Indigenous fish species recorded in the watercourse include banded kokopu, bluefin bully, common bully, giant kokopu, inanga, longfin eel, redfin bully, and shortfin eel.

3.2.11 Opahu Stream

Catchment characteristics

A minor low gradient urban stream that is piped through central Lower Hutt but then flows as an open channel from the vicinity of the HCC offices, winding through the residential area of Woburn and eventually flowing into the Hutt River near the end of the Whites Line West road.

Water quality

Routine monthly microbiological monitoring conducted by HCC show high levels of faecal contamination during the period 1995 to 2000 (Appendix H). However more recently, and especially since 2012, the annual median values been relatively low, and have mostly achieved the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100 ml).

A stormwater study conducted by Milne & Watts (2008) included a monitoring site on the lower reach of Opahu Stream at Nikau Grove. The results show elevated concentrations of dissolved Cu and very high concentrations of Zn in first flush, composite and baseflow samples, all above ANZECC 95% protection trigger values.

Streambed sediments sampled in Opahu Stream in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger values for silver (Ag), mercury (Hg), Pb, Zn, Total PAH, Dieldrin and Total DDT on at least one occasion, and the ISQC-High trigger values for Zn and Total HMW PAH were both exceeded during the 2006 round (Milne & Watts, 2008). The water quality and sediment results indicate that the stream environment at this location may be toxic to some aquatic organisms.

Aquatic ecology

No aquatic ecology information is available for this watercourse.

3.2.12 Hutt River

Catchment Characteristics

The Hutt River is the largest watercourse in the Wellington and Porirua harbour catchments. It is a steep gravel-bearing river which originates in the indigenous forest covered slopes of the southern Tararua Ranges and flows some 50 km to Wellington Harbour at Seaview. It has a catchment area of 655 km^2 (of which 6.1% has urban land-cover) and a median flow of approximately 12.6 m^3/sec at Birchville. Its main tributaries are the Pakuratahi, Mangaroa, Akatarawa and Whakatiki Rivers. The bed gradient reduces at Kennedy Good Bridge, and again at the Ewen Bridge as the river approaches

Wellington Harbour. The gravel bed load material drops out along this reach, from about Belmont, and in the Harbour adjacent to the river mouth.

GWRC maintains eight RsoE monitoring sites in the Hutt catchment, three of which are on the main-stem of the Hutt River. The upper-most site at Te Marua (RS20) is located upstream of the urban area while the middle site (RS21) is downstream of Upper Hutt City and the lower site (RS22) adjacent to the urban area of Lower Hutt. Details of river characteristics at the RsoE sites are included in Table 3-6.

Table 3-6: GWRC RsoE %Land-cover types in contributing catchment – Hutt

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS20	Hutt R. at Te Marua intake	Impacted	good	90.9	3.1	3.9	1.9	0.1	0.2
RS21	Hutt R. at Manor Park G.C.	Impacted	fair	72.6	11.7	5.0	6.3	4.2	0.3
RS22	Hutt R. at Boulcott	Impacted	good	70.7	11.0	4.7	7.3	6.1	0.3

Water Quality

Recreational water quality ranges from poor (Melling Bridge) to good (Moaribank & Poets Park) in the main stem of the Hutt River, with 5-year 95-percentile *E. coli.* Values ranging from 159 to 835 cfu/100 ml. The poorest recreational water quality was recorded at the Melling Bridge site adjacent to the large urban area of Lower Hutt (see Appendix D). There are 10 known wastewater overflow structures in the Hutt catchment (excluding the Waiwhetu catchment), including 3 upstream of Melling. The most significant of these is a consented discharge from the Silverstream Storm Tank which overflows to the river several times each year during periods of sustained wet weather when the capacity of the storage tank is exceeded (at which time the river is usually in flood).

All RsoE sites on the Hutt River received an 'excellent' WQI grading for the 2015/16 year. An upstream site at Te Marua was ranked 1st of 53 sites across the region while sites on the middle/lower river were ranked 16th and 17th (Appendix D). Dissolved Cu and Zn concentrations are consistently below ANZECC (2000) trigger values in the Hutt River main-stem, as would be expected given the small proportion of urban land cover in the catchment.

While water quality is normally good, it can deteriorate markedly during rainfall events. This is particularly the case in respect of suspended solids which is typically present in river water at <1 mg/L in baseflow conditions, but can increase as by as much as 700 mg/L during flood events (Cameron, 2015). This material is likely to be sourced from throughout the catchment and, given the small proportion of urban land-cover, the contribution from urban stormwater is likely to be small.

An examination of nutrient concentrations in water samples taken from nine stormwater culverts in Upper Hutt at their outlets to the Hutt River in base flow conditions is reported by Heath & Greenfield (2016). Both nitrogen and phosphorus concentrations were relatively low at all flowing stormwater outlets, except for one drain in California Drive which had a dry weather median TN concentration of 2.3 mg/L. Overall the investigation suggested that nutrient inputs to the Hutt River from Upper Hutt stormwater outlets during summer base flow are low.

An investigation conducted by GWRC into stormwater discharges to Te Mome Stream, a minor tributary of the Hutt River, identified very high concentrations of lead and antimony in both stream water sediments near the outlet from the East Street culvert (Markland, *et al*, 2015). The authors estimated that 1,500 tonnes of stream sediment had lead concentrations in excess of ANZECC (2000) ISQG- Low guidelines.

Aquatic Ecology

RsoE invertebrate survey results together with the results of surveys conducted as part of the Hutt River Ecological Monitoring Plan (Cameron, 2016), show a downstream decrease in invertebrate community quality which is inversely related to periphyton biomass and nitrogen concentrations (Table 3-7).

Schedule F1 of the PNRP identifies the Hutt River and all of its tributaries above and including the Pakuratahi River as watercourses with significant indigenous ecosystem values including high macroinvertebrate community health, habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reach of the Hutt River considered to have potential to provide inanga spawning habitat (Taylor & Marshall, 2016). Fish species recorded in the Hutt River include bluegill bully, common bully, Cran's bully, dwarf galaxias, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully and shortfin eel.

Table 3-7: QMCI, %EPT taxa and taxa richness scores for RsoE and HREMP sites* (summer 2015/16)

Site No.	Site name	QMCI	%EPT taxa	Taxa richness
H1*	Hutt R. above Kaitoke Weir	8.1	66	16
H3*	Hutt R. below Pakuratahi R.	7.6	62	21
RS20	Hutt R. at Te Marua intake	8.1	68	22
H4*	Hutt R. below Mangaroa R.	6.3	56	21
H5*	Hutt R. at Birchville below Akatarawa R.	6.5	55	22
RS21	Hutt R. at Manor Park G.C.	5.3	52	23
RS22	Hutt R. at Boulcott	5.5	43	23

3.2.13 Whakatikei River

Catchment Characteristics

The Whakatikei River flows into the Hutt River near Riverstone at Upper Hutt. It is situated on the north-western part of the Hutt Catchment between the Akatarawa and Horokiri rivers, and has a total catchment area of 81.8 km^2. It drains a moderately steep catchment predominantly of indigenous forest and scrub and with significant areas of pine plantation forestry (Table 3-8). Very little urban development has occurred in this catchment which has 0.1% urban land-cover and an estimated 0.01% impervious surface.

Table 3-8: GWRC RsoE %Land-cover types in contributing catchment – Whakatikei

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS26	Whakatikei R. at Riverstone	impacted	excellent	67.7	23.3	1.7	7.2	0.1	0.1

Water Quality

The GWRC RsoE site located at Riverstone on the lower Whakatikei River had an 'excellent' WQI grade for the 2015/16 year and was ranked 3rd equal out of 53 sites in the Wellington Region. Water quality summary statistics included in Appendix D show the median and maximum *E. coli*. Values for the 2015/16 monitoring years were 16 and 32 cfu/100 ml, respectively, indicating negligible faecal contamination and compliance with both primary and secondary contact recreation guidelines. There are no known wastewater overflow structures in this catchment.

Aquatic Ecology

RsoE invertebrate survey results (Appendix E) indicate "excellent" quality invertebrate community in the Whakatikei River at Riverstone (QMCI = 6.61, %EPT taxa = 61, Taxa richness = 28) which reflects the low levels of agricultural and urban development in the catchment.

Schedule F1 of the PNRP identifies the Whakatikei River as a watercourse with significant indigenous ecosystem values including high macroinvertebrate community health. Indigenous fish species recorded in the Whakatikei River include bluegill bully, koaro and longfin eel.

3.2.14 Akatarawa River

Catchment Characteristics

The Akatarawa River flows into the Hutt River at Birchville near Upper Hutt. It is situated on the northern part of the Hutt Catchment, between the Whakatikei and Waikanae catchments. It drains a steep catchment of approximately 116 km^2, predominantly of indigenous forest and scrub and with significant areas of pine plantation forestry (Table 3-9). Very little urban development has occurred in this catchment which has less than 0.01% urban land cover and <0.01% impervious surface.

Table 3-9: GWRC RsoE %Land-cover types in contributing catchment – Akatarawa

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS25	Akatarawa R. @Hutt R. con.	Impacted	Excellent	83.5	14.1	0.8	1.4	0.0	0.2

Water quality

The GWRC RsoE site located on the Akatarawa River just above the Hutt River confluence had an 'excellent' WQI grade for the 2015/16 year and was ranked 3rd equal out of 53 sites in the Wellington Region. Water quality summary statistics included in Appendix D show the median and maximum *E. coli.* Values for the 2015/16 monitoring year were 35 and 90 cfu/100 ml, respectively, indicating low levels of faecal contamination and compliance with both primary and secondary contact recreation guidelines.

Aquatic ecology

RsoE invertebrate survey results (Appendix E) indicate "excellent" quality invertebrate community in the lower Akatarawa River (QMCI = 7.64, %EPT taxa = 67, Taxa richness = 33) which reflects the low levels of agricultural and urban development in the catchment.

Schedule F1 of the PNRP identifies the Akatarawa River as a watercourse with significant indigenous ecosystem values including high macroinvertebrate community health, habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in the Akatarawa River include banded kokopu, bluegill bully, Cran's bully, dwarf galaxias, koaro, lamprey, longfin eel, redfin bully and shortfin eel.

3.2.15 Mangaroa River

Catchment characteristics

The Mangaroa River flows into the Hutt River at Te Marua north of Upper Hutt. It is situated on the western side of the Rimutaka Range, adjacent to the Pakuratahi River. It drains a broad low gradient valley with a total area of 104 km², which is predominantly indigenous forest and scrub with substantial areas of production pasture and pine plantation forestry (Table 3-10). Very little urban development has occurred in this catchment which has less than 2% urban land-cover and an estimated 0.01% impervious surface.

Table 3-10: GWRC RsoE %Land-cover types in contributing catchment – Mangaroa

Site no.	*Site name*	*Site type*	*Habitat grade*	*Indigenous forest and scrub (%)*	*Exotic forest (%)*	*Pasture (high prod.) (%)*	*Pasture (low prod.) (%)*	*Urban (%)*	*Other (%)*
RS24	Mangaroa River at Te Marua	Impacted	excellent	53.3	13.9	15.2	16.2	1.3	0.0

Water quality

The GWRC RsoE site located on the Mangaroa River just above the Hutt River confluence had a 'fair' WQI grade for the 2015/16 year and was ranked 35th out of 53 sites in the Wellington Region. Water quality summary statistics included in Appendix D show the median and maximum *E. coli.* Values for the 2015/16 monitoring year were 160 and 650 cfu/100 ml, respectively, indicating a moderate level faecal contamination reflecting the sheep and beef grazing activities in the catchment. The median value achieved the NPS-FM (MfE, 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100 ml).

Aquatic ecology

RsoE invertebrate survey results (Appendix E) indicate "good" quality invertebrate community in the lower Mangaroa River (QMCI = 5.98, %EPT taxa = 46, Taxa richness = 26) which has been slightly to moderately affected by agricultural development in the catchment.

Schedule F1 of the PNRP does not identify the Mangaroa River as a watercourse with significant indigenous ecosystem values. It is however a known as an important trout spawning river.

3.2.16 Pakuratahi River

Catchment Characteristics

The Pakuratahi River flows into the Hutt River at Kaitoke north of Upper Hutt. It is situated on the northern part of the Rimutaka Range adjacent to the Mangaroa catchment. It drains a steep catchment of just over 81 km², predominantly in indigenous forest and scrub with some production pasture and pine production forestry (Table 3-9). The Pakuratahi catchment has very little urban development and less than 0.01% impervious surface.

Table 3-11: GWRC RsoE %Land-cover types in contributing catchment – Pakuratahi

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS23	Pakuratahi R. below Farm Ck	impacted	good	79.9	6.7	9.3	3.7	0.0	0.4

Water quality

The GWRC RsoE site located on the lower Pakuratahi River near Farm Creek had a 'fair' WQI grade for the 2015/16 year and was ranked 35th out of 53 sites in the Wellington Region. Water quality summary statistics included in Appendix D show the median and maximum *E. coli*. Values for the 2015/16 monitoring year were 75 and 240 cfu/100 ml, respectively, indicating a low level faecal contamination and compliance with both primary and secondary contact recreation guidelines.

Aquatic ecology

RsoE invertebrate survey results (Appendix E) indicate "good/excellent" quality invertebrate community in the lower Pakuratahi River (QMCI = 6.15, %EPT taxa = 42, Taxa richness = 26) which has been slightly affected by agricultural development in the catchment.

Schedule F1 of the PNRP identifies the Pakuratahi River as a watercourses with significant indigenous ecosystem values including high macroinvertebrate community health and habitat for indigenous threatened or at risk fish. Fish species recorded in the Pakuratahi River include bluegill bully, Cran's bully, dwarf galaxias, koaro, longfin eel, redfin bully, shortfin eel and upland bully.

3.2.17 Days Bay Stream

Catchment characteristics

The Days Bay Stream drains a steep forested catchment and flows into Days Bay on the eastern coast of Wellington Harbour. The lower reaches of the stream flows beside Moana Road, through Williams Park and is piped under Marine Drive to the sea.

Water quality

No water quality data are available for Days Bay Stream.

Aquatic ecology

Schedule F1 of the PNRP identifies the Days Bay Stream as a watercourse with habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in the Days Bay Stream include banded kokopu, bluegill bully, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.

3.2.18 Wainuiomata River

Catchment characteristics

The Wainuiomata River originates in a native forest catchment of the south western Rimutaka Ranges, and flows southwest for a distance of approximately 35 km, eventually discharging into Cook Strait east of Bearing Head. The Wainuiomata catchment shares a drainage divide with the Orongorongo catchment where elevations reach 800m in altitude. The catchment has a total area of 134 km^2, and has a hard-sedimentary geology. While the upper catchment is steep the river bed gradient is fairly uniform downstream of the Wainuiomata Water Treatment Plant, dropping 5m per km in the upper part of the Wainuiomata Valley, then flattening to 2m per km over the last few km above the coast.

The main tributaries of the Wainuiomata River are Skull Gully Creek, Sinclair Creek, George Creek, Wainuiomata-iti Stream, Black Creek and Catchpool Stream. The upper catchment is reserved for water supply and retains indigenous forest cover. Water is taken at two locations by 'run of the river' intake galleries, one on the main-stem of the upper river and the other on Georges Creek. Two decommissioned water supply dams are located on the upper river. Although neither is now used for water supply, the lower dam continues to form a large impoundment, which has been developed as a wetland. Downstream of the water supply area the river enters the long narrow Wainuiomata Valley, bounded by the Rimutaka Ranges to the east and the Eastbourne foothills to the west. Land use includes plantation forestry, low productivity pasture, scrub and with approximately 6% under urban land-cover and an estimated 2% of the catchment is impervious surface (Table 3-12).

Table 3-12: GWRC RsoE %Land-cover types in contributing catchment – Wainuiomata

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS28	Wainuiomata R. at Manuka	Reference	excellent	99.9	0.0	0.0	0.0	0.0	0.0
RS29	Wainuiomata R. at White B.	Impacted	fair	79.6	3.7	2.9	7.5	6.2	0.1

Water quality

The GWRC RsoE sites located on the upper Wainuiomata River near Manuka Track and lower river near the coast both had a 'good' WQI grade for the 2015/16 year and were ranked 25th and 27th out of 53 sites in the Wellington Region. Water quality summary statistics included in Appendix D show the median and maximum *E. coli*. Values for the 2015/16 monitoring year were 4 and 15 cfu/100 ml, respectively at Manuka Track, increasing to 75 and 390 cfu/100 ml, respectively on the lower river. Both sites achieved primary and secondary contact recreation guidelines.

A stream sediment study conducted by Milne & Watts (2008) included a monitoring site on the lower reach of Black Creek at Rowe Road. The results for 2005 show relatively low concentration of dissolved metals and no exceedance of concentrations of ISQC-Low trigger, except for DDT which was elevated at almost all stream sites.

Aquatic ecology

RsoE invertebrate survey results (Appendix E) together with the results of surveys conducted for HCC (Cameron, 2015), show "excellent" invertebrate community quality at the upstream reference site within the forested catchment, declining sharply to "fair" quality at the Main Road Bridge where the predominant land cover types are low production pasture and light residential. The invertebrate community composition remains relatively unchanged through the middle and lower reaches of the river where the dominant land-cover types are scrub and low production pasture.

Urban Wainuiomata is concentrated in a broad valley drained by Black Creek which joins the Wainuiomata River between sites W1 and W2. The Black Creek monitoring site (B1), which is located immediately downstream of the urban area, has a "poor" quality invertebrate community, reflecting the influence of urban stormwater discharges and reduce habitat quality. Nevertheless, stormwater inflows to the Wainuiomata River via Black have not had a measurable effect on invertebrate community composition of the river.

KML (2005) surveyed invertebrate communities on Black Creek at one site above the urban area (BU) and one below it (BL). Metric scores for those location show a sharp decline that can be attributed to decreases in both habitat quality and water quality associated with the urban area.

Table 3-13: QMCI, %EPT taxa and taxa richness scores for RsoE, HCC sites* (summer 2015/16) and KML sites (2005)

Site No.	Site name	QMCI	%EPT taxa	Taxa richness
RS28	Wainuiomata R. at Manuka	6.68	58	33
W1*	Wainuiomata R. at Main Rd Bridge	4.23	51	18
W2*	Wainuiomata R. above storm tank	4.34	47	19
W3*	Wainuiomata R. below storm tank	4.59	49	18
W4*	Wainuiomata R. at Golf Course	4.10	52	18
RS29	Wainuiomata R. at White B.	4.91	44	25
BU (KML)	Black Creek above urban area	5.3	13	23
B1*	Black Creek below urban area	3.8	26	21
BL (KML)	Black Creek below urban area	2.7	1.8	26

Schedule F1 of the PNRP identifies the Wainuiomata River and all of its tributaries above and Black Creek as a watercourses with significant indigenous ecosystem values including high macroinvertebrate community health, habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in the Wainuiomata River include banded kokopu, bluegill bully, common bully, dwarf galaxias, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.

3.3 Estuarine and coastal habitats

3.3.1 Wellington Harbour characteristics

Wellington Harbour is a large (~85 km^2) semi enclosed temperate ecosystem, with a single entrance leading to Cook Strait. Mean water depth within the harbour is ~14m with a maximum water depth of 31m to the southeast of Matiu/Somes Island (Heath, 1977). It has a maximum tidal range of 1.5m and an average tidal range of 0.75 m. The tidal zone can be classified as low, mid and high tide and is a significant factor in the determination of biological communities inhabiting intertidal habitats. The Harbour is well flushed with a flushing time of approximately 10 days (Heath, 1977). During flood events the discharge from the Hutt River causes harbour waters to become more fresh and turbid, however at most times there is little if any influence of freshwater on harbour salinities. Tidal flow is generally in a clockwise direction on the flood tide and in an anticlockwise direction on the ebb tide (Brodie, 1958).

Wellington Harbour supports a large variety of habitats ranging from extremely exposed rocky reefs at the harbour heads to a sheltered and modified estuary. The diversity of habitats is also related to a diversity of substrate types; hard, natural reefs; hard, unnatural substrates (wharf pilings, slipways, seawalls, breakwaters) and a range of soft sediments (from silty mud to sand).

3.3.2 Owhiro Bay

Physical characteristics

Owhiro Stream catchment characteristics are described in Section 3.2.2. Owhiro Bay lies on the exposed south coast of Wellington, bounded by rocky headlands on either side, it is part of the Taputeranga Marine Reserve. It has a predominantly gravel upper beach with a firm sand and gravel lower shore, with little vegetation adjacent to the beach.

Aesthetics, amenity and recreation

Visual “aesthetics” are generally good, although there have been intermittent reports of suspended solids and biological growths in Owhiro Stream, which has been mostly been associated with landfills in the catchment. The stream forms a small shallow lagoon as it crosses the beach. Some die-off of biological growths has been reported, and is probably periphyton growing (and dying) under favourable conditions of light, nutrients and sufficiently long periods of dry weather low stream flow. Discoloration is observed in the beach water after rain.

Owhiro Bay is the closest south coast beach to the central city. The sheltered Owhiro Bay boat ramp and car park is on the eastern side of the bay. A project to restore and protect Owhiro Bay Stream, the only unpiped city stream flowing to the south coast, has been set up by The Friends of Owhiro Stream. The community group has planted more than 8,000 native trees.

Water quality

Owhiro Bay is open to the south coast and is exposed to a high energy wave environment. Despite this exposed aspect, the nearshore waters of Owhiro Bay have exhibited variable levels of microbiological contamination resulting in a five-year 95-percentile enterococci value of 2,650 cfu/100ml and a “poor” Suitability for Recreation Grade (SFRG) grade (refer Appendix C). Faecal source tracking conducted by GWRC in Owhiro Bay during February and March 2014 identified a number of faecal sources including wildfowl, human and dog (Morar & Greenfield, 2014).

There is no information on chemical contamination of the coastal waters or sediment of Owhiro Bay. Rates of sediment resuspension, dilution and dispersion are likely to be high in this exposed coastal area, and consequently contaminants are not likely to occur at high concentrations within the water column of the Bay or in marine sediments. However, the influence of operational landfills and the relatively little data makes this assessment uncertain (Diffuse Sources, 2014).

Legacy contamination, present day stormwater contamination, and future stormwater contamination have all be classified as low by Diffuse Sources (2014).

Aquatic ecology

The ecological sensitivity of Owhiro Bay is probably high, being a relatively pristine environment within the Taputeranga Marine Reserve, having high water quality from Cook Strait, and with rocky shore habitats. It has a predominantly gravel upper beach with firm sand and gravel mix along the lower shore. The bay is tightly bound by the road, and sits between rocky platforms at both ends (Stevens &

Robertson, 2004). Road runoff and stormwater occur directly onto the beach, nevertheless, any contamination is probably rapidly dispersed in the water column and into Cook Strait, and there is unlikely to be any accumulation of contaminants. For these reasons the risk of ecological effects has been assessed as low (Diffuse Sources, 2014).

3.3.3 Island and Houghton bays

Physical Characteristics

Island and Houghton bays lie on Wellington's exposed south coast, bounded by rocky headlands adjacent to Owhiro Bay and at Te Raekaihu. Island Bay is dominated by firm sand, with a small area of rock and grave near the centre of the beach. Houghton Bay is predominantly a firm sand beach characterised by a steep back dune area extending up to the road. It has a more exposed aspect and is subject to a high energy wave environment. Both bays are part of the Taputeranga Marine Reserve.

Aesthetics, amenity and recreation

The outfalls and their surroundings are visually inspected every month. Visual "aesthetics" are generally good at Island Bay, with few reports of odours, solids, discoloration or surface films, scums or foams (Diffuse Sources, 2014).

Aesthetics have historically been poor in Houghton's Bay with occasional reports of odours, and discoloration due iron oxide deposits (Diffuse Sources 2014). More recently Wellington Water has implemented operational procedures which appear to have significantly mitigated these effects.

Island Bay is at the end of the City to Sea and Southern walkways, and near the centre of Taputeranga Marine Reserve. Just east of the Bait House, divers and snorkelers can follow offshore reefs on a marked dive trail and see a wide variety of marine life. Divers can also explore the wreck of the navy frigate HMNZS Wellington, which lies east of Taputeranga Island. Shortland Park is just over the road and has plenty of play equipment, BBQs, picnic tables and toilets. A swim raft is moored in this bay during summer months.

Water quality

Island Bay and Houghton Bay are on the open south coast. They are subject to relatively high energy from large swells, although Island Bay is partially enclosed by Taputeranga Island. Island Bay has a large catchment, hence large storm flow volume, which discharge to a relatively small, partially sheltered bay.

The microbiological water quality is monitored at three locations in Island Bay and one location in Princess Bay. During the 2015/16 bathing season the suitability for recreation grading (SFRG) was "Poor" at all three Island Bay sites, but was "Very Good" at Princess Bay immediately to the east of Houghton Bay.

Monthly microbiological monitoring conducted by WCC at the Island Bay culvert at Reef Street indicates elevated faecal coliform levels at this location, with a median value 2200 FC cfu/100 ml. Water discharged from the Houghton Bay culvert had a median value of 600 FC cfu/100 ml.

There are no receiving water or sediment contaminant data for Island Bay. However, Cd, Pb and Hg concentrations were below national food standards in paua flesh collected in Island Bay, and concentrations of PAH, DDT and PCB were very low (Diffuse Sources, 2014). At Houghton Bay, sediment samples collected in 2000 (MWH, 2003) and 2012 (Capacity, 2012) where the stream crosses the beach did not show any serious contamination for heavy metals (except iron) or PAH. Because of dilution and dispersion, concentrations would be expected to be very low in water and sediments, and contaminants are not expected to have a significant effect in these Bays. Legacy contamination, present day stormwater contamination, and future stormwater contamination have all been classified as low (Diffuse Sources, 2014).

Aquatic ecology

Island Bay is dominated by firm sand, with a small area of rock and gravel near the centre of the beach and a constructed boulder field at the far west of the beach. The upper margin of the beach is bordered by the road with both ends of the beach flanked by creviced rock that has numerous surge gullies and rock pools (Stevens & Robertson, 2004). The ecological sensitivity is probably high, being relatively pristine environments, having high water quality from Cook Strait, and with diverse habitats. While Island Bay has a relatively large catchment discharging to a relatively small, partially sheltered bay, the risk of significant ecological impacts is probably low, mainly because of flushing with clean oceanic water from the exposed south coast, which provides rapid dilution and dispersion (Diffuse Sources, 2014). Stormwater may be held up in the bay for a few tidal cycles (depending on winds and tides) but because this is likely to be short-lived, effects are not expected to be significant.

Accumulation of contaminants in either bay is probably very low, because of the relatively high energy of these environments, especially the very exposed Houghton Bay. Therefore, the risk of stormwater related ecological impacts is likely to be low.

3.3.4 Lyall Bay

Physical Characteristics

Lyall Bay is a semi-circular, large open bay on Wellington's south coast, situated between the rocky headlands of Te Raekaihu to the west and Hue te Taka (Moa Point) to the east. It is a long gently sloping firm sand beach with two smaller gravel beds present within the sand. The Bay shoals progressively from about 28 m in outer Lyall Bay to the shoreline. It is very exposed and can be subject to strong southerly swells and large high energy waves.

Lyall Bay receives stormwater from Lyall Bay catchment, the southern parts of Miramar Golf Course and Wellington Airport and part of Moa Point Wastewater Treatment Plant.

Aesthetics, Amenity & Recreation

Diffuse Sources (2014) describes the "aesthetics" of Lyall Bay as good, with few or no reports of odours, solids, discoloration, surface films, scums, foams, biological growths or debris.

Lyall Bay is Wellington's most popular surf beach. It is home to two surf lifesaving clubs, and many of the activities here are surf-related. Lyall Bay also has a playground. Recreation includes walking, picnics, dog walking, swimming, surfing, windsurfing, kitesurfing and kayaking.

Water quality

The stormwater discharge zone in Lyall Bay is spread along a large beach, breakwater and rocky coast, all of which are exposed to the south and subject to a moderately high energy wave environment.

Microbiological quality is monitored at three locations in Lyall Bay. During the 2015/16 bathing season the suitability for recreation grade was "Good" near the middle of the beach and "Fair" towards either end (refer Appendix C).

Sediment Quality

A study of marine sediments and contaminants conducted in Lyall Bay as part of the Wellington Airport runway extension project included the collection and analysis of surface sediment samples at 13 sub tidal sites (Depree, *et al*., 2016). The results confirm that Lyall Bay is not a depositional environment, and is characterised by uniformly moderately well sorted fine sandy sediments with low mud and clay content. The results show that:

- Total extractable heavy metals (and arsenic) concentrations were consistent with background soil/rock for the Wellington region, with no measurable anthropogenic foot print observed in the Lyall Bay surficial sediments.
- Total extractable heavy metal concentrations of arsenic As Cd, Cr, Cu, Ni, Pb, Zn and Hg in Lyall Bay sediments (<2 mm fraction) were all well below ANZECC ISQG-Low trigger values.
- DDT and associated analogues were the main organochlorine pesticides present in the surficial sediments of Lyall Bay, but all were well below ANZECC ISQG-Low trigger values.
- PAH concentrations were an average 40 times lower than ANZECC ISQG-Low trigger value.

Depree *et al* (2016) concluded that contaminant concentrations in Lyall Bay surficial sediments are very low and uniformly distributed across the study area.

Aquatic ecology

Studies of benthic and reef communities were conducted by MacDiarmid, *et al*. (2015) and James *et al.* (2016), as part of the runway extension project. The authors noted that, as would be expected with a dynamic, exposed, highly mobile fine-sand dominated habitat, the epifaunal communities (animals living on the soft sediment surface) were very low in overall abundance and diversity. The macrofauna that live in the sediment were also not very abundant with densities half those typically encountered in similar environments in more sheltered harbours, due to the wave-exposed dynamic habitat.

Rocky reef habitats are found all along the exposed southern coast supporting a rich and diverse community of brown, red and green macroalgae which in turn support a rich reef community including gastropods, paua, kina and rock lobster (MacDiarmid, *et al*. 2015). The communities found on the reefs off the southern end of the runway are typical of those found along the Wellington coastline. Large strap-like canopy forming macroalgae (e.g. *Lessonia variegata* and *Macrocystis pyrifera*) were common in the subtidal parts of most transects. Crusting and turfing red algae occurred intertidally along most transects.

Artificial substrates (e.g. Akmons) in the intertidal and sub-tidal zones along the outer edge if the runway provide habitat for a range of species including green tubular "ulva" like algae and the red algae *Pyropia*. Small patch reefs with macroalgae holdfasts of giant kelp (*Macrocytis pyrifera*) were also observed in the centre of Lyall Bay at depths of 10-13m.

While the sensitivity of reef communities at either end of Lyall Bay is likely to be high, the risk of significant ecological impacts from stormwater discharges is probably low, mainly because of flushing with clean oceanic water from the exposed south coast, which provides rapid dilution and dispersion.

3.3.5 Miramar Peninsular east coast

Physical Characteristics

The East Coast catchment lies on the eastern side of the Miramar Peninsular, to the east of Wellington City. It includes Seatoun, a residential suburb with scattered small commercial areas. Seatoun Beach has approximately equal areas of gravel and sand; gravel dominant to the southeast and firm sand in the northwest by Worser Bay. To the north and south of Seatoun, most of the coast is open land, with through roads and small pockets of residential land use.

The Seatoun stormwater catchment does not form a single drainage area but rather a series of minor catchments, which have a limited stormwater collection system, or none at all. To the north and south, stormwater discharges through a series of small outfalls along the coast or in overland flow.

Aesthetics, amenity and recreation

The southern end of the Miramar Peninsula, from Huetetaka Point to Point Dorset, consists of very exposed rocky reef, which is subject to extreme wave action and is characterised by dramatic geomorphology with many deep clefts and cuts in the rock (MWH, 2003). The South East Coast is suitable for walking, picnicking, watching ships enter and leave the harbour, and admiring the ocean views. Breaker Bay is a picturesque sandy cove is part of the Oruaiti Reserve. Tracks lead from the beach to the escarpment, cliffs and ridgeline. The Eastern Walkway begins nearby and has excellent views of the harbour entrance and Pencarrow Head.

North of Point Dorset, from Seatoun to Scorching Bay, the coastline varies from rocky shore to sandy beaches. Worser Bay Beach is a large, sandy inner-harbour beach with views of the Orongorongo Range across the harbour, Steeple Rock and Seatoun Beach. In summer its calm waters make it a popular destination for families, and it is also well- used by the local yacht club. The Seatoun Coast is also suitable for walking, watching ships enter and leave the harbour, and admiring the ocean views. A large area of sand dunes at the southern end of the beach planted with marram and pingao is an attractive feature of the beach. Dunes once covered the entire seaward side of the road, but by the 1950s they had been stabilized and grassed (Diffuse Sources, 2014).

The northern end of the beach is the site of the Worser Bay Lifesaving Club (established in 1910) and the Worser Bay Boating Club (established in 1926). The bay was the site of a pilot station in the 1860s and was given its name after pilot James Heberley's frequent comment that the weather was getting ‘worser’. Eventually the bay became known as old Worser’s Bay (Diffuse Sources, 2014).

Scorching Bay Beach is a popular sandy inner-harbour bathing beach with a large grassed area. It is sheltered from the northerly wind. It is a great place to soak up the sun and watch ships entering and leaving the harbour. Other smaller cobble and pebble beach’s include Kau Bay, Mahanga Bay and Karaka Bay. There are many walking opportunities around the coastal road and over Mt Crawford. Point Halswell is a popular dive spot.

Water quality

Microbiological water quality is monitored at six popular recreational area in the catchment. During the 2015/16 bathing season the suitability for recreation grade was “Good” at Breaker Bay, “Fair” at Seatoun – Inglis St, “Fair” at Seatoun Wharf, “Good” at Worser Bay, “Fair” at Scorching Bay and “Good” at Mahanga Bay (refer Appendix C).

Microbiological water quality has been found to be fully compliant for shellfish gathering and consumption at Mahanga Bay (Morar & Greenfield, 2016).

A GWRC survey of blue mussel quality in 2006 found low faecal coliform concentrations in these shellfish at Mahanga and Scorching Bays, and at Pt. Dorset. Concentrations of heavy metals (Cd, Cr, Cu, Pb, Hg, Ni, and Zn) were all relatively low in mussels collected from these east coast location compared to inner harbour sites, and none of the metal concentrations exceeded the national food standards for edible tissue, where standards exist (Milne, 2006).

The chemical contamination of the receiving environment has not been assessed, but as none of these areas are depositional zones, and all have an exposed or very exposed shoreline, contamination levels are likely to be low or very low, as reported for Lyall Bay (see above).

Aquatic ecology

There is no information on the ecological sensitivity to stormwater along the east coast of Miramar Peninsular. The ecological sensitivity is probably high, being relatively pristine environments, having high water quality from Cook Strait, and with diverse habitats. The eastern and northern shores of the Miramar Peninsula support *Macrocystis*, and two other brown seaweeds, *Carpophyllum* and *Cystophora*, as well as numerous red and green seaweeds, which thrive in the shelter of the larger brown seaweeds.

At Mahanga Bay the intertidal zone supports a biologically rich community of invertebrates including many species of molluscs, crustaceans and polychaete worms. In the deeper sandy sub tidal zone (below 7m) the cushion star, whelks, hermit crabs and a rich burrowing fauna occur as well. At a depth of 7m the sandy bottom is dominated by sea cucumbers, gastropods and large green-lipped mussels. At a depth of more than 10m the bottom becomes muddy with a rich burrowing fauna, as well as horse mussels and sea cucumbers. (Lewis, 1990 in MWH, 2003).

Storm water catchments are small along the east coast and the risk of significant ecological impacts is probably low because of flushing with clean oceanic water from the exposed south coast, which provides rapid dilution and dispersion (Diffuse Sources, 2014).

3.3.6 Evans Bay

Physical Characteristics

Evans Bay is a large, semi-exposed bay on Wellington Harbour. It stretches from Point Jerningham east of Oriental Bay, to Point Halswell below Mount Crawford and has an area of 4.5 km^2. Is a major amenity for Wellington for port and boating activities and for recreation. Evans Bay receives stormwater from the suburbs of Grafton, Hataitai, Kilbirnie, Rongotai, Miramar and Mt Crawford via 10 major stormwater outfalls and numerous smaller outlets. The combined catchment has an area of 8.52 km^2.

Aesthetics, amenity and recreation

Amenity at the head of the bay is mostly related to boating and shipping, such as port activities, marina, boat launching and kayaking. Secondary contact recreation may occur through these activities and via wading in the shallow waters near the marina. Some passive recreation (walking, viewing) also occurs. In contrast, the outer half of the bay is used for recreational activities involving primary contact – swimming, kite and wind surfing, and scuba/snorkelling, as well as boating and fishing.

Diffuse Sources (2014) observed that a persistent hydrocarbon odour, reported oil surface films, and minor scums and froth compromise aesthetics at the Miramar outfall. These surface characteristics and any discoloration by high turbidity during rainfall runoff will be easily noticed from the vantage point of the wharf.

Aesthetics are generally observed to be good at the Cobham culvert. Some scums/foam, floating/suspended matter, oil and grease, biological growth and die-off and discoloration are observed at the Hataitai and Kilbirnie outfalls. These outfalls are located in sheltered waters in the marina, which itself may be contributing to these problems. It may be difficult to disentangle their relative contributions. The sheltered waters will also be a factor in biological growth and die-off.

Along the northern shores of the bay, aesthetics are affected by debris, including plastic litter, from time to time. It is difficult to attribute the source of debris to local stormwater runoff, and this problem is probably consistent with the location of the beaches in a major city.

Water quality

Microbiological water quality is monitored at three recreational locations in the catchment. During the 2015/16 bathing season the suitability for recreation grade was “Good” at Balaena Bay, “Fair” at Hataitai Beach, and “Fair” at Shark Bay (see Appendix C).

Microbiological water quality has been found to be fully compliant for shellfish gathering and consumption at Shark Bay (Morar & Greenfield, 2016).

A GWRC survey of blue mussel quality in 2006 found low faecal coliform concentrations in these shellfish at Shark Bay on the eastern side of Evans Bay. Concentrations of heavy metals (Cd, Cr, Cu, Pb, Hg, Ni, and Zn) were all relatively low in mussels collected at Shark Bay, and none of the metal concentrations exceeded the national food standards for edible tissue, where standards exist (Milne, 2006).

Sediment quality

A number of studies have measured chemical contamination in Evans Bay marine sediments. Very high levels of heavy metals (Zn, Pb and Cu) have been found within 50m Miramar and Kilbirnie outfalls (Pilloto, 1996; Tonkin & Taylor 1996; Bolton-Ritchie, 2003). The relatively sheltered water of Evans Bay allow discharged contaminants to settle, and dispersal processes (such as waves on the shore) are sufficiently weak to allow high levels to remain near the outfalls.

High concentrations of PAH and total petroleum hydrocarbons (TPH) found close to the Miramar outfall may have been partly due to runoff or groundwater contamination from the former gasworks. High levels of PAH have also been attributed to the historical use of coal tar (a by-product of gasworks) for roading adhesive (Ahrens *et al*. 2007; Depree, 2010). As this material became abraded by road use, it could have been carried by stormwater to the bay. Spillage of petroleum products, perhaps associated with port activities, is also a potential issue (Ahrens *et al*. 2007).

Over the wider area PAH, Pb, Hg, DDT, Cu and Zn exceeded sediment quality guidelines (Stephenson *et al* 2008, Oliver, 2014). These guidelines are used to signal the possibility of effects on benthic animals that live in and on the sediments of the bay.

PAH, Pb, DDT and Hg are currently not being discharged in sufficient quantities in urban stormwater to have led to such high levels of contamination, but stormwater may have carried high loads of these substances in the past resulting in “legacy contamination” (Diffuse Sources 2014). There may also have been other sources such as industrial discharges (before connection to the sanitary system), spillage during port loading/off-loading, and leaching/cleaning of antifouling paints from ships and boats. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly (Diffuse Sources, 2014).

In 2016, as part of the most recent sediment quality survey in Wellington, GWRC commissioned an assessment of a range of emerging organic contaminants (EOCs) at ten sub tidal sites. These included glyphosate, perfluorinated compounds, flame retardants, plasticisers, surfactants, mush fragrances, pharmaceuticals, steroid estrogen, personal care products, methyl paraben and pyrethroid insecticides. The levels of EOCs observed in the surface sub tidal sediments were low compared with levels observed at other sites in New Zealand and other countries (Olsen, 2017).

Oliver (2014) reported that sediments in roadside stormwater catch pits in Hataitai and Miramar contained Cu, Pb and Zn at concentrations five to ten times higher than in harbour sediments near major stormwater outfalls. In contrast Hg concentrations were approximately eight times lower in catch pit sediments. Concentrations of TPH were higher in catch pit sediments compared to harbour sediments, while PAH concentrations were similar in catch pit and harbour sediments.

Aquatic ecology

The high levels of heavy metal contamination found close to the outfalls appeared to be having a strong effect on the ecology near the outlets, with large decreases in the types and numbers of animals (Bolton-Ritchie, 2003). However, this biological effect could also be partly due to other perturbations at the outfalls, such as frequent high flows, coarse sediments due to the outfall flows and shallow shoreline, enrichment with organic matter, salinity changes and other contaminants (Bolton-Ritchie, 2003).

Whatever the causes, the effects on benthic communities are quite marked close to the outfalls but diminish rapidly within distances of 30–50m from the outfall (e.g., Bolton-Ritchie, 2003; Stevenson, 2007). Further offshore, where samples are more indicative of the overall ecological health of the bay, and in the southern part of the bay, ecological monitoring has distinguished “moderate” biological effects (Kelly, 2010). In the northern part of the bay, these effects are slight. Small or no effects are only found out towards the middle of Wellington Harbour at considerable distances (4-6 km) from the bay (Kelly, 2010). Schedule F5 of the PNRP identifies *Adamsiella* algal beds in Evans Bay as habitat with significant biodiversity values in the CMA.

3.3.7 Lambton Harbour

Catchment Characteristics

Lambton Harbour covers the north-eastern corner of Wellington Harbour. It stretches from the northern coast along Aotea Quay to Lambton Basin, and the beach front at Oriental Bay. Its commercial amenities include the Port of Wellington, Inter-island ferry terminals, and large marina. Recreational amenities include the waterfront of the CBD, Oriental Bay beaches and boat launching and mooring facilities.

The Southern CBD stormwater drainage system discharges to Lambton basin via five major outfalls located under wharves and harbour walls, stretching from the Overseas Passenger Terminal to the Bluebridge Ferry terminal. The Northern CBD stormwater drainage system discharges to Wellington Harbour through 14 major culverts under Aotea Quay. Stormwater from Oriental Bay discharges via five major outfalls and numerous smaller culverts to the coastal waters fringing these catchments.

Amenity and recreation

The major amenity in the vicinity of these outfalls is the port, including local and Cook Straight ferry terminals, and non-commercial port activities, such as the Chaffers marina. Most of the Lambton Basin shore is accessible to the public and is a major recreational asset for Wellington. Walking and viewing are popular recreational activities over much of the southern area. Swimming at Frank Kitt Park, small boat activities, and fishing also occur in these areas.

Aesthetics

Occasional scums and oil slicks and murky water are seen in the Lambton Basin Thordon Quay discharge (Diffuse Sources, 2014). On the popular Oriental Bay beaches aesthetics are occasionally compromised by debris, which has included litter and sea lettuce. The source of debris may not be local stormwater runoff, because the beach and surrounding facilities such as cafes and street have many users who might contribute to litter problems, and it may be subject to spillages at the port or marina. The debris issue is probably consistent with the location of the beach in a major harbour.

Water quality

Microbiological water quality is monitored at five recreational areas in the catchment. During the 2015/16 bathing season the suitability for recreation grade was “Good” at all three sites on Oriental Bay and at Aotea Lagoon. A suitability for recreation grade has not yet been determined for the Taranaki Street Dive Platform because the sampling record is not yet long enough, however 19 of 20 samples collected during the 2015/16 summer were below the “alert” trigger value (refer Appendix C).

A 2006 GWRC survey of blue mussel quality at 12 sites found slightly elevated faecal coliform concentrations in shellfish at Frank Kitts Park and at the Ferry Terminal (Milne, 2006). The author observed that the detection of faecal coliforms at Frank Kitt Park is not surprising given its close proximity to major stormwater outfalls.

Milne (2006) also observed some spatial variation in metal concentrations in mussels across the 12 sampling sites. Mussel samples collected adjacent to Frank Kitts Park in Lambton Harbour contained the highest concentrations of Cu, Pb, Zn and Cr. By contrast samples collected from Mahanga Bay, Shark Bay and Sunshine Bay in the outer and eastern harbour recorded the lowest metal concentrations. None of the metal concentrations recorded in any sample exceeded the national food standards for edible tissue, where standards exist (Milne, 2006).

Sediment quality

Sediment in the harbour is mostly muds and silts. Well-sorted mud or silt has been found next to wharves, while a little distance away, sediments were well mixed and more silty (Haddon & Wear, 1993, Anderlini & Wear, 1995). These patterns may reflect shipping activity in wharf areas; sediments immediately adjacent to the wharves being less disturbed by propeller wash, while those further away from the wharves are resuspended by manoeuvring during dockings and departures. Seabed sediments in front of Aotea Wharf are well-mixed and predominantly very fine silt or mud, but with quantities of large greywacke gravel, thought to be derived from the reclamation work which produced the container terminal. The seabed here showed signs of actual physical disturbance despite the wharf being in a relatively low energy region of the harbour, possibly caused by propeller backwash of large or powerful ships manoeuvring near the wharf edge (Haddon & Wear 1993).

The chemical contamination and ecological effects of the receiving environment have been assessed close to five outfalls in Lambton Harbour. Very high levels of heavy metals Zn, Pb, and Cu have been found within 50m of the outfalls (Bolton-Ritchie, 2003; MWH, 2008). The relatively sheltered harbour allows deposition of discharged contaminants and dispersal processes (such as propeller disturbance and wave action around the wharves) are sufficiently slow to allow high levels to remain near the outfalls (Diffuse Sources, 2014).

GWRC's Wellington harbour marine sediment quality investigations conducted in 2006 and 2011 include 17 sub tidal sampling locations (Figure 3-1). Those studies found DDT, high molecular weight PAH, Pb, Hg, Cu and Zn all exceeded sediment quality guidelines in Lambton Harbour (Stephenson *et al.* 2008; Oliver, 2014). DDT, PAH, Pb and Hg are not currently being discharged in sufficient quantities in urban stormwater to produce these levels of contamination (Diffuse Sources 2014).

This is therefore thought to be legacy contamination carried by stormwater in the past. There may also have been other sources such as industrial discharges (before connection to the sanitary system), spillage during port loading/off-loading, and leaching of heavy metals from antifouling paints and treated timber. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly (Diffuse Sources, 2014).

In 2016, as part of the most recent sediment quality survey in Wellington, GWRC commissioned an assessment of a range of emerging organic contaminants (EOCs) at ten sub tidal sites. These included glyphosate, perfluorinated compounds, flame retardants, plasticisers, surfactants, mush fragrances, pharmaceuticals, steroid estrogen, personal care products, methyl paraben and pyrethroid insecticides. The levels of EOCs observed in the surface sub tidal sediments were low compared with levels observed at other sites in New Zealand and other countries (Olsen, 2017).

Monitoring of stormwater catch pit sediments in Thordon, Waring Taylor Street and Newtown reported by Oliver (2014) shows that concentrations of Cu, Pb and Zn were generally five to ten times higher in catch pit sediments compared to harbour sediments near major stormwater outfalls. In contrast Hg concentrations were approximately eight times lower in catch pit sediments, with the exception of Waring Tylor catch pit samples which were roughly half of the concentration in nearby harbour sediments. Concentrations of TPH were higher in catch pits sediments compared to harbour sediments, while PAH concentrations were similar in catch pit and harbour sediments.

Figure 3-1: Map of Wellington Harbour sub tidal locations, 2006 -2011 (from Oliver *et al*., 2014)

Aquatic ecology

Wear (2001) described the rocky reef communities at Oriental Bay. In total 12 macroalgal and 38 animals were recorded. The high shore was dominated by the littorinid gastropods *Eulittorina cincta* and *E. unifasciata* which were common or very common, and the midshore by abundant columna barnacles *Chamaesipho*, top shells *Melagraphia aethiops,* and limpits *Cellana* which were common. Towards the lower part of the mid-shore, blue mussels *Mytilus galloprovincialis* were very common and dominated, and the cat's eye *Turbo smaragdus* was common. The cobble substrate of the low shore was dominated by barnacles and blue mussel clumps but much of the habitat lacked macroalgae of animal life due to substrate mobility. Brown macroalgae (especially *Carpophyllum maschalocarpum* and *Cystophora* spp.) and red algae (*Corallina officinalis*, *Gigartina spp.)* dominated towards ELWS. The biota beneath cobbles was rich, with dominant and very common gastropod species being *Melagraphia aethiops*, *T. smaragdus*, amphipods and the crab *Petrolisthes elongates*.

Studies of soft sediment benthic communities within Lambton Harbour have shown that communities near the wharves can be strongly disturbed, with very low numbers of benthic species and individuals (Haddon & Wear, 1993; Anderlini & Wear, 1995). Biota becomes rapidly more varied and numerous with increasing distance from the wharf, with species richness, species diversity, and total abundance increasing markedly within 50m from the wharf edge. Diving observations suggested the effects of ship movements appeared to be concentrated within 10 or 15m of the wharf edge. Beyond the immediate vicinity of the wharf, the ecological community was found to be typical of mixed silty/muddy sediments found within Wellington Harbour (MWH 2003).

Ecology near four outfalls in Lambton Harbour studied by Bolton-Richie (2003) showed a "halo" affect, with the sediment ecology showing a strong gradient within the first 10-34m of the outfalls. A far greater area of influence may occur but could not be distinguished under the study design (Bolton-Richie, 2003). Diffuse Sources (2014) described these effects as strong but localized biological effects.

Such effects are not always observed near outfalls. At Queens Wharf, in the vicinity of the Harris Street and Waring Taylor Street outfall, surveys in 1995 found benthic communities were (relatively) stable and did not exhibit signs of ecological stress or pollution-induced disturbance

(Anderlini & Wear 1995). Both these outfalls discharge stormwater from relatively small catchments, so possibly stormwater effects were difficult to distinguish from other perturbations and stressors close to the wharves.

Stephenson *et al.* (2008), Milne (2010) and Oliver (2014) described the benthic community health at subtidal sites in Wellington Harbour, including sites offshore from Lowry Bay, Petone Beach, the Hutt River mouth, Ngauranga Stream, Kaiwharawhara Stream, Aotea Quay, in Lambton Harbour and in Evans Bay. Oliver (2014) reported a total of 124 invertebrate taxa identified in the 2011 survey. The most abundant species within the community were polychaete worms, crustaceans, sipunculids and bivalves. The heart urchin, *Echinocardium cordatum*, was the dominant member of the biomass, along with the bivalve *Dosina zelandica*, and the brittle star *Amphiura rosea*. Overall, the invertebrate community composition was broadly similar across surveys conducted in 2006 and 2011, despite some differences in the relative abundance of most dominant species at some sites.

The sub tidal sites included in the Wellington Harbour sediment and biota studies are all far field sites, not located close to outfalls, where samples are more indicative of the overall ecological health of the harbour. At these locations, within 4 km of the wharves and quay, stormwater related effects are still evident but are classified as slight (Kelly, 2010). Small or no effects are only found out towards the middle of Wellington Harbour at considerable distances (4-6 km) from Lambton Harbour.

3.3.8 North Harbour

Catchment Characteristics

The north coast of Wellington Harbour stretches from Kaiwharawhara to the western end of Petone Beach. The Kaiwharawhara coastline is made up of approximately 5 ha of reclaimed land. The shoreline has been modified with the deposition of man-made rubble (EHEA 1998). East of Kaiwharawhara the straight coast is rocky and exposed and has limited access due to the proximity of SH1, SH6 and the main trunk railway. It receives stormwater from Onslow, Ngauranga and Horokiwi. Ngauranga Stream drains a predominantly residential catchment, but includes significant commercial and light industry areas in Johnsonville, Newlands and Ngauranga (see Section 3.2.5). Onslow is predominantly Open Space with significant areas of motorway and light industrial/commercial premises. Horokiwi/Bellevue stream carries mostly “rural” runoff.

Aesthetics, amenity and recreation

Along the northern shoreline the main amenity values of the receiving waters are boating and fishing. Some water skiing and rowing occurs from the west end Petone Beach.

Water quality

The coastal receiving waters are not monitored for microbiological quality. Monitoring results for Ngauranga Stream are reviewed in Section 3.2.5.

Sediment quality

GWRC’s Wellington harbour marine sediment quality investigations conducted in 2006 and 2011 (Stephenson *et al.* 2008; Milne 2010, and Oliver, 2014) showed that Cu and Zn were below guideline levels near Ngauranga Stream mouth while DDT, Pb, and Hg exceeded sediment quality guidelines at that location. Diffuse Sources (2014) considered that DDT, Pb and Hg are not currently being discharged in sufficient quantities in urban stormwater to have led to these levels of contamination and that this is legacy contamination. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly (Diffuse Sources 2014).

Aquatic ecology

Ecological monitoring has distinguished moderate biological effects (Kelly 2010) at distances 0.5 to 1 km off the northern shore. Low or no effects are only found towards the middle of Wellington Harbour at considerable distances (4-6 km) from the shore. However, the sediments along the northern coast of Wellington are probably also affected by other major stormwater discharges from Wellington’s CBD, from the Hutt River discharge and by stormwater from Hutt City (Diffuse Sources 2014).

3.3.9 Petone and Hutt Estuary

Catchment Characteristics

The Hutt and Waiwhetu catchments include the coastal areas of Petone Beach and the Hutt/Waiwhetu estuaries. The Korokoro shoreline at the west end of Petone Beach consists of a predominantly gravel beach flanked at each end by man-made boulder fields The Hutt River catchment is described in Sections 3.2.7 to 3.2.16. It includes the urban areas of Hutt and Upper Hutt cities as well as large areas of pasture, exotic forest and indigenous forest.

Aesthetics, amenity and recreation

Petone Beach is a popular beach for walking, sunbathing, shell gathering and offers safe swimming in most places. Toilets, changing rooms, parks, playgrounds and plenty of parking can be found at this beach. The beach is groomed and a swimming raft is anchored off Oriental Street making it a very popular recreation area and a recognised bathing beach.

Water quality

Three sites on Petone Beach are monitored as part of the GWRC recreational water quality monitoring programme. The recreational water quality monitoring is specifically designed to inform the public about the suitability of various sites across the region for swimming and other recreational activities.

During the 2015/16 bathing season the suitability for recreation grade (SFRG) was “Fair” at Petone – Water Ski Club, “Fair” at Petone – Sydney St and “Fair” at Petone – Kiosk. Two “alert” and one “action” triggers were recorded at Petone Beach during the 2015/16 bathing season.

No chemical water quality data is available for Petone Beach. Water quality monitoring results for the Waiwhetu Stream and Hutt River are summarised in Sections 3.2.8 and 3.2.12, respectively.

Sediment Quality

Stevens *et al.* (2004) observed that while stormwater flows entering the foreshore have the potential to contaminate the intertidal area of Petone Beach, sediment quality monitoring results showed that nearshore sandy sediments are not acting as a significant sink for common stormwater contaminants such Cu and Zn.

GWRC’s Wellington harbour marine sediment quality investigations conducted in 2006 and 2011 (Stephenson *et al*. 2008, Milne, 2010, and Oliver, 2014) found that Cu and Zn were below guideline levels at two sites off Petone Beach while DDT, Pb, and Hg exceeded sediment quality guidelines at those locations. Diffuse Sources (2014) considered that DDT, Pb and Hg are not currently being discharged in sufficient quantities in urban stormwater to have led to these levels of contamination, and this is most likely legacy contamination. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly (Diffuse Sources, 2014).

Stevens *et al.* (2016) reported that Hutt Estuary sediment concentrations of Cd, Cr, Cu, Hg, Pb, Hg and arsenic, are present at “Very Low” to “Moderate” concentrations with all non-normalised values below ANZECC (2000) ISQG-Low trigger values (and therefore unlikely to pose a toxicity threat to aquatic life). However, the heavy metal nickel exceeded the ISQG-Low trigger values at the majority of lower estuary sites, but not the ISQG-High values.

Aquatic ecology

The Petone Beach foreshore has been identified as an important conservation area. It is considered to be a valuable roosting and feeding ground for variable oyster catchers, gulls, pied stilts and terns that feed on the invertebrate fauna of the beach (Wear and Hatton, 1992). The results of infaunal sampling conducted at Petone Beach in 2004 showed that overall the infauna was dominated by bivalve shellfish (pipi) and numerous polychaete worms (Stevens, *et al*, 2004).

The Hutt Estuary is a moderate sized (3km long) “tidal river mouth” type estuary which drains into Wellington Harbour at Petone. It has been extensively reclaimed and modified, and the banks clad with large rip-rap boulders. The estuary has been highly modified from it original state. As a result the estuary now has extremely low habitat diversity. High value habitats such as tidal flats, saltmarsh and seagrass beds are virtually absent (Stevens, *et al.*, 2016).

Stevens *et al* (2016) observed that the estuary currently receives high inputs of nutrient and sediment from the large catchment and consequently growths of green nuisance macroalgae are common along its banks, and the bed near the mouth is muddy and enriched. The authors summarised the broad scale assessment results as follows:

- Intertidal flats (21% of the estuary area) were dominated by cobble (3.7ha, 38%) located primarily in the upper estuary, and firm sandy mud (2.8ha, 31% - 58-87% sand) on intertidal flats. While relatively small, these are the largest remaining estuarine intertidal sandflats in Wellington Harbour.
- Seawalls, river protection works and reclaimed margins (2.3ha, 24%) extended throughout the upper tidal zone of the entire estuary.
- Soft mud (0.2ha, 2%) was not a prominent feature, and sediment rate monitoring showed no net annual accumulation on the Te Mome intertidal flats since 2010, and no increase in sediment muddiness since measures were established at this site in 2014.
- Opportunistic macroalgal growth (primarily *Ulva intestinalis)* was extensive (98% of the available habitat), but biomass was generally low with only very localised intertidal nuisance conditions (rotting algae, poorly oxygenated and sulphide-rich sediments) – most likely due to strong flushing and flood scouring of the estuary. Macroalgal cover has not changed appreciably since 2010.
- No significant gross eutrophic zones were present in 2016 (e.g. combined dense macroalgae, soft muds, and poor sediment oxygenation).
- Saltmarsh covered <1% of the estuary (0.5ha) and was limited by the hardened rock walls that surround much of the upper tidal margin.
- The densely vegetated 200m margin cover (i.e. forest, scrub, tussock, and duneland) of the estuary was very low (<1%).
- A synoptic assessment of deeper sub tidal habitat in the lower estuary found sediments to be relatively muddy with high organic, nutrient and total sulphur contents, low levels of sediment oxygenation, and high levels of the heavy metal nickel.

In relation to the key issues addressed by the broad scale monitoring (i.e. sediment, eutrophication, and habitat modification), Stevens *et al* (2016) reported that overall there is currently a “High” risk of adverse impacts to the estuary ecology occurring because of extensive modification of estuary margins which has displaced saltmarsh and vegetated terrestrial margin buffers, excessive macroalgal growth throughout the estuary, and degraded sub tidal habitat quality which indicates a high risk of stress to benthic communities in the area. No significant changes were recorded from baseline measures. Strong flushing and flood scouring of the estuary appears to currently restrict the extent of nuisance conditions (rotting macroalgae and poorly oxygenated and sulphide rich sediments) to localized areas on intertidal flats, and in sub tidal areas near the Hutt River mouth. The key consequence is a reduction in the ecological value of important habitat features, particularly a reduced capacity to assimilate sediment and nutrient inputs, and reduced supporting habitat to birds, fish (whitebait) and shellfish.

3.3.10 Eastbourne

Catchment Characteristics

The Eastbourne ‘catchment’ extends from Point Howard to beyond Burdens Gate. It includes Sorrento Bay, Lowry Bay, York Bay, Mahina Bay, Sunshine Bay, Days Bay, Rona Bay and Robinsons Bay. A number of minor watercourses, including Days Bay Stream, run off the forested hills which rise above the coastal strip. Urban development is mostly limited to a narrow band running beside the coast.

Aesthetics, amenity and recreation

Sorrento Bay is a small sandy beach located near Point Howard that is popular for sunbathing and swimming. No facilities are present at this site. Lowry Bay is a narrow gravel beach bounded by rocky outcrops. The road runs alongside the beach and while there are no facilities in the immediate area, parking and a boat ramp can be found at the southern end of the beach. York Bay is a sandy beach nestled between two rocky outcrops. It is popular for walking but not often used for swimming, and has not facilities. Days Bay is a sandy beach popular with swimmers and walkers. Parking toilets and changing facilities are located at the beach front while a café and parks are situated across the road. Sand and pebble beaches are found at Rona and Robinsons Bay adjacent to Eastbourne. Parks, toilets, and changing facilities are located at several locations along this long strip of beach, making this popular for bathing and walking.

Water quality

Ten sites on along the Eastern Bay are monitored as part of the GWRC recreational water quality monitoring programme, which is specifically designed to inform the public about the suitability of various sites across the region for swimming and other recreational activities. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was “Fair” at Sorrento Bay and Lowry Bay, “Good” at York Bay and three sites on Days Bay, “Fair” at two sites on Rona Bay and “Good” at adjacent to the HWS Recreation Ground and Nikau Street.

No chemical water quality data is available for the Eastern Bays.

Sediment quality

Sediment chemistry surveys conducted by Stevens, et al (2004) indicated that Lowry Bay is relatively free of contaminants. Metal concentrations were very low and do not indicate contamination of the nearshore sediments.

Wellington’s harbour marine sediment quality investigations conducted by GWRC in 2006 and 2011 (Stephenson *et al.* 2008; Milne, 2010; and Oliver, 2014) found that site WH17 located offshore of Eastbourne was probably the least contaminated site in the survey. None of the metals, PAH or other organic contaminants tested exceeded sediment quality guidelines at that location.

Aquatic ecology

Intertidal habitats along the eastern side of Wellington Harbour include sandy beaches and rocky shores. Moderately sheltered and sheltered rocky reef habitat is found on outcrops between Pt Howard and Eastbourne, with firm sandy beaches and gravel field at Lowry Bay, York Bay, Mahina Bay, Days and Eastbourne. South of Eastbourne, the rocky reef is moderately exposed, becoming very exposed south of Inconstant Point (EHEA, 1998).

In the shallow sub tidal, soft sediments of Lowry Bay bivalves such as cockles, pipi, clams (*Cylomactra*) and wedge shells are present. Further south mussels are found on rocky outcrops, while scallops occurs in deeper sub tidal waters.

In a broad scale habitat assessment of intertidal habitats along the eastern bays McMertrie & Brennan (2016) found a total of 36 invertebrate taxa, with the snails *Melagraphia (Diloma) aethiops, D. nigerrima* and the porcelain crab *Petrolisthes elongates* the most widespread taxa. Based on density data the community was dominated by the columnar barnacle *Chamaesipho columna*, with the snails *D aethiops, D nigerrima,* and *Austrolittorina antipodum* the only other species representing more than 1% of total abundance. McMertrie & Brennan (2016) concluded that the community composition of the surveyed area was as expected for this general location and rocky shore habitat, and is similar to the rocky shore communities found elsewhere in Wellington Harbour. No taxa that are indicative of significant nutrient enrichment or fine sediment input were present in any great abundance, with exposure and substrate seeming to be the main factors influencing the communities of this area.

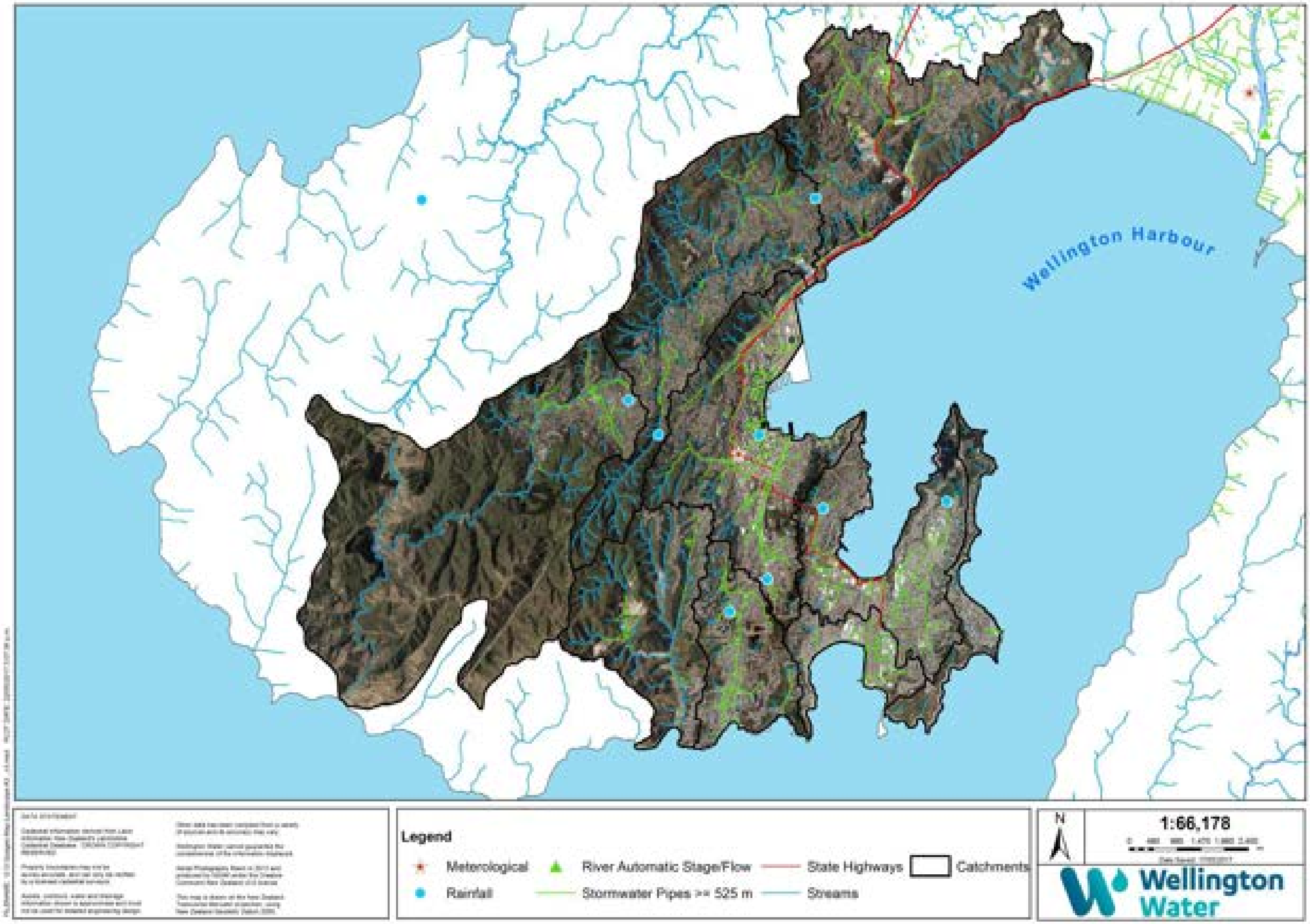

Figure 3-2: Rainfall and river flow gauging stations

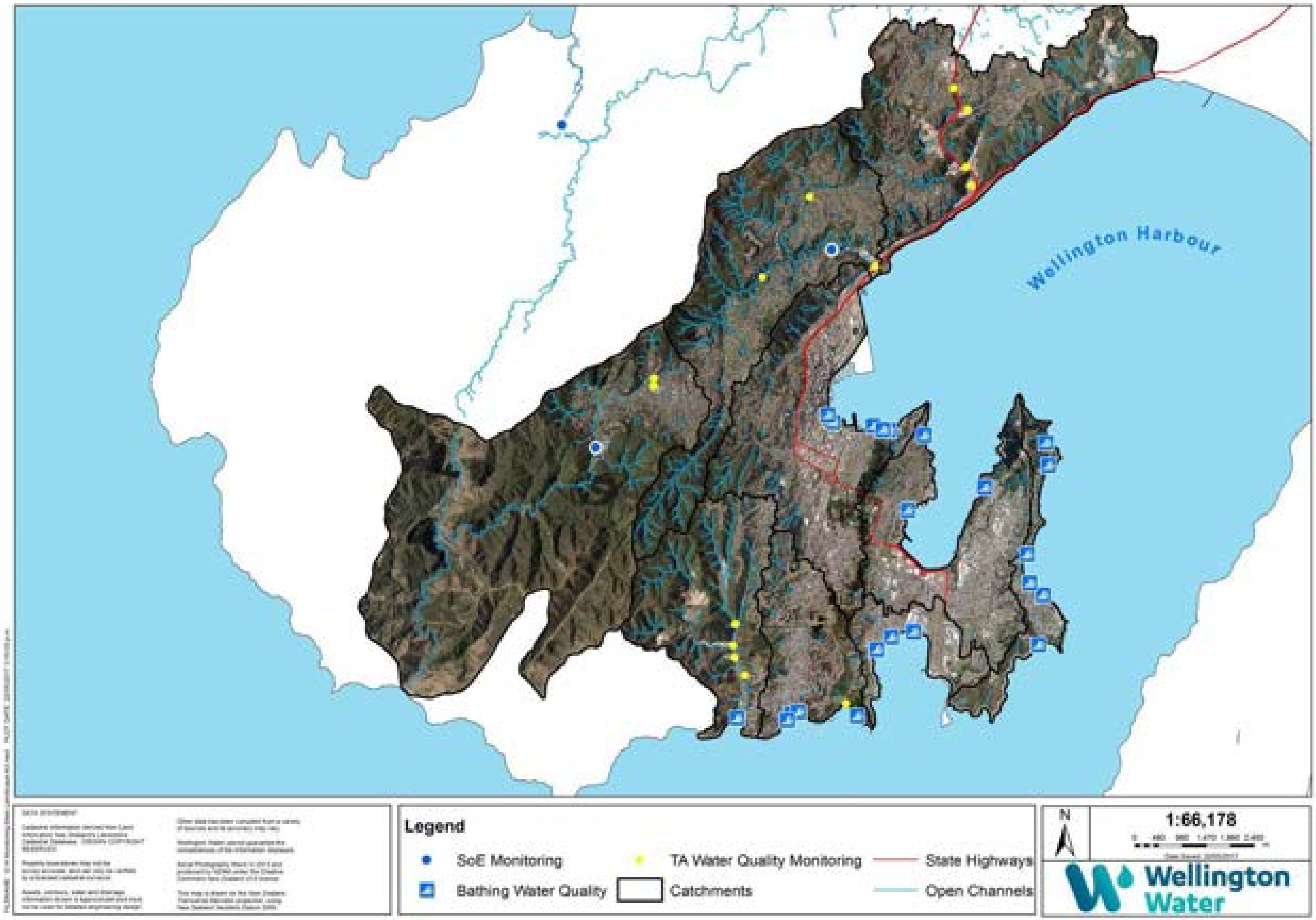

Figure 3-3: RsoE and recreational water quality monitoring sites in an around Wellington Harbour

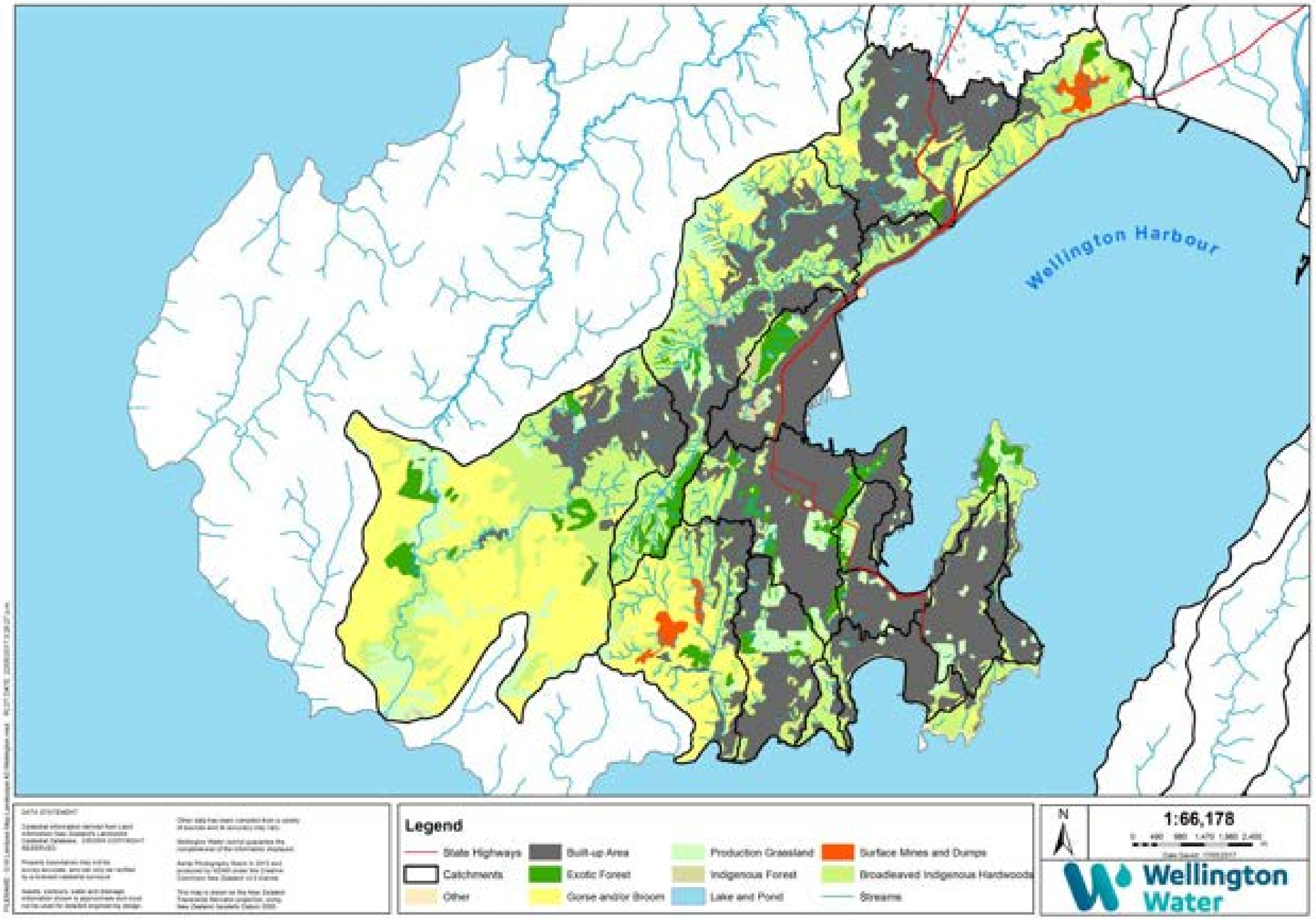

Figure 3-4: Land use categories in the Wellington area

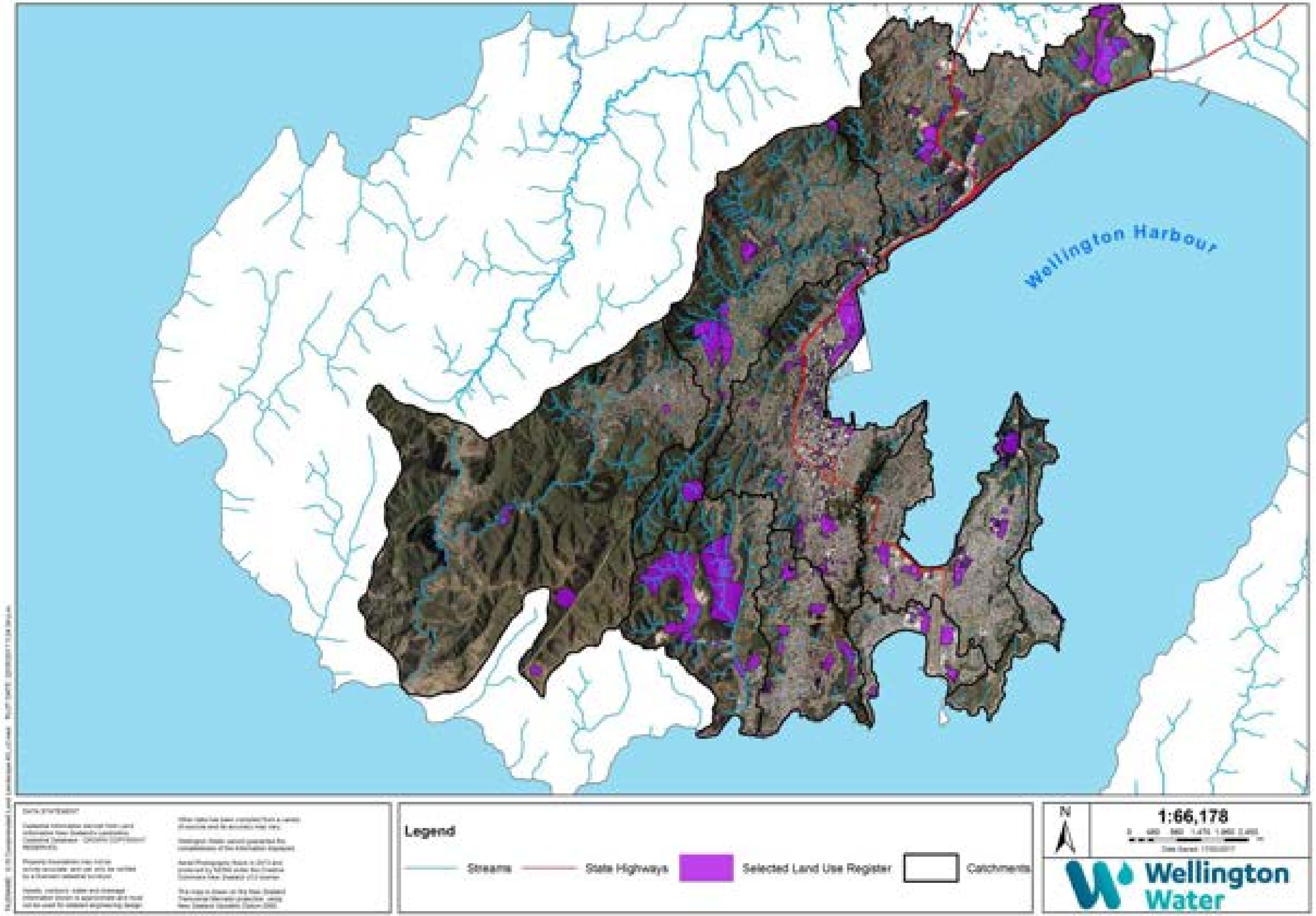

Figure 3-5: SLUR Sites that are known or suspected to have been involved in the use, storage, or disposal of hazardous substances and which may contain residues of these substances

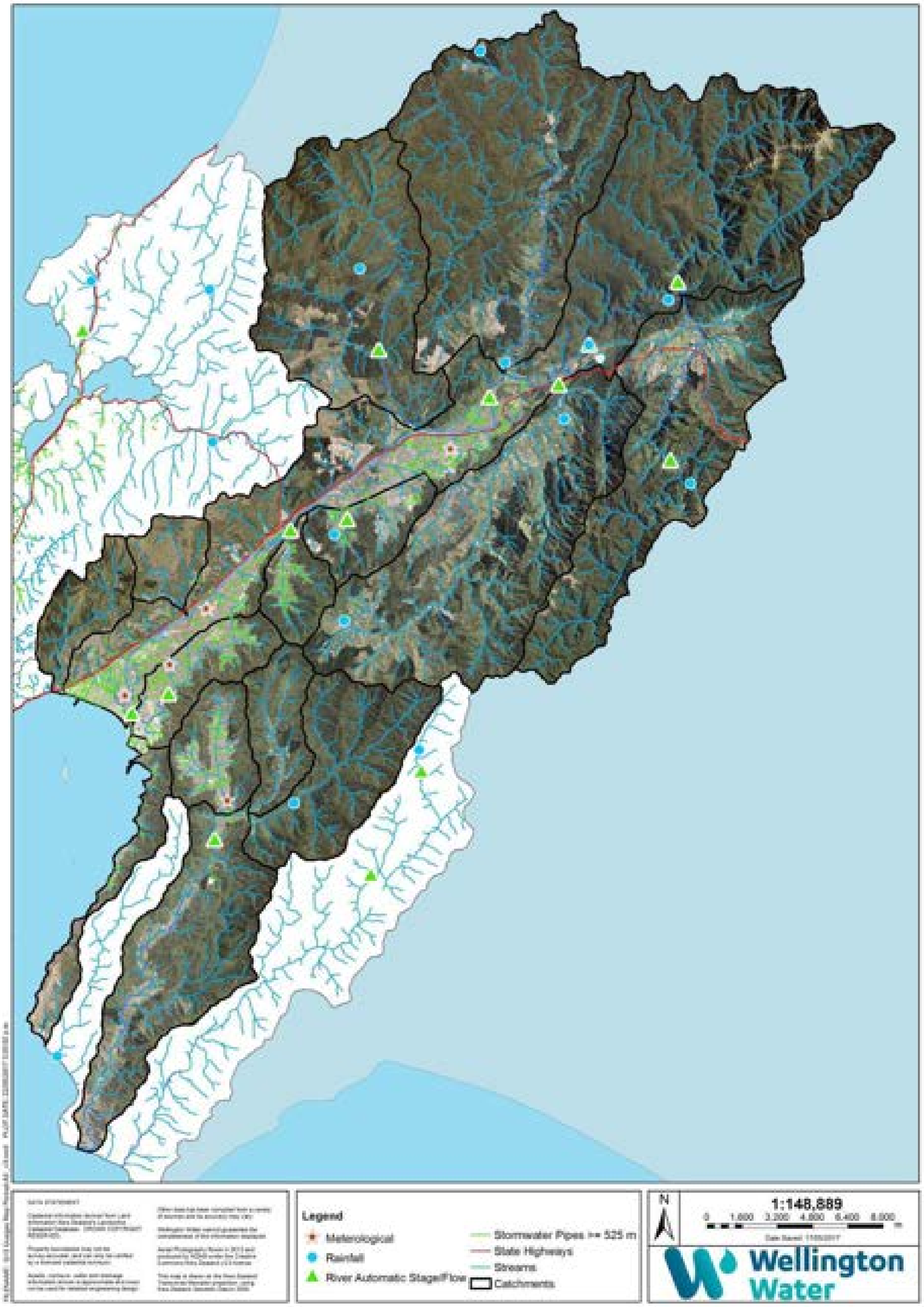

Figure 3-6: Rainfall and river flow gauging stations

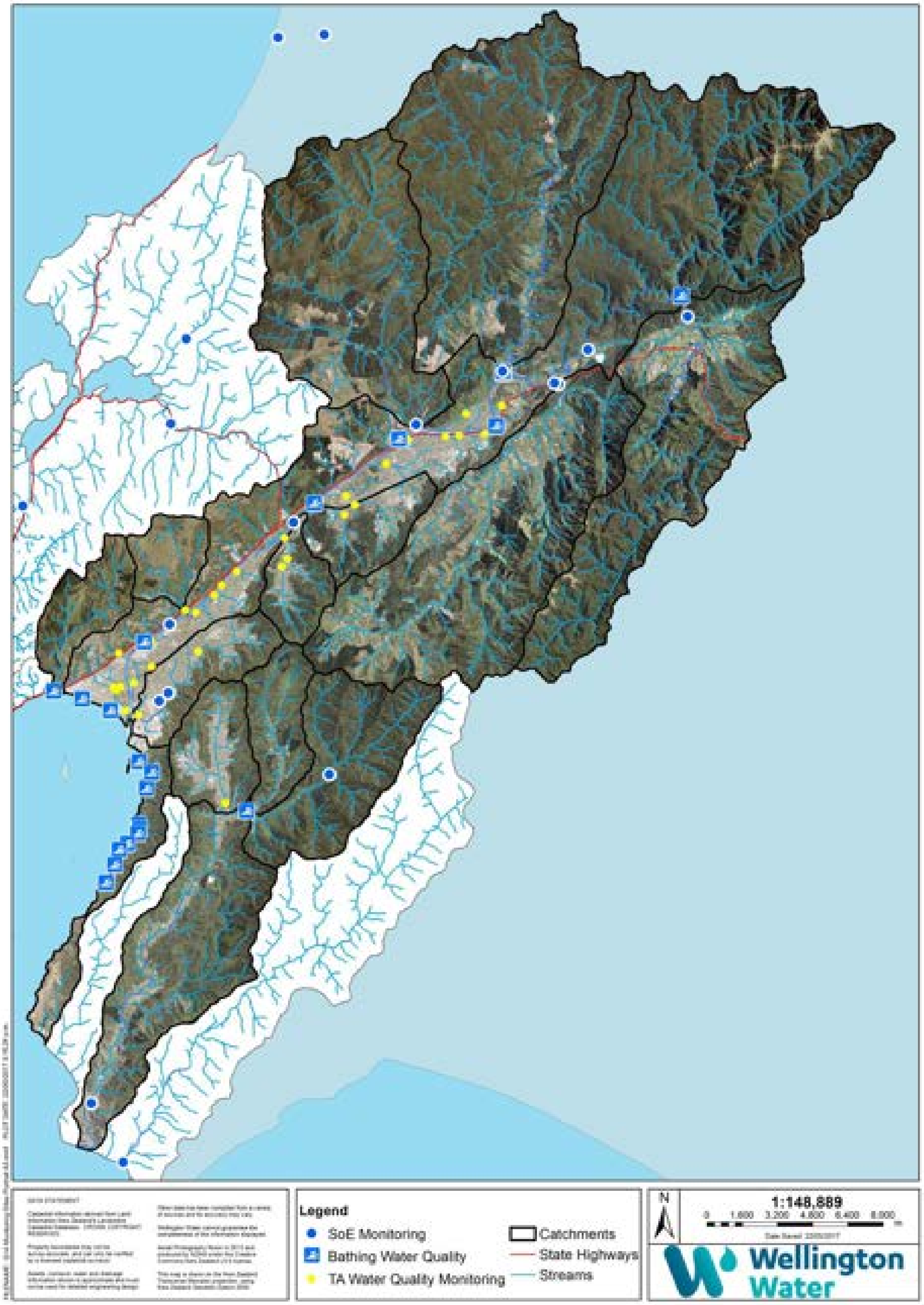

Figure 3-7: RsoE and recreational water quality monitoring sites at the Hutt Valley

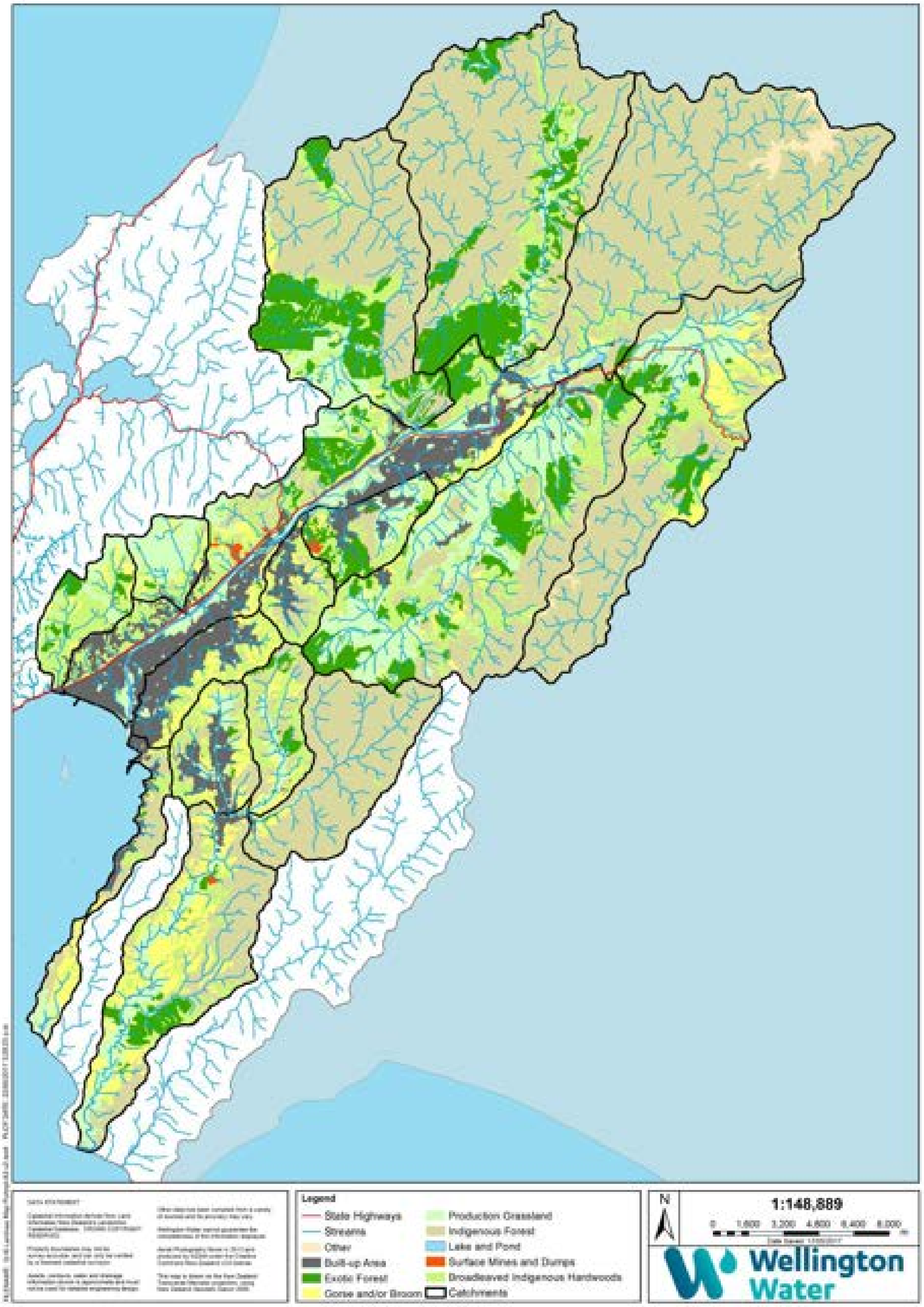

Figure 3-8: Land use categories for the Hutt Valley

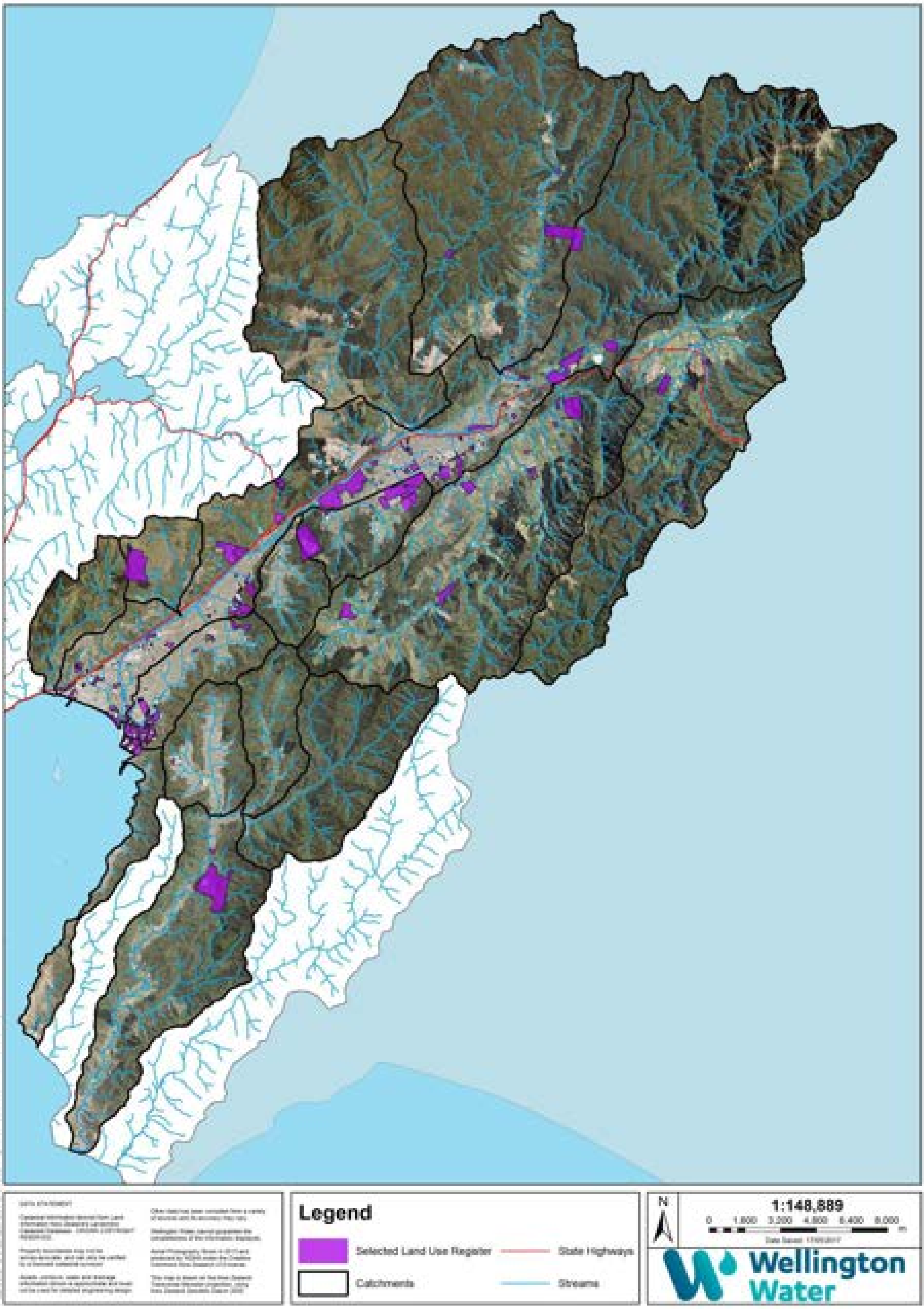

Figure 3-9: SLUR Sites that are known or suspected to have been involved in the use, storage, or disposal of hazardous substances and which may contain residues of those substances

4 Stormwater networks in Wellington & Hutt Valley

4.1 Wellington City

4.1.1 Overview

Wellington's public stormwater system has developed over the last 130 years or more, corresponding with the city's growth in population. Over that period natural watercourses within the urban edge have become increasingly confined or piped to allow more intensive use of the land. While some urban streams still remain, including the Kaiwharawhara, Owhiro and Karori streams, most of Wellington is serviced by a piped stormwater system.

Mostly, Wellington's steep topography enables gravity-flow of stormwater to discharge points. In low lying areas such as Kilbirnie stormwater needs to be pumped to the discharge point. The use of stormwater pump stations is not common practice; they are only used as a last resort.
The stormwater primary system is made up of nearly 700 km of pipelines, 2.2 km of tunnels, over 15,000 inlets/outlets, 1 pump station and 2,700 associated fittings. These structures include kerbs, channels, and sumps. Kerbs, channels and sumps are managed as part of Council's transportation activity.

4.1.2 Owhiro Bay

Owhiro Bay lies on Wellington's exposed south coast. It is part of the Taputeranga Marine Reserve and has boat launching facilities. Owhiro Stream discharges at the beach and drains open space, rural land as well as the urban area of Brooklyn and three operating landfills.

The layout of the stormwater network, its location within the stream catchment, and the locations of stormwater outfalls, stormwater monitoring locations, sewer mains and sewer overflows are show in Appendix A. Characteristics of the catchment and stormwater network are summarised in Table 4-1. A summary of wastewater overflows to the stormwater network is provide in Table 4-2.

Table 4-1: Owhiro Bay stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchment name:	Owhiro Bay
Stream catchment area:	9.71 km^2
Stormwater catchment area:	4.93 km^2 (50.8% of stream catchment)
Impervious surface area:	1.02 km^2 (14.5% of stream catchment)
Number of outfalls to CMA:	One stream outlet
Total public stormwater length:	33 km
Age of stormwater system:	Circa 1900 onwards. Less than 10% constructed prior to 1940's and 15% between the 1940s and 1960s. The remaining 74% was constructed from 1970 onwards.
Constructed sewer overflows::	1
Pump station overflows:	2 (PS38 & PS39)
System type	100% separate
Open water courses:	Owhiro Stream and numerous tributaries. Owhiro Stream flows as an open watercourse from 353 Owhiro Bay Road to the coast however some of it length is culverted, including nearly all headwater stream in urban Brooklyn. The two major tributaries are Careys Gully Stream and an unnamed stream that drains Polhill Gully. The reticulated stormwater system discharges to Owhiro Stream and its tributaries at multiple locations throughout its length.
Open channel stream length:	26 km
Landfills:	Landfill related issues include: • Leachate from the Southern Landfill is collected and diverted to the wastewater systems for treatment. • Leachate for the T&T Landfill, which is a clean-fill, is treated in a wetland prior to discharge to a tributary of Owhiro Stream. • The fate of leachate from the C&D Landfill, also a clean-fill, is uncertain. • Closed landfills at Prestons Gully and Happy Valley Park.

Contamination Sources	Catchment wide sources are dominated by runoff from gorse scrubland. While urban stormwater is a relatively minor input, contaminants sourced from the urban area include metal roofs and building materials, road surfaces and other permeable pavements, soil disturbance, vegetation, wild and domestic animals, and vehicles (tyres, brake linings, oil leakage, and exhaust).
Contamination hot spots	Potential known point sources include three operating landfills, at least one of which is known to have a measurable effect on the water quality of Owhiro Stream (Cameron 2017).
Contaminant loads	Calculated stormwater loads of Zn, Cu, Pb and PAH from the catchment, excluding inputs from the landfill sites, are low (Table 2-4). The catchment area is about 13% of Wellington City and loads are about 6% of the total stormwater load from Wellington (Diffuse Sources, 2014).
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Sewage contamination of stormwater has been a major issue in the past. Predicted overflow locations and frequencies are listed in Table 4-2. Other potential sources of faecal contamination in the Owhiro Stream include droppings from birds, dogs, cats, possums, goat, horse, cattle and sheep.

Table 4-2: Owhiro Bay constructed wastewater overflows and PS overflows (from Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
WW11051	Owhiro Bay Parade	PS overflow to beach at WW22478 (TBC)	0	0
WW111058	86 Owhiro Bay Parade	PS39 overflow to beach at WW39789	0	0
WW27373	275 Owhiro Road	Network overflow to stormwater culvert at SW08033	2	11

4.1.3 Island/Houghton Bay

Island and Houghton Bays lie of Wellingtons exposed south coast. They are part of the Taputeranga Marine Reserve and have popular beaches. They receive stormwater from the suburbs of Island Bay, Southgate, Berhampore, Vogeltown, Mornington, Kingston and Houghton Bay. The combined catchment covers an area 6 km^2.

The Island Bay catchment was historically drained by an unnamed stream which followed the approximate alignment of the trunk stormwater system. Stormwater is now discharged to the Bay via three major outfalls opposite Shortland Park and 218 the Esplanade.

The Houghton Bay catchment lies immediately to the east of Island Bay covering an area of 0.88 km^2. An unnamed stream historically drained the catchment. The closed Houghton Bay Landfill extends up the original valley floor from Cave Rd to Sinclair Park. It was opened in 1951 and completed in 1971.

The layout of the stormwater network, its location within the stream catchment, and the locations of stormwater outfalls, stormwater monitoring locations, sewer mains and sewer overflows are show in Appendix A. Characteristics of the catchment and stormwater network are summarised in Table 4-3. A summary of wastewater overflows to the stormwater network is provide in Table 4-4.

Table 4-3: Island/Houghton Bay stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchment name:	Island Bay and Houghton Bay
Stream catchment area	6.0 km^2
Stormwater catchment area	4.63 km^2 (77% of total catchment)
Impervious surface area	1.84 km^2 (31% of total catchment)
Number of outfalls to CMA (>600mm dia)	3 to Island Bay and 1 to Houghton Bay

Catchment characteristic	Description
Total public stormwater length	60 km^2
Age of stormwater system	Island Bay circa 1900 onwards. The main spine was constructed in the 1910's gradually extending though Berhampore the 1930's. The network extended into the upper hills in the 1960, 70s & 80s. Houghton Bay circa 1930's onwards.
Constructed sewer overflows	2
Pump station overflows	3 (PS36, 37 & 40)
System type	100% separate
Open water courses	No significant watercourses in Island Bay or Houghton Bay (but several minor headwater streams on upper hill-slopes
Open channel stream length	6 km in Island Bay, 1km in Houghton Bay.
Landfills	Historic landfills include: • Macalister Park • Martin Luckie Park • Tapu Te Ranga Marae • Southgate Reserve • Former Melrose Road/ Albert Street Landfill • Former clean-fill on Wye Street • Former Houghton Bay Landfill
Contaminant sources	Catchment wide sources common to all older urban areas include metal roofs and building materials, road surfaces and other permeable pavements, soil disturbance, vegetation, wild and domestic animals, and vehicles (tyres, brake linings, oil leakage, exhaust). Land use is predominantly residential and traffic densities are moderate to low.
Contamination hot spots	Potential known point sources include a large closed landfill Houghton Bay Landfill which appears to be a major source of contamination of stormwater is Houghton Bay (Capacity, 2012).
Contaminant loads	Stormwater loads of Zn, Cu, Pb and PAH from the catchment, excluding inputs from the landfill sites are moderate (Table 2-4). The catchment is about 6.5% of the Wellington City area and loads are about 9% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington (Diffuse Sources 2014)
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Sewage contamination of stormwater has been a major issue in the past. There are five locations in the catchments where sewage is designed to overflow into the stormwater system during extreme situations. These include two constructed network overflows and two pumping stations (see Table 4-4).

Table 4-4: Island/Houghton Bay constructed wastewater overflows and PS overflows (Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
WW34516	230 the Esplanade	PS37 overflow to the eastern side of Island Bay beach (ww27962)	0	0
WW32065	53 Mersey Street	Network overflow to stormwater pipe at SW30380	1	43
WW30645	35 Mersey Street	Private lateral connected to WWP037066 passes through stormwater manhole, top of pipe cut open to allow overflow	0	0
WW20320	126 The Esplanade	PS36 overflow to Houghton Bay beach at WW39668 and WW39669	0	0

4.1.4 Lyall Bay

Lyall Bay is a large embayment that lies on Wellington's exposed south coast. It has a large popular beach enclosed by rocky headlands. It receives stormwater from Lyall Bay catchment, the southern parts of Miramar Golf Course and Wellington Airport and part of Moa Point Wastewater Treatment Plant

The Lyall Bay catchment is bounded by the ridgeline between Lyall bay and Houghton Bay to the west, the Kilbirnie/Rongotai catchment to the north and the Miramar/Strathmore catchment to the east. The south-eastern corner of the catchment in Strathmore Park rises steeply to a maximum height of 120m, while the remainder of the catchment is relatively low and flat, being historic sand dunes (Table 4-5). The old coastline used to bisect the airport runway towards Moa Point (the southern part of the runway was added in two stages between the 1950s and 1970's).

Table 4-5: Lyall Bay stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchments	Lyall Bay West, Lyall Bay East, Airport South Strathmore Park South and Moa Point
Stream catchment area	2.84 km^2
Stormwater catchment area	2.64 km^2 (93% of stream catchment)
Impervious surface area	1.36 km^2 (48% of stream catchment)
Number of outfalls to CMA (>600mm dia)	14 to Lyall Bay (and many minor outfalls)
Total public stormwater length	27 km
Age of stormwater system	Circa 1909 onwards. The network developed gradually over time. Western Lyall Bay is the oldest part of the suburb, mostly constructed prior to 1940. The majority of the eastern catchment was constructed between 1939 and 1963.
Constructed sewer overflows	1
Pump station overflows	Six (PS 19, 22, 24, 31, 34 & 35)
System type	100% separate
Open water courses	No significant open watercourses (some minor headwater streams in western hill-slopes)
Open channel stream length	1.0 km
Landfills	2 historic landfill (Endeavour Park and ex WCC work depot)
Contaminant sources	Catchment-wide sources in Lyall Bay includes roofs and other building materials found in older urban areas, traffic, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a significant generic source. Land use in the Lyall catchment is predominantly residential, light commercial, industrial and airport. Traffic densities are likely to be relatively high. The high proportion of impervious area and high density of sources means that diffuse sourced pollution is probably at the medium of the urban contamination range (Diffuse Sources 2014).
Contamination hot spots	Closed landfills (above)
Contaminant loads	Stormwater loads of Zn, Cu, Pb and PAH from the catchment are moderate (Table 2-4). The catchment area is about 4%, and loads are about 5%, of the total stormwater load from Wellington (Diffuse Sources 2014). The specific loads (the mass of contaminant per area) are moderate for Wellington.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Sewer rehabilitation works undertaken in the Lyall Bay/Airport catchment since 1993 include cross connection studies and repairs, removal of constructed sewer overflow, rehabilitation of known sewer faults, pump stations upgrades including backup facilities to prevent overflows, and a major trunk sewer upgrade. Because of the old ceramic piping system (some parts are *circa* 1910) maintenance repairs continue as needed to the present day (Diffuse Sources 2014). There are five pumping stations and one constructed network overflow in the catchment (see Table 4-6)

Table 4-6: Lyall Bay constructed wastewater overflows and PS overflows (from Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
WW12811	Lyall Parade/ Freyburg Street	Network overflow to stormwater culvert at SW24896	TBC	TBC
WW19593	120 Tirangi Road	PS24 overflow to stormwater pipe at SW02253	TBC	TBC
WW19670	26 Lyall Parade	PS22 overflow to beach, outfall location TBC	TBC	TBC
WW21652	398 Queens Drive	PS35 overflow to beach at WW06562 and WW06669	0	0
WW38331	118 Lyall Parade	PS overflow to stormwater pipe SW012915	1	89
WW39565	33 Moa Point Rd	PS31 overflow to Moa Point short outfall at WW39566	TBC	TBC

4.1.5 East Coast

The East Coast lies on the eastern side of the Miramar Peninsula, to the east of the city. It forms the western side of the channel leading into Wellington Harbour and is very exposed in the south but more sheltered in the north. It has a rocky coastline interspersed with popular beaches such as Breaker, Worser and Karaka bays.

The east coast receives stormwater from four stormwater catchments: Crawford, Karaka Bays, Seatoun, and South-east Coast. The combined catchment has an area of 2.94 km^2 (Table 4-7)

The Miramar Peninsula was originally an island at the entrance to Port Nicholson. A major earthquake in the 15th century raised the Kilbirnie area, and sand dunes began to accumulate, leading to the formation of present da Miramar Peninsula.

Table 4-7: East Coast/Seatoun stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchment	Crawford, Karaka Bays, Seatoun, and South-east Coast
Stream catchment area	2.94 km^2
Stormwater catchment area	1.29 (44% of total catchment)
Impervious surface area	0.65 (22% of total catchment)
Number of outfalls to CMA (>600mm dia)	2 (Tarakena Bay and end of Gore St)
Total public stormwater length	13 km
Age of stormwater system	Circa 1928 onwards.
Constructed sewer overflows	2
Pump station overflows	7 (PS25, 26, 27, 29, 31, 33 and 41)
System type	100% separate
Open water courses	Several minor water courses
Open channel stream length	2.92km
Landfills	One historic landfill at Fort Dorset (1937-1940)
Contamination sources	Catchment-wide sources are minor and include roofs and other building materials found in residential land, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source, and contaminants from roads probably dominate urban runoff quality. Diffuse urban-sourced pollution is expected to be at the low end of the urban contamination range (Diffuse Sources 2014)
Contamination hot spots	None anticipated.
Contamination loads	Stormwater loads of Zn, Cu, Pb and PAH from the catchment, excluding any inputs from the landfill sites, are low (Table 2-3). The catchment is about 3.4% of the Wellington City area and loads are about 2.5% of the total stormwater

	load from Wellington. The specific loads (the mass of contaminant per area) are very low for Wellington, a reflection of the large area of open space.
Wastewater contamination	Seven pump stations located within the catchment include constructed overflow facilities and have the potential to overflow into the stormwater system or directly to a beach (Table 4-8). However, all of these pump stations have been fully rehabilitated, including automatic monitoring and control equipment and the provision of flow storage to minimise the risk of overflows.

Table 4-8: SE Coast/Seatoun constructed wastewater overflows and PS overflows (Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
WW39659	172 Breaker Bay Road	PS33 overflow to beach (ww39659)	Not available	TBC Not available
WW39565	33 Moa Point Road	PS31 overflow to Moa Point short outfall at WW39566	Not available	Not available
WW3380	Hector Street	PS25 overflow to stormwater pipe at SW26542	Not available	Not available
WW36798	Ludlam Street	PS41 overflow to stormwater pipe at SW26565	Not available	Not available
WW36798	Marine Pde	PS26 overflow to beach	Not available	Not available
WW35385	455 Karaka Bay Road	PS29 overflow to beach	Not available	Not available
WW36808	305 Karaka Bay Road	PS27 overflow to beach	Not available	Not available

4.1.6 Evans Bay

Evans Bay is a large, semi-exposed bay on Wellington Harbour. It stretches from Point Jerningham east of Oriental Bay, to Point Halswell below Mount Crawford and has an area of 4.5 km². Is a major amenity for Wellington for port and boating activities and for recreation. Evans Bay receives stormwater from the suburbs of Rata, Grafton, Hataitai, Kilbirnie, Rongotai, Miramar and Mt Crawford via 10 major stormwater outfalls and numerous smaller outlets. The combined catchment has an area of 8.52 km².

Table 4-9: Evans Bay stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchments	Crawford, Grafton, Rata, Hataitai, Kilbirnie, Rongotai and Miramar
Stream catchment area	9.45 km²
Stormwater catchment area	7.92 km² (84% of stream catchment)
Impervious surface area	4.08 km² (43% of stream catchment)
Number of outfalls to CMA (>600mm dia)	10
Total public stormwater length	108 km
Age of stormwater system	Circa 1900 onwards. Developed gradually over time.
Constructed sewer overflows	7
Pump station overflows	8 (PS14, 15, 16, 17, 18, 23, 24, 30, 42)
System type	100% separate
Open water courses	Stream fragments
Open channel stream length	4.5 km
Landfills	Closed landfills at: • Kilbirnie Park, • Miramar Park, • Strathmore Park
Contamination sources	Catchment-wide sources include roofs and other building materials found in older largely residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a significant generic source. Land use is predominantly residential with some significant commercial and light industrial areas including part of the airport runway. Traffic densities are likely

Catchment characteristic	Description
	to be moderate to heavy. The Crawford area is mostly open land, with through roads and small pockets of residential land use. A former Wellington Gas Company gasworks site at Miramar, which operated from 1915 to 1972, caused significant levels of shallow groundwater contamination in that vicinity (Diffuse Sources 2014). Contaminated groundwater was moving off-site to the east and southeast in 1996, with a potential pathway to Evans Bay (Tonkin & Taylor 1996 in MWH 2008). Contaminants included a variety of volatile organic compounds and PAHs. Relatively high concentrations of PAH have been found in the bay near the Miramar outfall (Ahrens & Olsen, 2007), and gasworks-derived contaminants from runoff probably have affected sediment contamination in the bay (Depree, 2010). Oils have also been observed in sediments near Miramar Wharf in the southern bay, and are likely to be sourced from seepage or spillage (Ahrens et al. 2007). These probably caused the elevated concentrations of Total Petroleum Hydrocarbons found in the bay sediments.
Contamination Hot spots	Closed landfills (above) former gasworks, oils in marine sediments near Miramar Wharf
Contaminant Loads	Chemical quality of stormwater has not been measured. Calculated stormwater loads of Zn, Cu, Pb and PAH from the catchment are moderate (Diffuse Sources 2014). The catchment area is about 12% and predicted loads are about 14% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of well-developed, predominantly residential area.
Wastewater contamination	Eight pump stations and six network overflows in the catchment have the potential to overflow into the stormwater system or directly to a beach (Table 4-10). All of eight of these pump stations have been fully rehabilitated, including automatic monitoring and control equipment and the provision of flow storage to minimise the risk of overflows.

Table 4-10: Evan Bay constructed wastewater overflows and PS overflows (from Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
WW35907	Kilbirnie Crescent/ Tully Street	PS17 overflow to stormwater culvert at SW25149	1	4
WW37669	40 Park Road	PS18 overflow to stormwater pipe SWP003313	3	406
WW16560	386 Broadway, Miramar	Network overflow to stormwater pipe at SW00023	0	0
WW18889	40 Park Road	PS23 overflow to stormwater culvert SWP003313	3	406
WW20948	5 Elphinstone Ave	Network overflow to stormwater at SW02201	4	326
WW23985	1 Southampton Road	Network overflow to stormwater culv. SWP003144	4	14
WW31812	Devonshire Road	PS24 overflow to stormwater culvert SWP003144	TBC	TBC
WW36808	15 Strathmore Ave	PS30 overflow to stormwater culvert at SW02647	TBC	TBC
WW38597	Miramar North Rd	Network overflow to stormwater pipe at SW30388	TBC	TBC
WW19570	24 Moxham Ave	Network overflow to stormwater culvert SWP008087	0	0
WW19626	Wellington Road	Network overflow to stormwater pipe at SW09008	6	50
WW33693	88 Evans Bay Pde	PS14 overflow to beach (WW39541).	TBC	TBC
WW33648	194 Evans Bay Pde	PS15 overflow to beach	TBC	TBC
WW20400	392 Evans Bay Pde	PS16 overflow to stormwater pipe at SW09587	TBC	TBC

4.1.7 Lambton Harbour

Lambton Harbour covers the north-eastern corner of Wellington Harbour. It stretches from the northern coast along Aotea Quay to Lambton Basin, and the beach front at Oriental Bay (Table 4-11). Its commercial amenities include the Port of Wellington, Inter-island ferry terminals, and large marina. Recreational amenities include the waterfront of the CBD, Oriental Bay beaches and boat launching and mooring facilities.

The catchment of Lambton Harbour drains the northern and western slopes of Mt Victoria and the large basin comprising the CBD and Newtown. It includes parts of the CBD, Newtown, Vogeltown, Mount Cook, Mount Victoria, Tinakori, Highbury, Northland, Kelburn, Thorndon, Oriental Bay and Roseneath.

Table 4-11: Lambton Harbour/Oriental Bay stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchments	Aotea North, Tinakori, Glenmore St, Aitken, Bowen, Waring Taylor, Hunter, Harris, Te Aro, Taranaki, Tory, Newtown, Oriental Bay.
Stream catchment area	13.7 km^2
Stormwater catchment area	11.5 km^2 (84% of stream catchment)
Number of outfalls to CMA (>600mm dia)	16
Impervious surface area	6.5 km^2 (47% of stream catchment)
Total public stormwater length	165 km
Age of stormwater system	Circa 1860s onwards. The network developed gradually over time
Constructed sewer overflows	29
Pump station overflows	11 (PS1, 2, 3, 4, 5, 8, 10, 11, 12, 13, 20)
System type	100% separate
Open water courses	Kumutoto Stream (between Kelburn and the Terrace Tunnel), Pipitea Stream (within the Botanic Gardens), and a number of smaller watercourses which feed the stormwater network in the upper parts of the catchment. A detailed description of the stream fragments remaining within the Lambton Harbour stormwater catchment is provided by James (2015).
Open channel stream length	13.7 km
Landfills	Historic landfills are located at: Blind Garden, Kelburn Park, Anderson Park, Central Park, Rugby League Park, Hanson Street Hall and Regent Park Flats
Contamination sources	The Southern CBD catchments are predominantly inner city commercial and high density residential, with significant port and railway areas, motorways, and light industrial and green spaces. Traffic densities are very heavy and include many truck and rail movements. The northern CBD catchments have large areas of Open space (Botanic Gardens and Tinakori Hill) and low-medium density residential in the upper parts, and significant port and railway areas, motorways, commercial and light industrial in the lower regions. Traffic densities in the lower areas are very heavy and include many truck and rail movements. Land use in the Oriental Bay catchment is predominantly residential, which also includes a number of cafés, restaurants, the Freyberg Swimming pool, and the Port Nicholson Marina. Traffic densities are moderate. Catchment-wide sources include roofs and other building materials found in older urban areas, road surfaces and other impermeable pavements. These are a major stormwater contaminant source as much of the land is built-on and impervious, and many buildings are tall, with large surface areas of building materials. Vehicles (tyres, brake linings, oil leakage, and exhaust) are another major generic source, as the catchment has a dense network of motorways, major city streets, parking lots and buildings, and transport hubs, including Wellington's main train and bus stations and product distribution yards (Diffuse Sources 2014).
Contamination hot spots	Railway shunting yards and workshops, Port marshalling yards,

	Urban motorway, Closed landfills (see above), Constructed wastewater overflow at Murphy Street
Contaminant loads	Stormwater loads of Zn, Cu, Pb and PAH from the catchment are predicted to be high (Table 2-4). The catchment area is about 18% of Wellington City and loads are about 37% of the total stormwater load from Wellington (Diffuse Sources 2014). The specific loads (the mass of contaminant per area) are high for Wellington, a reflection of well-developed high density urban area.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Sewer rehabilitation works undertaken since 1993 include cross connection studies and repairs, removal of constructed sewer overflows, rehabilitation of known sewer faults, and pump station upgrades including backup facilities to prevent overflows. The most significant constructed overflow in the wastewater network is located at Murphy Street and is discharged via the Davis Street culvert. The recorded average annual overflow volume is about 6000 m^3 with an average frequency of 1 in 4 months (see Table 4-12).

Table 4-12: Lambton Harbour constructed wastewater overflows and PS overflows (Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
Tinakori Catchment				
WW06789	Aotea Quay	PS13 overflow to s/w pipe at SWP027955	TBC	TBC
WW16749	62A Tinakori Rd	Network overflow to stormwater pipe at SWP028706	0	0
WW36252	243 Thorndon Quay	PS12 overflow to s/w culvert at SW20855	0	0
Davis Catchment				
WW06800	75 Thorndon Quay	PS10 overflow to s/w pipe at SW26316	2	96
WW20729	157 Thorndon Quay	PS11 overflow to s/w pipe at SW12623	0	0
WW29768	38 Hawkestone St	network overflow to s/w pipe at SW12159	0	0
WW38277	Murphy St	Network overflow from the wastewater interceptor to s/w culvert at SW04558	3	6,632
Aitken & Bunny Catchment				
WW21279	Waterloo Quay	PS20 overflow to s/w culvert at SW20472	TBC	TBC
Hunter Catchment				
WW33639	152 Featherston St	PS08 overflow to s/w pipe SWP032963	0	0
Newtown Catchment				
WW04696	47 Constable St	Network overflow to s/w pipe at SW30440	3	TBC
WW11419	49 Hall St	Network overflow to s/w pipe at SW29205	0	0
WW17577	Douglas St	Network overflow to s/w pipe at SW12195	1	TBC
WW19192	Drummond St	Network overflow from interceptor to stormwater	TBC	TBC
WW19618	38 Rintoul St	Network overflow to s/w pipe at SW41139	0	0
WW21379	190 Tasman St	Network overflow to s/w pipe at SW24458	0	0
WW26930	39 Kent Tce	Network overflow to s/w pipe at SW04573	3	29
WW26938	66 Oriental Pde	PS2 overflow to s/w culvert at SWP024401	6	479
WW29555	78 Constable St	Network overflow to s/w pipe at SW08817	9	38
WW30039	70 Tasman St	Network overflow TBC	1	TBC
WW30078	60 Kent Tce	PS3 overflow to s/w culvert pipe at SW04530	12	307
WW30412	91 Owen St	Network overflow to s/w pipe at SW08819	0	0
WW30444	17 Douglas St	Network overflow to s/w pipe at SW17807	0	0
WW33635	Chaffers St	PS4 overflow to s/w pipe at SW04579	0	0
WW34419	12 Manley Tce	Network overflow to s/w pipe at SW17958	3	25
Taranaki Catchment				
WW17548	3 Brooklyn Rd	Network overflow to s/w pipe at SW17483	0	0
WW21492	Wakefield/Taranaki	PS5 overflow to s/w culvert SWP033751	TBC	TBC
WW35569	Taranaki St	Network overflow to s/w pipe SWP033753	2	5
WW38599	19 Taranaki St	Network overflow to s/w pipe at SW025785		

4.1.8 Kaiwharawhara

The Kaiwharawhara Stream catchment discharges to Wellington Harbour via Ngaio Gorge, to the north of the CBD. The Kaiwharawhara Stream and stormwater catchment lies to the north and west of the CBD and includes parts of Karori, Northland, Wilton, Crofton Downs, Wadestown, Ngaio and Khandallah. The stream catchment covers an area of 16.7 km^2 and is bounded to the east and south by the ridgeline extending from Te Ahumairangi Hill (Tinakori Hill) and around the Zelandia Wildlife Sanctuary, to the west by Karori, Johnsons Hill and to the north by Mt Kaukau and a low ridge through Khandallah (Table 4-13). The stream receives multiple stormwater discharges throughout its length.

Table 4-13: Kaiwharawhara stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchment:	Kaiwharawhara
Stream catchment area	16.7 km^2
Stormwater catchment area	9.3 km2 (56% of stream catchment)
Number of outfalls to CMA	One stream outlet
Impervious surface area	2.96 km^2 (18% of stream catchment)
Total public stormwater length	86 km
Age of stormwater system	Circa 1880s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions. Less than 20% of the current network was constructed prior to the 1940's. Around 50% was constructed during major housing development in Wilton and Ngaio between 1950 and 1970, and the remaining 30% was constructed from the 1980s onwards.
Constructed wastewater overflows	One
Pump station overflows	One (PS46)
System type	100% separate
Open water courses	Kaiwharawhara Stream, Korimako Stream, Te Mahanga Stream, Silverstream and numerous unnamed headwater streams.
Open channel stream length	58 km
Landfills	Historic landfills are located at Ian Galloway Park (1946 – 1973), Appleton Park (filled in the 1930s), Creswick Terrace play area, Otari Native Pant Museum (former clean-fill, completed around 1980), Calcutta / Bengal St.
Contamination sources	Catchment-wide sources include roofs and other building materials found in older largely residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a significant generic source.
Contamination hot spots	Historic landfill (above)
Contaminant loads	Stormwater loads of Zn, Cu, Pb and PAH from the catchment are predicted to be moderate (Table 2-3). The catchment area is about 19% of Wellington City and loads are about 10% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of the mixed open space and high density urban areas in this catchment.
Wastewater contamination	One wastewater pump station and one wastewater network overflow located within the catchment have the potential to overflow into the stormwater system (see Table 4-14).

Table 4-14: Kaiwharawhara constructed wastewater overflows and PS overflows (from Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
WW27900	34 Clutha Ave	Network overflow to stormwater pipe at SW00939	20	220
WW08234	Hutt Road	PS46 overflow to stream	TBC	TBC

4.1.9 North Harbour (Onslow/Ngauranga/Horokiwi)

The north coast of Wellington Harbour stretches from Aotea Quay to the western end of Petone Beach. This straight coast is rock and exposed and has limited access due to the proximity of SH1, SH6 and the main trunk railway. It receives stormwater from Onslow, Ngauranga and Horokiwi (Table 4-15).

Onslow is a small coastal catchment that lies between the Kaiwharawhara and Ngauranga stream mouths. The Ngauranga stormwater catchment includes parts of Khandallah, Johnsonville and Newlands. Horokiwi/Belleview lies to the west of Petone and is mostly rural and conservation land.

Table 4-15: Wellington Harbour North stormwater catchment characteristics (from Capacity, 2013)

Catchment characteristic	Description
Sub-catchments:	Onslow, Ngauranga and Horokiwi/Belleview
Stream catchment area	15.8
Stormwater catchment area	10.65 (67% of total catchment)
Number of outfalls to CMA (>600mm dia)	10 piped outfalls and stream outlets at Ngauranga and Horokiwi
Impervious surface area	3.78 (24% of total catchment)
Total public stormwater length	104 km
Age of stormwater system	Circa 1926 onwards. The stormwater network in the Ngauranga catchment developed gradually over time. Less than 5% was constructed prior to the 1940s, about 30% was constructed between 1940 and 1960, and 65% was constructed from the 1960 onwards.
Constructed wastewater overflows	Two
Pump station overflows	Two (PS45 and 49)
System type	100% separate
Open water courses	Ngauranga Stream (Waitohu Stream), Tyers Stream, Horokiwi Stream and numerous minor watercourses.
Open channel stream length	32 km
Landfills	Homebush Park, Coastal filling, Raroa Park, Cashmere Avenue (completed in 1930s), Former Ramsbottom's Yard.
Contamination sources	Catchment-wide sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tires, brake linings, oil leakage, exhaust) are probably the major generic source; from motorways, SH1, major city streets, and parking lots.
Contamination hot spots	Potential hotspots include the Wellington to Hutt and Porirua motorways. State Highway 1 has an average daily traffic count in excess of 50,000 vehicles. One large landfill operated in Ngauranga catchment from 1961 to 1971. The Kiwi Point Quarry and Taylor Preston Abattoir are currently located in this area.
Contaminant loads	Stormwater loads of Zn, Cu, Pb and PAH from these catchments are predicted to be moderate because the combined catchment area is about 21% of Wellington City. Loads are about 18% of the total stormwater load from Wellington (Capacity 2014). The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of higher loads for Ngauranga and low loads from large areas of Open Space.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. In these catchments, sewer rehabilitation works have been undertaken since 1993, including checking and repairing cross connections studies and fixing known sewer faults. Four constructed wastewater overflows are located in the catchment (see Table 4-16 for details)

Table 4-16: Wellington Harbour north coast constructed wastewater overflows and PS overflows (Capacity, 2013)

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
Not assigned	Onslow Road	PS45 overflow to stormwater pipe at SWP030618	TBC	TBC
WW19810	17A Delhi Crescent	Network overflow to Tyers Stream at WW39528	12	1028
WW20987	Centennial Highway	Network overflow to NZTA stormwater culvert at WW39513	4	13
WW31754	Centennial Highway	PS49 overflow	TBC	TBC

4.1.10 Karori

The Karori Stream catchment lies to the west of Wellington City centre, extending from Messines Road in north-eastern Karori to the stream mouth between Karori Rock and Sinclair Head on Wellington's south coast (Table 4-17). The principal headwater tributary of Karori Stream arises within urban Karori and is fed by run-off from a residential catchment. A second major headwater tributary (Silver Stream) drains "Long Gully" which is in pasture and scrub and is relatively unaffected by urban development.

Table 4-17: Karori stormwater catchment characteristics (from Capacity, 2013)

Catchment characteristic	Description
Sub-catchments:	Karori
Stream catchment area	30.9 km^2
Stormwater catchment area	4.29 km^2 (14% of stream catchment)
Impervious surface area	1.70 km^2 (6% of stream catchment)
Number of outfalls to CMA (>600mm dia)	One: Karori Stream outlet
Total public stormwater length	62 km
Age of stormwater system	Circa 1860s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions. Less than 20% of the current network was constructed prior to the 1940's. Around 50% was constructed during major housing development in Karori between 1950 and 1970, and the remaining 30% was constructed from the 1980s onwards.
Constructed wastewater overflows	8
Pump station overflows	0
System type	100% separate
Open water courses	Karori Stream
Open channel stream length	33 km
Landfills	Ben Burn Park, Fortuna
Contaminant sources	Catchment-wide sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from major city streets and parking lots.
Contamination hot spots	Historic landfills (above)
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. In these catchments, sewer rehabilitation works have been undertaken since 1993, including checking and repairing cross connections studies and fixing known sewer faults. Eight constructed wastewater overflows are located in the catchment (see Table 4-18 for details)

Table 4-18: Karori constructed wastewater overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
Available in GIS but not yet been extracted.	Shown in the map series attached as Appendix N.	Available in GIS but not yet been extracted.	No information	No information

4.2 Hutt City

4.2.1 Overview

Hutt City is serviced by a reticulated stormwater system comprising approximately 546km of stormwater pipes, 11,600 manholes, 5 retention dams and 14 pump stations and 27km of channels and canals that convey stormwater to receiving watercourses (Hutt City Council, 2015). The stormwater pipelines in the Hutt City system range in size from 100mm to 1800mm in diameter with 65% of the pipes being between 225mm and 450mm in diameter. The components include:

- Pipe system: Approximately 8,600 sumps and 2,247 other inlet/outlets direct stormwater from streets and gullies into the stormwater system comprising 548 kilometres of pipelines and culverts and 11,824 access chambers. Flap gates are fitted to stormwater pipelines where there is a significant risk of high water levels in receiving watercourses leading to backflows up the stormwater drains.
- Open drains: There are 27 kilometres of open drains. The major watercourses are the Wainuiomata River, Waiwhetu Stream, Opahu Stream, Black Creek, Awamutu Stream and the Waddington Canal. Other watercourses through private property are the responsibility of the property owner.
- Pumping stations: Fourteen pumping stations supplement gravity drainage in low-lying areas, and one pumping station (William Street) provides the only means of stormwater discharge from an area of Petone. There is also a pumping station which pumps groundwater into Opahu Stream to overcome odour and insect problems in dry periods.
- Retention dams: Five earth retention dams are designed to slow the stormwater entering the drainage system during heavy rainfall, reducing the peak loading on the system.

The primary stormwater management system collects and discharges stormwater from moderate rainfall into streams, rivers or directly into the sea. Most of the stormwater pipelines in Hutt City were designed to accommodate rainfall with a 20% chance of occurring annually (a 5 year ARI). It is not practical to provide stormwater drains that can accommodate all foreseeable rainfall and the risk of blockages in stormwater systems cannot be eliminated.

Stormwater systems in new green field developments are now required to comprise both a primary system consisting of pipes and open channels intended to cater for more frequent rainfall events, and a secondary system to cater for higher intensity rainfall events. The secondary system consists of overland flow paths that convey floodwaters safely when the primary system is unable to cope. New stormwater pipelines are now designed to accommodate rainfall with an average return period between 10 years (10% chance of occurring annually) and 50 years (2% chance of occurring annually) depending on the risk in specific situations.

4.2.2 Korokoro

The Korokoro Stream drains a moderately small catchment that is mostly in regenerating and mature indigenous forest and scrub. It is situated within Belmont Regional Park on the western hills of the Hutt Valley (Table 4-19).

Table 4-19: Korokoro stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchments:	Korokoro Stream
Stream catchment area	15.7 km^2
Stormwater catchment area	0.41 km^2 (3% of total catchment)
Impervious surface area	0.41 km^2 (3% of total catchment)

Number of outfalls to CMA (>600mm dia)	1 Stream outlet
Total public stormwater length	4.9 km
Age of stormwater system	Circa 1950s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions. Less than 20% of the current network was constructed prior to the 1960's.
Constructed wastewater overflows	0
Pump stations	2
System type	100% separate
Open water courses	Most of Korokoro Stream
REC stream length	23.2
Landfills	None identified; 0.1 km^2 of contaminated land in Cornish St
Contamination sources	Catchment-wide sources are dominated by runoff from regenerating forest and scrub. In the Cornish Street commercial/light industrial area at the bottom of the catchment, sources includes roofs and other building materials found in urban areas, road surfaces, other permeable pavements and vehicles (tyres, brake linings, oil leakage, exhaust).
Contamination hot spots	Cornish Street commercial area
Contaminant loads	Contaminant load predictions are not available
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Two constructed wastewater overflows are located in the catchment (see Table 4-20 for details)

Table 4-20: Korokoro constructed wastewater overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
--	Maungaraki Road Lwwps	Purpose built emergency OV at PS	<1	Not known
--	Titiro Moana Lwwps	Purpose built emergency OV at PS	<1	Not known

4.2.3 Hutt River

The Hutt River is the largest watercourse in the Wellington and Porirua harbour catchments. It is a steep gravel-bearing river which originates in the indigenous forest covered slopes of the southern Tararua Ranges and flows some 50 km to Wellington Harbour at Seaview. It has a catchment area of 655 km^2 of which 77 km^2 is serviced by a stormwater network and an estimated 37 km^2 is impervious surfaces. The total stream channel length is estimated at 1006 km. The Hutt River at Birchville has a median flow of approximately 12.6 m^3/s. The main tributaries of the Hutt River are the Pakuratahi, Mangaroa, Akatarawa and Whakatiki Rivers. The stormwater catchment characteristics are described here in 9 sub-catchments, these being Hutt mainstem (Table 4-21), Speedy's, Waiwhetu, Stokes Valley, Hulls, Whakatikei, Akatarawa, Mangaroa and Pakuratahi.

Table 4-21: Hutt River mainstem catchment characteristics

Catchment characteristic	Description
Sub-catchments:	Hutt River mainstem
River catchment area (km^2)	199
Stormwater catchment area (km^2)	51 (26% of total catchment)
Impervious surface area (km^2)	21 (11% of total catchment)
Outfalls to CMA (>600mm dia)	One river outlet to Wellington Harbour
Total public stormwater length	362 km
Age of stormwater system	Circa 1950s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions. Less than 20% of the current network was constructed prior to the 1960's.
Constructed wastewater overflows	2
Pump station overflows	28
System type	100% separate

Open water courses	100% of mainstem
REC stream length	317
Landfills/contaminated sites	Large operating landfill at Silverstream.
Contamination sources	Catchment-wide sources are dominated by runoff from regenerating forest and scrub. Within the residential, commercial and light industrial areas of the Hutt Valley, sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from major city streets and parking lots and Hutt motorways (SH2).
Contamination hot spots	Silverstream landfill, Hutt motorway, main trunk railway, and the industrial area of Gracefield.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Ten constructed wastewater overflows are located in the Hutt mainstem catchment. These include consented discharges from the Silverstream storm tank and the Seaview Waste Water treatment Plant storm tank (see Table 4-22 for details).

Table 4-22: Hutt mainstem catchment constructed wastewater overflows and PS overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
--	Jackson St Lwwps	Purpose built emergency OV at PS	<1	tbc
--	St Albans Grv Lwwps	Purpose built emergency OV at PS	<1	tbc
--	Percy Cameron Lwwps	Purpose built emergency OV at PS	<1	tbc
--	Te Toru Lwwps	Purpose built emergency OV at PS	<1	tbc
--	Kelso Grv Lwwps	Purpose built emergency OV at PS	<1	tbc
--	George Gee Drive	No purpose built OV at PS	tbc	tbc
--	Victoria St	No purpose built OV at PS	tbc	tbc
--	Massey Ave	No purpose built OV at PS	tbc	tbc
--	Silverstream	Consented overflow from storm tank	4	tbc
--	Barber Grv DBO wwps	Consented overflow at PS	1	tbc
--	Mary Huse DBO wwps	Consented overflow at PS	<1	tbc
--	Welcon scour DBO	Non consented overflow	<1	tbc
--	Te Marua wwps	Purpose built emergency OV at PS	7	tbc
--	Esplanade Central	Purpose built OV at PS (Petone)	<1	tbc
--	Esplanade East	Purpose built OV at PS (Petone)	<1	tbc
--	Esplanade West	Purpose built OV at PS (Petone)	<1	tbc
--	Marine Parade	Purpose built OV at PS (Petone)	<1	tbc
--	Regent St	Purpose built OV at PS (Petone)	<1	tbc
--	Black Beech	Purpose built OV at PS	tbc	tbc
--	65 Bridge Rd	Purpose built OV at PS	tbc	tbc
--	Tennyson St	Purpose built OV at PS	tbc	tbc
--	49 Bridge Rd	Purpose built OV at PS	tbc	tbc
--	Akatarawa Bridge	Purpose built OV at PS	tbc	tbc
--	245 Plateau Rd	Purpose built OV at PS	tbc	tbc
--	191 Plateau Rd	Purpose built OV at PS	tbc	tbc
--	63 Plateau Rd	Purpose built OV at PS	tbc	tbc
--	621 Main Rd	Purpose built OV at PS	tbc	tbc
--	20 Maymorn Rd	Purpose built OV at PS	tbc	tbc
--	1176 Maymorn Rd	Purpose built OV at PS	tbc	tbc
--	Riverstone Drive	Purpose built OV at PS	tbc	tbc

4.2.4 Hutt – Speedy's

Speedy's Stream drains a small steep forested catchment on the western side of the Hutt River valley adjacent to the suburb of Kelson, and joins the Hutt River on its true right bank immediately downstream of the Kennedy Good Bridge (Table 4-23). The watercourse is well entrenched into the greywacke base rock, and confined at the bottom of steep sided valleys.

Table 4-23: Speedy's stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchments:	Speedy's Stream
Stream catchment area	11.61 km^2
Stormwater catchment area	1.41 km^2 (12% of total catchment)
Impervious surface area	0.92 (8% of total catchment)
Number of outfalls to CMA (>600mm dia)	1 stream outlet
Total public stormwater length	7.5 km
Age of stormwater system	Circa 1950s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions. Less than 20% of the current network was constructed prior to the 1960's.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Speedys Stream is mostly open channel
REC stream length	19.35
Landfills or other contaminated sites	No landfills; Belmont magazines historically use for ordnance production and storage (1.13 km^2)
Contamination sources	Catchment-wide sources are dominated by runoff from regenerating forest and scrub. Within the small residential urban area at the bottom of the catchment, sources includes roofs and other building materials found in urban areas, road surfaces, other permeable pavements and vehicles (tyres, brake linings, oil leakage, exhaust).
Contamination hot spots	Significant sources of contamination are not anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

4.2.5 Hutt - Waiwhetu

The Waiwhetu Stream is a small low elevation watercourse which flows into the Hutt River estuary (Table 4-24).

Table 4-24: Waiwhetu stormwater catchment characteristics

Catchment characteristic	Description
Sub-catchment names:	Waiwhetu & Gracefield
Stream catchment area:	18.65 km^2
Stormwater catchment area:	11.05 km^2 (59% of the stream catchment)
Impervious surface area:	10.17 km^2 (55% of the stream catchment)
Number of outfalls to CMA:	One stream outlet
Total public stormwater length:	120 km
Age of stormwater system:	Circa 1940s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions.
Constructed sewer overflows:	1 (at Seaview WWTP)
Pump station overflows:	9
System type	100% separate
Open water courses:	Much of the main stem of Waiwhetu Stream flows in an open channel, as well as the upper reaches of some headwater tributaries. However the majority of the contributing tributaries are piped
REC stream length:	27 km
Landfills and other contaminated sites	No landfills; Most of the Gracefield industrial area is identified on SLUR as a contaminated site (1.38 km^2)
Contamination sources	Catchment-wide sources includes roofs and other building materials found in urban areas, road surfaces and other permeable

	pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from major city streets and parking lots.
Contamination hot spots	Gracefield industrial area, including vehicle dismantling & metal recycling (Macaulay Metals, The Heavy Metal Company), metal galvanising (Perry Metals), spray painting and panel beating, truck transport yards, bulk fuel oil storage, and extensive areas of Zn roofing.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Thirteen constructed wastewater overflows are located in the Waiwhetu catchment (see Table 4-25 for details)

Table 4-25: Waiwhetu catchment constructed wastewater overflows and PS overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
--	Seaview WWTP	Consented overflow of treated ww	4	tbc
--	Malone Rd wwps	Consented PS overflow	<1	tbc
--	White Line East wwps	Consented PS overflow	1	tbc
--	Rossiter Av	Purpose built emergency OV at PS	18	tbc
--	Hutt Park Lwwps	emergency OV at PS	tbc	tbc
--	Laura Freg. Grv Lwwps	emergency OV at PS	tbc	tbc
--	Massey Ave Lwwps	emergency OV at PS	tbc	tbc
--	Randwick Rd Lwwps	emergency OV at PS	tbc	tbc
--	Totara Cres Lwwps	emergency OV at PS	tbc	tbc
--	Kereru Lwwps	Emergency OV at PS	tbc	tbc

4.2.6 Eastbourne

The Eastbourne 'catchment' extends from Point Howard to beyond Burdens Gate. It includes Sorrento Bay, Lowry, York, Mahina, Sunshine, Days, Rona and Robinsons bays (Table 4-26).

Table 4-26: Pakuratahi stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Sorento, Lowry, York, Mahina, Sunshine, Days, Eastbourne
Stream catchment area (km^2)	15
Stormwater catchment area (km^2)	3.4 (23% of total catchment)
Impervious surface area (km^2)	3.1 (20% of total catchment)
Number of outfalls to CMA (>600mm dia)	Numerous minor stormwater outlets
Total public stormwater length (km)	20
Age of stormwater system	Circa 1920's onwards.
Constructed wastewater overflows	0
Pump station overflows	12
System type	100% separate
Open water courses	Days Bay Stream and numerous stream fragments
REC stream length (km)	12.5
Landfills	No landfills or other contaminated sites
Contamination sources	Catchment-wide sources are minor and include roofs and other building materials found in residential land, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a significant generic source, but traffic volumes are relatively low.
Contamination hot spots	Significant contamination is not anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage

	system become overloaded or fails. There are 10 constructed wastewater overflows are located in the catchment. In addition the main outfall pipeline from the Seaview Wastewater Treatment Plant that runs along the eastern bays is fitted with scour valves at low points along the route so that the pipeline can be emptied, if required, for maintenance works. None of the scours valves discharge into the stormwater network, instead most discharge directly onto the shoreline.

Table 4-27: Eastern bays constructed overflows and PS overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
--	Howard Rd	Purpose built emergency OV at PS	<1	tbc
--	Sorrento Bay	Purpose built emergency OV at PS	<1	tbc
--	Williams Park	Purpose built emergency OV at PS	<1	tbc
--	Puketea St	Purpose built emergency OV at PS	<1	tbc
--	Rona Bay	Purpose built emergency OV at PS	<1	tbc
--	Port Road wwps	Purpose built emergency OV at PS	<1	tbc
--	Days Bay	Purpose built emergency OV at PS	<1	tbc
--	Point Arthur	Purpose built emergency OV at PS	2	tbc
--	York Bay	Purpose built emergency OV at PS	<1	tbc
--	Lowry Bay	No purpose built OV at PS	tbc	tbc
--	Mahina Bay	No purpose built OV at PS	tbc	tbc
--	Kereru	No purpose built OV at PS	tbc	tbc

4.2.7 Wainuiomata

The Wainuiomata River originates in a native forest catchment of the south western Rimutaka Ranges, and flows southwest for a distance of approximately 35km, eventually discharging into Cook Strait east of Bearing Head (Table 4-28).

Table 4-28: Wainuiomata stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Wainuiomata mainstem (excluding headwater catchments)
Stream catchment area (km^2)	58
Stormwater catchment area (km^2)	1.84 (3.2% of total catchment)
Impervious surface area (km^2)	1.28 (2.2% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	12.4
Age of stormwater system	Circa 1950s onwards.
Constructed wastewater overflows	1
Pump station overflows	0
System type	100% separate
Open water courses	Wainuiomata River, modified
REC stream length (km)	91
Landfills	Wainuiomata Landfill, currently operating.
Contamination sources	Catchment-wide sources are dominated by runoff from indigenous forest, scrub and low production pasture. These include soil disturbance by erosion during flood events, and wild animals.
Contamination hot spots	Wainuiomata Landfill
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and, leaking sewerage pipes and overflows. Two constructed wastewater overflows are located in the catchment (refer to Table 4-28 for details)

Table 4-29: Wainuiomata mainstem catchment constructed wastewater overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
--	Wainuiomata Storm tank	Consented overflow to Wainuiomata River	3	tbc

4.2.8 Black Creek

A minor tributary of the Wainuiomata, the Black Creek catchment contains the most of the suburban area of Wainuiomata (4-30).

Table 4-30: Black Creek stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Black Creek
Stream catchment area (km^2)	18.4
Stormwater catchment area (km^2)	8.1 (44% of total catchment)
Impervious surface area (km^2)	6.1 (33% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	78
Age of stormwater system	Circa 1950s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions.
Constructed wastewater overflows	8
Pump station overflows	5
System type	100% separate
Open water courses	Black Creek and fragments or minor tributaries
REC stream length (km)	26
Landfills	The Wainuiomata Landfill is outside (downstream) of the urban area.
Contamination sources	Catchment-wide sources are minor and include roofs and other building materials found in residential land, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source.
Contamination hot spots	Significant contamination is not anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment however nine (refer to Table 4-30 for details)

Table 4-31: Wainuiomata catchment constructed wastewater overflows and PS overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
--	Wellington Rd	Consented PS overflow to Black Creek	6	tbc
--	Dunn St	Overflow to SW and Black Creek	tbc	tbc
	Heath St	Overflow to SW and Black Creek	4	tbc
	Fitzhebert Rd	Overflow to SW and Black Creek	tbc	tbc
	Best St	Overflow to SW and Black Creek	tbc	tbc
	Hyde St	Overflow to SW and Black Creek	tbc	tbc
	Fraser St	Overflow to SW and Black Creek	5	tbc
	Row Parade	Overflow to SW and Black Creek	11	tbc
	Main Rd	Overflow to SW and Black Creek	10	tbc
	Wise Park	Purpose built emergency OV at PS	<1	tbc
	Wood St	Purpose built emergency OV at PS	<1	tbc
--	Ngaturi Grv	Purpose built emergency OV at PS	<1	tbc

4.2.9 Wainuiomata-iti

A minor tributary of the Wainuiomata, the Wainuiomata catchment is predominantly in production pasture and low density residential land use (Table 4-32).

Table 4-32: Wainuiomata-iti stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Wainuiomata-iti
Stream catchment area (km^2)	17.4
Stormwater catchment area (km^2)	0.0 (0.0% of total catchment)
Impervious surface area (km^2)	0.29 (1.64% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	0.453
Age of stormwater system	No significant stormwater network
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Wainuiomata-iti Stream 100% open channel
REC stream length (km)	24.6
Landfills	No landfills or other contaminated sites
Contamination sources	Catchment-wide sources are dominated by runoff from low production pasture. These include soil disturbance, and domestic and wild animals.
Contamination hot spots	Significant contamination is not anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

4.2.10 Morton

Morton is the Wainuiomata River native forest headwater catchment which is reserved for water supply purposes (Table 4-33).

Table 4-33: Morton stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Morton
Stream catchment area (km^2)	40
Stormwater catchment area (km^2)	0.21 (0.52% of total catchment)
Impervious surface area (km^2)	0.18 (0.45% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	0.726
Age of stormwater system	Circa 1940s onwards.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Nearly 100% pristine watercourses
REC stream length (km)	58
Landfills	None
Contamination sources	Catchment-wide sources are dominated by runoff from mature indigenous forest. These include soil disturbance by erosion during flood events, and wild animals.
Contamination hot spots	Significant contamination is not anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

4.3 Upper Hutt City

4.3.1 Overview

Upper Hutt City's stormwater network is spread across 21 identifiable catchment areas each with their own discharge points to Hutt River. To drain these catchments there are approximately 150.6km of mains with diameters ranging from 100mm to 2.1m consisting mainly of concrete pipes; 3284 manholes; 6 pump stations; 11.4 kilometres of open drains and two detention dams (Upper Hutt City Council, 2016). The GWRC maintains a number of open drains under the Water Courses Agreement, with the remainder being maintained by the Upper Hutt City Council. The following open drains are included in the watercourses agreement:

- Pinehaven Stream downstream of the Pinehaven Reserve
- Hulls Creek
- Collins Stream
- the urban section of the Mangaroa River
- the urban section of the Akatarawa River

The remainder of the open drains in the urban area are only part of Council's stormwater assets if they have been accepted by the Council as public drains. Otherwise they are private drains. The two detention dams, at Heretaunga and Emerald Hill, have been designed and built to reduce the frequency and severity of the flooding.

The age profile of the stormwater assets indicates that reticulation construction began in the late 1950s, significant pipe laying took place during the 1960s at Totara Park and the 1970s at Birchville, and relatively little activity in the 1980s and early 1990s.

4.3.1 Hutt – Stokes Valley

Stokes Valley Stream is a minor tributary of the Hutt River. It begins as a relatively natural watercourse in regenerating bush in the upper valley but once it enters the urbanised valley floor it becomes channelised, straightened and is enclosed by culverts at a number of locations (Table 4-34).

Table 4-34: Stokes Valley stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Stokes Valley
Stream catchment area (km^2)	11.96
Stormwater catchment area (km^2)	4.71 (39% of total catchment)
Impervious surface area (km^2)	4.47 (37% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	52
Age of stormwater system	Circa 1950s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Heavily modified, partly open channel
REC stream length	16.7
Landfills	No landfills or known contaminated sites
Contamination sources	Catchment-wide sources are minor and include roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from suburban streets and parking lots.
Contamination hot spots	Significant sources of contamination are not anticipated.
Contaminant loads	Contaminant load predictions are not available.

Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment.

4.3.2 Hutt – Hulls

The Hulls Creek catchment is made up of low lying hills in the Blue Mountains, Pinehaven, and Trentham/Wallaceville areas and low gradient areas around Heretaunga and Silverstream (Table 4-35).

Table 4-35: Hulls Creek stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Pinehaven, Blue Mountains, Silverstream, Trentham, Wallaceville
Stream catchment area (km^2)	16.58
Stormwater catchment area (km^2)	7.18 (43% of total catchment)
Impervious surface area (km^2)	0.04 (0.2% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length	30
Age of stormwater system	Circa 1950s onwards. The stormwater network has been developed gradually over time and generally reflects the age of the main housing subdivisions.
Constructed wastewater overflows	0
Pump station overflows	1
System type	100% separate
Open water courses	Heavily modified, partly open channel
REC stream length	24.8
Landfills	Silverstream landfill is currently in operation
Contamination sources	Catchment-wide sources include roofs and other building materials found in older largely residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a significant generic source.
Contamination hot spots	Silverstream Landfill, Trentham Racecourse, Trentham Riffle Range
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment (refer to Table 4-35 for details)

Table 4-36: Hulls Creek catchment constructed wastewater overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
--	Heretaunga	Purpose built emergency OV at PS	<1	tbc

4.3.3 Hutt – Whakatikei

The Whakatikei River flows into the Hutt River near Riverstone at Upper Hutt. It is situated on the north-western part of the Hutt Catchment between the Akatarawa and Horokiri rivers (Table 4-37).

Table 4-37: Whakatikei stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Whakatikei, Riverstone
Stream catchment area (km^2)	81.8
Stormwater catchment area (km^2)	0.39 (0.47% of total catchment)
Impervious surface area (km^2)	0.04 (0.00% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil

Total public stormwater length (km)	1.89
Age of stormwater system	Circa 1990s onwards. The stormwater network has been developed gradually over the last 25 year.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Slightly modified open river
REC stream length	128
Landfills	Nil
Contamination sources	Catchment-wide sources are dominated by runoff from regenerating forest, plantation forest and scrub. Within the very small residential urban area at the bottom of the catchment, sources includes roofs and other building materials found in urban areas, road surfaces, other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals.
Contamination hot spots	Significant contamination is not anticipated
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

4.3.4 Hutt - Akatarawa

The Akatarawa River flows into the Hutt River at Birchville near Upper Hutt. It is situated on the northern part of the Hutt Catchment, between the Whakatikei and Waikanae catchments (Table 4-38).

Table 4-38: Akatarawa stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Akatarawa
Stream catchment area (km^2)	116
Stormwater catchment area (km^2)	0.07 (0.06% of total catchment)
Impervious surface area (km^2)	0.00 (0.00% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	0.766
Age of stormwater system	Circa 1960's.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Slightly modified open river
REC stream length	181
Landfills	Nil
Contamination sources	Catchment-wide sources are dominated by runoff from regenerating forest, plantation forest, pasture and scrub. They include soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals.
Contamination hot spots	Significant contamination is not anticipated
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

4.3.5 Hutt – Mangaroa

The Mangaroa River flows into the Hutt River at Te Marua north of Upper Hutt. It is situated on the western side of the Rimutaka Range, adjacent to the Pakuratahi River (Table 4-39).

Table 4-39: Mangaroa stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Mangaroa
Stream catchment area (km^2)	104
Stormwater catchment area (km^2)	0.93 (0.89% of total catchment)
Impervious surface area (km^2)	0.00 (0.00% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	3.88
Age of stormwater system	Circa 1960's.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Slightly modified open river
REC stream length	167
Landfills	Nil
Contamination sources	Catchment-wide sources are dominated by runoff from regenerating forest, plantation forest, pasture and scrub. They include soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals.
Contamination hot spots	Significant contamination is not anticipated
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

4.3.6 Hutt – Pakuratahi

The Pakuratahi River flows into the Hutt River at Kaitoke north of Upper Hutt. It is situated on the northern part of the Rimutaka Range adjacent to the Mangaroa catchment (Table 4-40).

Table 4-40: Pakuratahi stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Pakuratahi
Stream catchment area (km^2)	81.4
Stormwater catchment area (km^2)	0.00 (0.00% of total catchment)
Impervious surface area (km^2)	0.00 (0.00% of total catchment)
Number of outfalls to CMA (>600mm dia)	Nil
Total public stormwater length (km)	0
Age of stormwater system	N.A/
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Slightly modified open river
REC stream length	167
Landfills	Nil
Contamination sources	Catchment-wide sources are overwhelmingly dominated by runoff from regenerating forest, plantation forest, pasture and scrub. They include soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals.
Contamination hot spots	Significant contamination is not anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

5 Current state of receiving environments in Porirua

5.1 Catchment overview

Porirua City's stormwater network now extends from Pukerua Bay at the northern end of the city to the boundary with Tawa at the southern end. To the east, the system serves all residential areas of Whitby. Because the topography of Porirua contains numerous sharply defined watersheds, individual stormwater catchments are generally fragmented in nature and thus easily identified and defined. The proximity of two harbours and numerous streams and their tributaries results in a system of localised networks. There are many rural catchments made up of open streams and watercourses, but in the majority of built-up areas these streams have been enclosed in piped systems. Run-off from residential properties and streets is directed into reticulation wherever possible, with all new developments required to provide for stormwater disposal as a condition for consent.

Catchment characteristics including total area, area of stormwater catchment area, area of impervious surface, area of contaminated land and predicted stormwater peak flow for defined rainfall events area summarised in Table 1-2. Overview maps of Porirua Harbour catchment areas, boundaries, impervious surfaces and contaminated land are shown in Figures 5-2 to Figure 5-5. Detailed maps showing the location of stormwater infrastructure, RSoE monitoring locations, sewer mains, constructed sewer overflows and pump station overflows are included in Appendix O.

The Horokiri and Pauatahanui sub-catchments have the largest total area, but neither have a significant stormwater network or area of impervious surface. By contrast the Porirua Stream catchment (Porirua + Paparangi + Churton) has extensive stormwater networks and relatively large areas of impervious surface and contaminated land.

5.2 Freshwater habitats

5.2.1 Taupo Stream

Catchment characteristics

The Taupo Stream catchment contains parts of Plimmerton and State High 1 to the north of Porirua City centre. The drainage area extends from near Pukerua Bay to Plimmerton Beach. It covers an area of 10.6 km^2, of which an estimated 12% is impervious. The catchment contains Taupo Swamp which is a nationally significant flax wetland and one of the most import flax swamps in the Wellington region.

Water quality

Regular monthly monitoring of *E. coli.* bacteria conducted by PCC from January 2015 to August 2016 gave a median value of 350 cfu/100 ml and a maximum of 23,000 cfu/100 ml. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100 ml). Nevertheless, occasional elevated counts indicate intermittent faecal contamination of this watercourse (Appendix D).

PCC monthly monitoring for a wider suite of parameters between November 2011 and June 2014 indicated elevated levels of dissolved reactive phosphorus in Taupo Stream, while metal concentrations with consistently low with no exceedence 95% protection trigger values (Milne & Morar, 2017).

Aquatic ecology

Schedule F1 of the PNRP identifies the Taupo Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, habitat for more than six species of indigenous fish and inanga spawning habitat. The fish species include banded kokopu, giant kokopu, inanga, longfin eel, redfin bully and shortfin eel.

5.2.2 Kakaho Stream

Catchment characteristics

The Kakaho Stream catchment lies to the northwest of Porirua City. The drainage area extends from the western side of the Paekakariki Hill to the Pauatahanui Inlet. It covers an area of 17.8 km^2, of which an estimated 8% is impervious. The catchment is predominantly in production pasture but contains areas of regenerating indigenous vegetation and pine production forestry, as well as most of urban Camborne.

Water Quality

No routine water quality information is available for this watercourse.

Aquatic ecology

Schedule F1 of the PNRP identifies Kakaho Stream as a watercourse with significant indigenous values including habitat for more than six species of indigenous fish. The tidal reach is known to provide inanga spawning habitat (Taylor & Marshall, 2016). The fish species recorded include banded kokopu, common bully, common smelt, giant bully, grey mullet, inanga, longfin eel, redfin bully and shortfin eel.

5.2.3 Horokiri Stream

Catchment characteristics

The Horokiri Stream catchment lies to the northwest of Porirua City. The drainage area extends from the Wainui saddle (at around 500m a.s.l) to the Pauatahanui Inlet, draining from north to south into the Inlet. It covers an area of 41 km^2, of which less than 1% is impervious, and with no significant stormwater network (Table 5-1). The upper headwaters of the Horokiri east branch are largely in rough pasture with the larger tributaries coming from the east in native regenerating shrub lands.

Table 5-1: GWRC RSoE %Land-cover types in contributing catchment - Horokiri

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS13	Horokiri at Snodgrass	Impact	fair	15.1	25.9	4.1	54.7	0.0	0.0

Water quality

The GWRC RSoE site located on the Horokiri Stream had a 'fair' WQI grade for the 2015/16 year and was ranked 34th out of 53 sites in the Wellington Region. Water quality did not met GWRC guideline criteria for *E. coli.* or nitrate/nitrite nitrogen, but did achieve guidelines for dissolved oxygen, visual clarity, ammoniacal nitrogen and dissolved reactive phosphorus. Summary statistics included in Appendix D show the median and maximum *E. coli.* values for the 2015/16 monitoring year were 300 and 1,100 cfu/100 ml, respectively. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100 ml).

Streambed sediments sampled at Horokiri Stream in 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Total DDT (Milne & Watts, 2008). No other trigger values were exceeded at this site.

Aquatic ecology

RSoE invertebrate survey results (Appendix E) indicate "good" quality invertebrate community in the Horokiri Stream (QMCI = 5.98, %EPT taxa = 52, Taxa richness = 23) which has been slightly affected by agricultural development in the catchment. Boffa Miskell (2011) found that the aquatic ecology values of the Horokiri Stream were regionally significant, being high in terms of invertebrates and fish and moderate in term of habitat quality.

KMA (2005) reported "fair" invertebrate community quality in the lower reaches of the stream (MCI = 87, QMCI = 4.2, %EPT taxa = 31.7, Taxa richness = 20).

Schedule F1 of the PNRP identifies Horokiri Stream as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reach is known to provide inanga spawning habitat (i.e., Taylor & Marshall, 2016). Fish species recorded include banded kokopu, black flounder, common bully, common smelt, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully, shortfin eel, shortjaw kokopu and torrentfish.

5.2.4 Pauatahanui Stream

Catchment characteristics

The Pauatahanui Stream catchment lies to the east of Cannons Creek and Whitby. The drainage area extends from the western face of Haywards Hill to the eastern end of the Pauatahanui Inlet. It covers an area of 42 km², of which approximately 4% is impervious. The catchment is predominantly in production pasture but contains areas of regenerating indigenous vegetation and pine production forestry, as well as small settlements at Pauatahanui and Judgeford and much of State Highway 58 (Table 5-2).

Table 5-2: GWRC RSoE %Land-cover types in contributing catchment - Pauatahanui

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS14	Pauatahanui S. at Elmwood	Impact	fair	17.1	12.9	31.4	37.3	1.3	0.0

Water Quality

The GWRC RSoE site located on the Pauatahanui Stream had a 'fair' WQI grade for the 2015/16 year and was ranked 36th out of 53 sites in the Wellington Region. Water quality did not met GWRC guideline criteria for *E. coli.* or dissolved reactive phosphorus, but did achieve guidelines for dissolved oxygen, visual clarity, ammoniacal nitrogen and nitrate/nitrite nitrogen. Summary statistics included in Appendix D show the median and maximum *E. coli.* values for the 2015/16 monitoring year were 205 and 430 cfu/100 ml, respectively, indicating a low level of faecal contamination. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100 ml).

Streambed sediments sampled at Pauatahanui Stream at SHW58 in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-High trigger value for Total DDT in 2005 and exceeded the ISQC-Low trigger value for Total DDT in 2006 (Milne & Watts, 2008). No other trigger values were exceeded at this site. The water quality and sediment results indicate that the stream environment at this location may be toxic to some of the more sensitive aquatic organisms.

Aquatic ecology

RSoE invertebrate survey results (Appendix E) indicate "fair" quality invertebrate community in the Pauatahanui Stream (QMCI = 4.04, %EPT taxa = 33, Taxa richness = 27) which has been significantly affected by agricultural development in the catchment. Boffa Miskell (2011) found that the aquatic ecology values of the lower Pauatahanui Stream were high for fish, moderate for aquatic invertebrates and low for habitat quality.

Schedule F1 of the PNRP identifies Pauatahanui Stream as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reach is known to provide inanga spawning habitat (i.e., Taylor & Marshall, 2016). Fish species recorded in the Pauatahanui Stream include banded kokopu, common bully, common smelt, giant kokopu, inanga, lamprey, longfin eel, redfin bully and shortfin eel.

5.2.5 Duck Creek/Browns Bay Creek

Catchment characteristics

The Duck Creek catchment lies to the south of the Pauatahanui Inlet. The drainage area extends from the northern face of Round Knob, through Whitby to the southern side of the Pauatahanui Inlet. For the purposes of this assessment it also includes the small catchment of Browns Creek and the peninsula between Browns Bay and Ivy Bay. It total it covers an area of 10 km², of which approximately 24% is impervious. The catchment is predominantly in pine plantation forestry, scrub and farmland but contains part of urban Whitby.

Water Quality

Regular monthly monitoring of *E. coli.* bacteria conducted by PCC from January 2015 to August 2016 in Duck Creek gave a median value of 240 cfu/100 ml and a maximum of 17,000 cfu/100 ml. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100 ml). The adjacent Browns Bay Creek had markedly poor water quality with an E. coli median value of 3,000 cfu/100 ml and a maximum of 31,000 cfu/100 ml. Browns Bay Creek appears to be significantly affected by wastewater pollution and did not meet the NPS-FM bottom line for secondary contact recreation (Appendix I).

Streambed sediments sampled at Duck Creek in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Total DDT (Milne & Watts, 2008). No other trigger values were exceeded at this site.

Results of PCC monthly monitoring between November 2011 and June 2014, reported by Milne and Morar (2017), show nutrient levels and turbidity consistently exceeded recommended guidelines Browns Bay Stream. Dissolved Cu and Zn exceeded 95% protection trigger values in Browns Bay Stream while Pb did not exceed the trigger value in any sample.

Aquatic Ecology

Boffa Miskell (2011) assessed the aquatic ecology values of the Duck Creek as being regionally significant, especially in the middle reaches where they were high for invertebrates and fish and moderate in terms of habitat quality.

KMA (2005) reported "good" invertebrate community quality in the lower reaches of Duck Creek (MCI = 110, QMCI = 5.0, %EPT taxa = 35.6, Taxa richness = 20).

Schedule F1 of the PNRP identifies Duck Creek as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reach is consider to have potential to provide inanga spawning habitat (i.e., Taylor & Marshall, 2016). Fish species recorded in Duck Creek include banded kokopu, common bully, common smelt, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully and shortfin eel.

5.2.6 Porirua and Kenepuru streams

Catchment characteristics

Porirua Stream catchment lies to the south and west of Porirua Harbour. The drainage area extends from Glenside and the Takapu Valley, through Tawa and Porirua City to the western end of Porirua Harbour. It covers an area of nearly 32 km^2 of which 37% is impervious surfaces. There are seven main sub-catchments (Kenepuru, Linden, Takapu, Belmont, Churton Park, Tawa and Mitchell) several of which have little vegetation other than pasture grass or residential gardens. The catchment is predominantly production pasture in its upper reaches and urban in its lower reaches, with areas of regenerating indigenous forest, scrub and exotic forest (Table 5-3).

Table 5-3: GWRC RSoE %Land-cover types in contributing catchment - Porirua

Site no.	Site name	Site type	Habitat grade	Indigenous forest and scrub (%)	Exotic forest (%)	Pasture (high prod.) (%)	Pasture (low prod.) (%)	Urban (%)	Other (%)
RS15	Porirua S. at Glenside	impacted	poor	15.1	3.9	13.7	40.0	27.4	0.0
RS16	Porirua S. at Wall St.	impacted	poor	14.6	11.3	13.6	29.6	30.6	0.0

Water quality

The upper and lower GWRC RSoE sites located on the Porirua Stream both had a 'fair' WQI grade for the 2015/16 year and were ranked 39th and 45th out of 53 sites in the Wellington Region. Water quality did not met GWRC guideline criteria for *E. coli.*, nitrate/nitrite nitrogen or dissolved reactive phosphorus, but did achieve guidelines for dissolved oxygen, visual clarity and ammoniacal nitrogen. Dissolved Cu and Zn exceeded ANZECC 95% protection trigger values in 42% and 58% of samples, respectively, at the Wall Street RSoE site.

Summary statistics included in Appendix D show the median and maximum *E. coli.* values for the 2015/16 monitoring year at the lower site (RS16) were 1,450 and 4,900 cfu/100 ml, respectively. The median value the NPS-FM 'bottom line for secondary contact recreation (<1,000 cfu/100 ml), indicating significant faecal contamination. Faecal source tracking conducted on samples collected at both sites during 2013 and 2014 indicate a predominantly human source, but dog, ruminant and waterfowl sources were also detected. Human sources were detected in both wet and dry weather, suggesting that leaking pipes or cross connections exist (Milne & Morar, 2017).

PCC fortnightly monitoring of *E. coli.* at five sites on Porirua Stream and tributaries (Belmont Gully, Boscobel Lane and Lindon Park on Porirua Stream; Boscobel Lane at Takapu Stream; and Stebbings Stream at Gully) between July 2010 and June 2014 (n = 105) gave median values in the range 400-650 cfu/100 ml and maximum values in the range 12,000 - 32,000 cfu/100 ml (Milne & Morar, 2017). At these locations the NPS-FM bottom line for secondary contact recreation was achieved, but significant faecal contamination occurred from time to time, often but not always associated with significant rainfall events.

PCC monthly microbiological monitoring at Kenepuru Stream from January 2015 to August 2016 gave a median *E. coli* value of 1,700 cfu/100ml indicating that compliance with the NPS-FM bottom line for secondary contact recreation is not achieved (Appendix I).

GWRC conducted monthly monitoring in the Mitchell and Stebbings streams for 12 months between July 2011 and June 2012 (Milne & Morar, 2017). Samples were analysed for a similar suite of physic-chemical and microbiological variables to urban RSoE samples, in addition to chloride and a wider suite of dissolved metals at the Mitchell Stream site. Applying GWRC's water quality index to these sites results in grade of "fair" at for Mitchell Street and "poor" for the Kenepuru Site. The authors found that the Kenepuru Site was amongst the poorest in urban streams across the Wellington Region, with median values of four of the six core indicators failing to meet guideline values. In particular sewage contamination was highlighted as a known issue for Kenepuru Stream, in both wet and dry weather conditions.

Stream water quality results obtained from 12 separate wet weather sampling events between June 2012 and June 2014, reported by Milne & Morar (2017) characterises the quality of storm flows in terms of TSS, SS, turbidity TN, TP and *E. coli*. The authors observed that:

- The single highest TSS, SSC and turbidity results were recorded in Stebbing Stream (and subsequently downstream in Porirua Stream, during a heavy rainfall event (25.2mm of rainfall in 6 hours);
- Wet weather can contribute significant sediment inputs to Porirua Harbour via tributary streams, with the Kenepuru and Takapu streams, owing to their larger baseflows, likely to contribute the greatest contaminant load to Porirua Stream;
- *E. coli.*, where measured, was consistently over 2,000 cfu/100 ml across all sites. The highest results were recorded in samples from Kenepuru Stream at Mepham Place; on four separate occasions exceeded 10,000 cfu/100 ml, and highest being 31,000 cfu/100 ml;
- Concentrations of TN and TP exceeded recommended guidelines in the Kenepuru Stream;
- Dissolved Cu and Zn exceeded 95% protection trigger values in the lower Kenepuru Stream while Pb did not exceed the trigger value in any sample.

Sediment Quality

Streambed sediments sampled in Porirua Stream at three locations in 2005 and 2006 (Redwood Station, Glenside & Kenepuru playing field) did not exceed ANZECC ISQC trigger values for metals or PAHs, but exceeded the ISQC-Low trigger value for Total DDT at all locations, and exceeded the ISQC-High trigger value for Total DDT at Glenside. An additional 2 sites sampled in 2006 (No. 2 Tunnel & Wingfield Place) both exceed the ISQC-Low trigger value for Total DDT. The Wingfield Place site also exceeded the ISQC- Low trigger value of Pb and the ISQC-High trigger value for Zn (Milne & Watts, 2008).

Aquatic ecology

RSoE invertebrate survey results (Appendix E) indicate "excellent" quality invertebrate community in the Porirua Stream at Glenside (QMCI = 6.39, %EPT taxa = 40, Taxa richness = 25) and "fair" quality at the Wall Street site (QMCI = 4.32, %EPT taxa = 18, Taxa richness = 28) which has been significantly affected by both agricultural and urban development in the catchment.

KML (2005) reported metric scores indicating only "fair" quality in Porirua Stream at Glenside and "poor" quality in the middle and lower stream. They also surveyed the Kenepuru Stream and reported metric scores indicating "fair" quality in the middle stream reach reducing to "poor" in the lower reach.

Schedule F1 of the PNRP identifies Porirua Stream and tributaries as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reaches of Porirua Stream and the Keneperu streams are known to provide inanga spawning habitat (i.e., Taylor & Marshall, 2016). A detailed description of the ecological values of the Porirua Stream and enhance priorities is given by Blaschke *et al* (2009).

5.2.7 Porirua minor urban streams

The results of routine monthly microbiological monitoring conducted by PCC at nine minor urban streams and culverts are included in Appendix I. The highest *E. coli* concentrations were consistently recorded at the Semple Street culvert which runs through the Porirua CBD and discharges to the southern end Onepoto Arm of Porirua, to the west of the Porirua Stream mouth. Median and maximum values of 16,000 cfu/100 ml and 420,000 cfu/100 ml, respectively indicate significant leakage from the wastewater to system to the stormwater culvert. Titahi Bay South had a median value well in excess of the NPS-FM bottom line for secondary contact recreation (*E. coli.* <1000 cfu/100 ml), indicating significant wastewater reticulation faults.

Results of monthly monitoring reported by Milne and Morar (2017) show nutrient levels exceeded recommended guidelines in Onepoto Drain. Dissolved Cu and Zn also exceeded 95% protection trigger values in the Onepoto Drain. Pb did not exceed the trigger value in any sample.

5.3 Estuarine and coastal habitats

5.3.1 Onepoto Inlet

Porirua Harbour characteristics

The Porirua Harbour is a large, shallow, well flushed “tidal lagoon” type estuary consisting of two shallow drowned river valleys, the southern Porirua or Onepoto Arm and the northern Pauatahanui Inlet, meeting at a deep narrow confluence which opens to the west coast of the lower North Island opposite Mana Island. Porirua Harbour at 807 ha (524 ha in the Pauatahanui Inlet and 283 ha in the Onepoto Arm) is moderate in size compared to other New Zealand estuaries (Robertson & Stevens, 2007; Stevens & Robertson, 2008) but is the largest estuary system in the Wellington region.

Stevens and Robertson (2008) undertook broad-scale habitat mapping of the harbour in 2007/08 and noted that, unlike other similar sized estuaries which largely drain at low tide, Porirua Harbour remains largely filled and is comprised of mainly sub tidal habitats (65%), particularly the Onepoto Arm. At the confluence of the two arms water depth reaches at least 13 m. This characteristic is important as it influences the range of habitats and species occurring within the harbour. The authors observed that in relation to the major habitat types, the majority of the intertidal area in both arms was dominated by unvegetated, poorly sorted firm muddy sands (122ha in Pauatahanui Arm and 33ha in Porirua Arm). Firm sands and mobile sands occupied 28ha and 4.4ha respectively, whereas soft muds occupied only 1.9ha and 1.5ha respectively.

The Porirua Stream in the primary freshwater inflow to the Onepoto Arm of Porirua Harbour, entering the harbour at the southern end. Porirua Stream catchment characteristics are described in 5.2.6.

Aesthetics

Occasional scums, oil slicks, murky water and debris are report in the vicinity of the Porirua Stream mouth and in the Onepoto Arm of the harbour

Amenity and recreation

The Onepoto Inlet has moderate amenity and recreational uses including walking, fishing, sailing, rowing, windsurfing and paddle boarding.

Water quality

One site on the Onepoto Inlet (Onepoto Rowing Club), and one just outside of the harbour (Onehunga Bay) are monitored as part of the GWRC recreational water quality monitoring programme, which is specifically designed to inform the public about the suitability of various sites across the region for swimming and other recreational activities.

During the 2015/16 bathing season the suitability for recreation grade (SFRG) was “Poor” at the Rowing Club and “Good” at Onehunga Bay. One “alert” trigger was recorded at the Rowing Club during the 2015/16 bathing season, and none were recorded at Onehunga Bay.

No chemical water quality data are available for the Onepoto Arm of the harbour

Sediment quality

Oliver (2016) described the subtidal basins in each arm of the harbour as being dominated by fine muds and providing a ‘sink’ in which contaminants accumulate. To date GWRC has conducted four sub tidal sediment quality monitoring surveys at five sub-tidal sampling sites in Porirua Harbour, three in the Pauatahanui Inlet and two in the Onepoto Inlet (Figure 5-1). These sites were sampled in 2004, 2005, 2008 and 2010. Oliver and Conwell (2014) reported in relation to the 2010 survey report that concentrations of total Cu, Pb and Zn exceed ‘early warning’ sediment quality guidelines (i.e.ARC ERC or ANZRCC ISQG-Low) in sub tidal sediments of the Onepoto Inlet. Mercury concentrations are approaching guidelines levels but otherwise, along with the other five metals analysed, are below guideline levels in Onepoto Inlet. TOC-normalised total DDT and Dieldrin exceeded the ANZECC ISQG-Low trigger values at all sites.

The general trend across the five sites over the last four surveys has been for Zn concentrations to increase steadily, for Pb concentrations to decrease and for Cu concentrations to be variable, showing both increases and decreases.

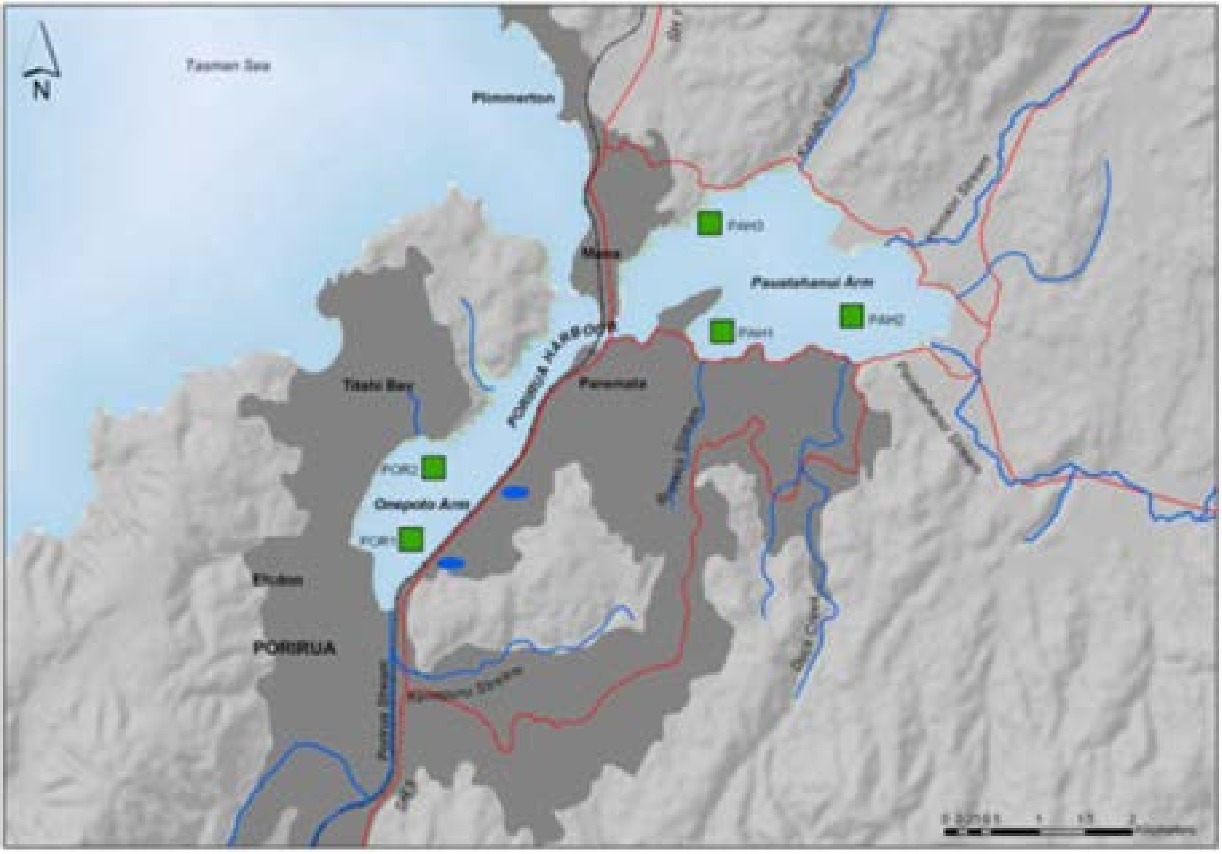

Figure 5-1: Location of GWRC sediment quality monitoring sites (from Oliver & Conwell, 2014)

Catchment stormwater investigations (see Sections 5.2.6 and 5.2.7) have demonstrated that urban stormwater is contributing to metal and other contamination of the Onepoto Arm, either directly via outfalls, or indirectly, via the Porirua and Kenepuru streams.

Aquatic ecology - intertidal

Saltmarsh was virtually non-existent in the Onepoto Arm but occupied 51ha in the Pauatahanui Arm where it was dominated by wide beds of rushland (mostly searush and jointed wire rush) which , as the terrestrial influence increased, transitioned through areas dominated by saltmarsh ribbonwood and grassland (mostly tall fescue). Area of seagrass were relatively extensive, 41.2ha in the Pauatanui Arm and 17.3ha in the Porirua Arm.

MacDiarmid, et al., (2012) identified Porirua Harbour as a site of signifcance for marine biodiversity. The authors noted that New Zealand’s shallow harbours and estuaries are important centres of diversity for shore and wading birds, coastal fish and invertebrates, as well as a variety of marine algae and flowering plants such as seagrass and saltmarsh species. Harbours and estuaries are key breeding, nursery and foraging areas for many species. Porirua Harbour is typical in this general sense but because of the limited size of most estuaries within the Wellington region the biodiversity value of Porirua Harbour is considerably elevated.

That assessment is reflected in Schedule F2c of the PNRP which lists both arms of the Porirua Harbour as being one of only a handful of relatively large estuaries in the Wellington Region, and a regionally important stop-over for several migrant shorebird species such as the NZ pied oystercatcher and bar-tailed godwit. Schedule F3 identifies the tidal flats of Pauatahanui Inlet as significant natural wetlands.

Aquatic ecology - sub tidal

According to Bell et al., 1969 (cited in Blaschke, et al, 2010) Porirua Harbour is the most southerly habitat for some benthic species. Blaschke *et al* (2010) noted that eight species of invertebrates (a polychaete, a snail and six copepod species) were first described and identified in Porirua Harbour.

Of the meiofaunal species, copepods dominate within the Pauatahanui Inlet with the highly abundant *Parastenheli megarostrum* occurring at a density of around 263,000 individuals per m^2 (PICT 2001). Kinorhynchs (mud dragons), also meiofaunal, are well represented in the inlet. At Ration Point, Coull and Wells (1981) found densities of 80 individuals of an unnamed *Echinoderes* per 10 square centimetres of surface mud, the second-highest kinorhynch abundance ever recorded anywhere in the world. A related phylum – Priapulida or penis worms – is also found in the inlet, which is the shallowest known and most accessible locality for collecting these zoologically interesting creatures (Storch et al. 1995).

Blaschke *et al.* (2010) recently reviewed the available information on the benthic communities in Porirua Harbour. They concluded that of the macro-faunal species, polychaete worms dominated numerically (>50%), then bivalve molluscs, crustaceans, and gastropod molluscs. Stevens and Robertson (2008) described this as 'unbalanced' as it was dominated by species tolerant of moderate sedimentation and enrichment. However, because of its size and moderately healthy status, the Porirua Harbour is likely to be the most significant area for estuarine invertebrates in the Wellington region.

In relation to the GWRC sub tidal sediment surveys, Oliver and Conwell (2014) concluded that "*there is currently no clear evidence that any of the sub tidal sediment contamination has resulted in significant adverse effects on invertebrate communities, however, the combination of heavy metals, mud and organic carbon content at some sites, is linked with less diverse community structure. Adverse effects may eventuate as long as stormwater discharges continue in their present form and contaminants continue to accumulate in the harbour sediments."*

Fish Resources

There have been a number of studies of the fish fauna of Porirua Harbour. Healy (1980) coordinated the first significant study, producing a multi-disciplinary assessment of the geography, geology, hydrology, water chemistry, sedimentology, biology, and ecology of the harbour. Its goal was to increase the level of knowledge of the estuary in the wake of increased coastal development. Healy (1980) classified each fish species into abundance categories (rare, common, abundant) and three behavioral types (resident, seasonal, transient). Thirty species were identified from the harbour, with some being mainly or exclusively found in one of the harbour arms, reflecting each arm's different physical characteristics. Common sole, common warehou, trevally and kahawai were caught mostly in the sandy, less turbid Pauatahanui Inlet. Red cod, sand flounder and yellow-belly flounder were caught mostly in the muddy, more turbid Onepoto Arm. Healy (1980) identified Porirua Harbour as a nursery for rig, kahawai, sand flounder, speckled sole, yellow-belly flounder, yellow-eyed mullet, common sole, garfish, spotty, and triplefins.

Jones and Hadfield (1985) carried out a set net survey of Porirua Harbour in 1983 and 1984, and supplemented that with a diary kept by a fisher who set nets in Onepoto during 1983. They assessed the species composition, seasonal abundance and growth of fishes in the harbour. Using a range of set net mesh sizes, they determined that fish abundance changed seasonally, with the greatest abundance occurring in summer. Jones and Hadfield (1985) caught a total of 24 fish species, including eight new species not recorded by Healy (1980), as well as identifying five diadromous fishes (two eels and three whitebait species), raising the number of fish species known from the harbour to 43.

Lyon, *et al* (2013) observed that Porirua Harbour has year-round residents, such as kahawai, sand flounder and yellow-belly flounder; it is used as a pupping, mating and nursery area for rig; as a nursery site for some estuarine and coastal species such as yellow-eyed mullet, triplefins, and trevally; and also has many seasonal visitors during spring–autumn, such as snapper and grey mullet.

Lyon, *et al* (2013) noted that the Pauatahanui Inlet is almost twice as large as the Onepoto arm, it has a greater amount of intertidal habitats, such as four times the unvegetated firm mud/sand, six times more firm sand, and 1.3 times more soft mud habitats. Because of this Pauatahanui is able to carry higher numbers of some species than Onepoto. This was reflected in the catches reported by Lyon *et al* (2013) with only three species (conger eel, estuarine triplefin, and speckled sole) caught in higher numbers in Onepoto than Pauatahanui. For the remaining 18 species all were caught in the same or greater numbers in Pauatahanui. For the most populous species the numerical differences between both arms was considerable, with four times more yellow-eyed mullet, 50 times more spotty, three times more mottled triplefins, and 4.5 times more rig in Pauatahanui.

5.3.2 Pauatahanui Inlet

Porirua Harbour characteristics

The Pauatahanui Inlets has high uses and ecological values and provides a natural focal point for the people that live near or visit its shores. It is less modified than Onepoto Inlet, and has extensive areas of saltmarsh, a large percentage of which has been improved through local community efforts. Catchment land use is dominated by grazing in the Pauatahanui Inlet catchment, although residential urban development is significant in some areas, particularly the southern shoreline (Stevens and Robertson 2008).

The Kakaho, Horokiri, Pauatahanui streams and Duck Creek flow into the Pauatahanui Arm of Porirua Harbour. The characteristics or these watercourses are described in Sections 5.2.2 to 5.2.4.

Aesthetics

The aesthetic values of Pauatahanui Inlet are high and although litter accumulates at some locations conditions are generally good.

Amenity and Recreation

The Pauatahanui Inlets has high amenity and recreational uses including walking, fishing, sailing, boating, jet skiing, windsurfing, paddle boarding, water skiing and bathing.

Water Quality

Two sites in the Pauatahanui Inlet are monitored as part of the GWRC recreational water quality monitoring programme, which is specifically designed to inform the public about the suitability of various sites across the region for swimming and other recreational activities.

During the 2015/16 bathing season the suitability for recreation grade (SFRG) was “Fair” at the Water Ski Club and “Good” at Paremata Bridge. No “alert” or “action” triggers were recorded during the 2015/16 bathing season.

Sediment Quality

Oliver & Conwell (2014) reported that sediments in the Pauatahanui Inlet have a lower proportion of mud and lower levels of total organic carbon (TOC) relative to sediments in the Onepoto Inlet. Consistent with earlier surveys total metal concentrations (Cu, Pb, Zn, Hg, As, Cd, Cr, Ni, Ag) were all below early warning guideline levels (i.e., ARC ERC or ANZECC ISQG-Low).

TOC-normalised total DDT and Dieldrin exceeded the ANZECC ISQG-Low trigger values at all sites.

Aquatic ecology

The aquatic ecology of the Pauatahanui Inlet is described in Section 5.3.1.

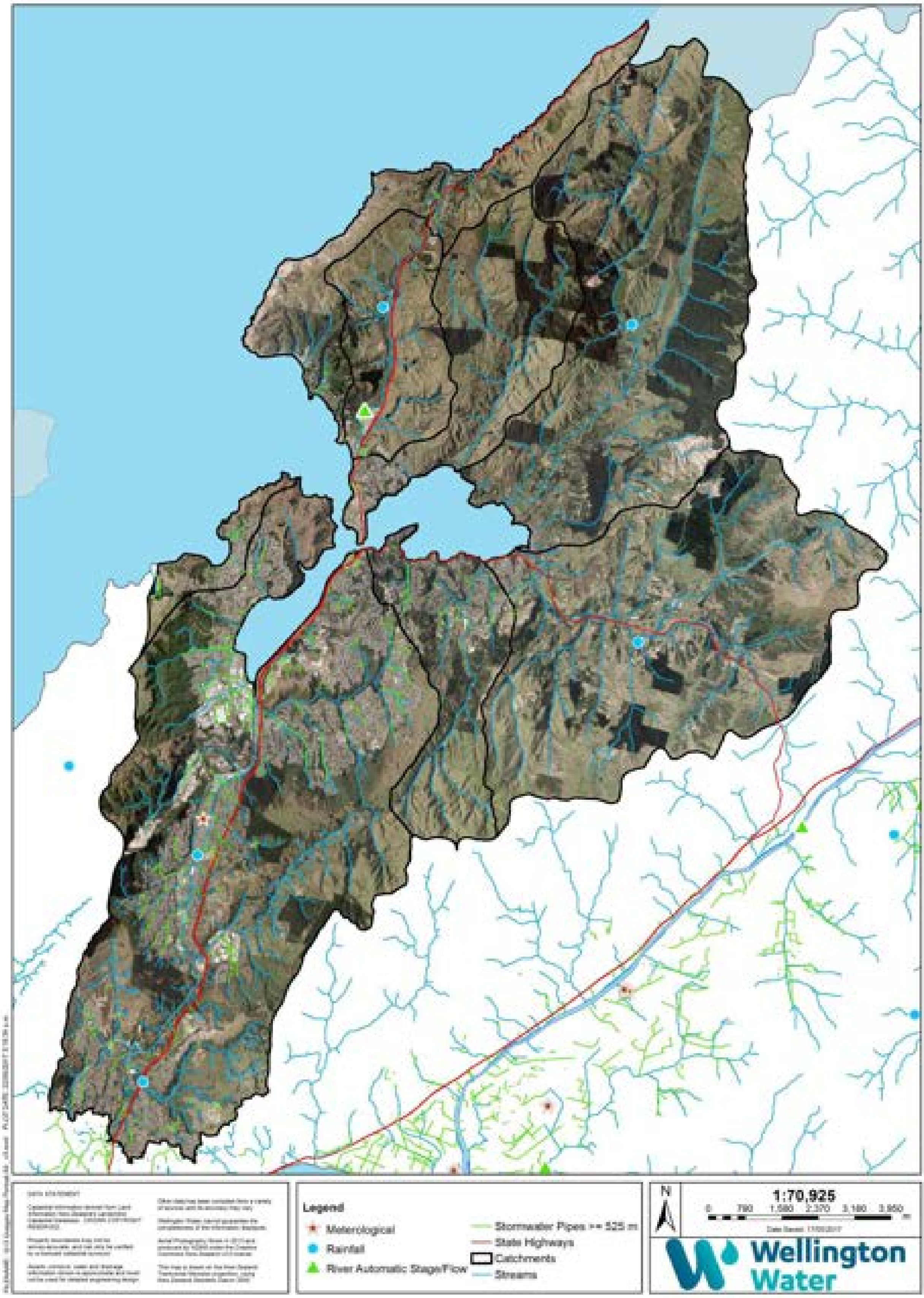

Figure 5-2: Rainfall and stream flow gauge stations within the Porirua Harbour Basin

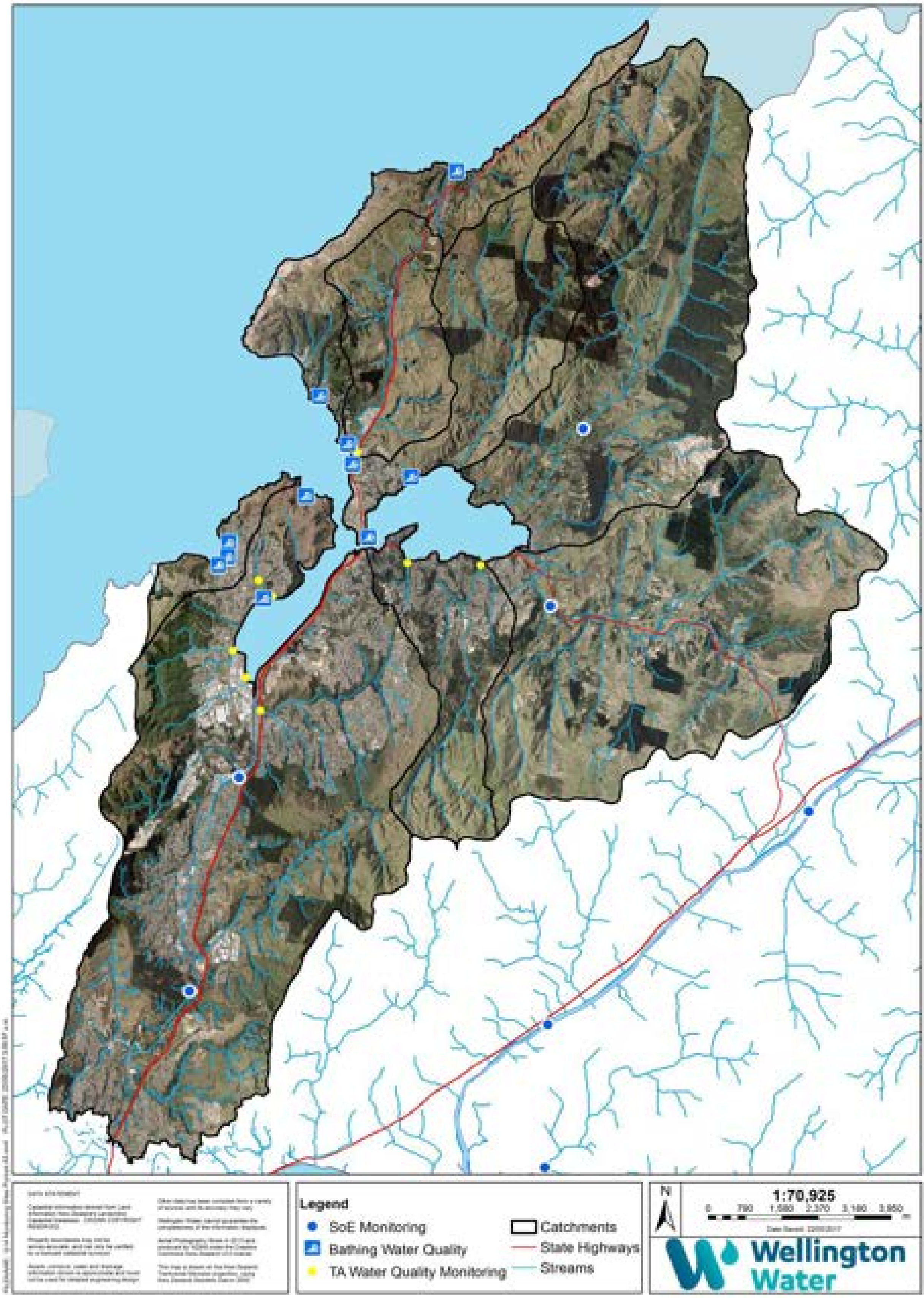

Figure 5-3: SoE and recreational water quality monitoring sites within the Porirua Harbour Basin

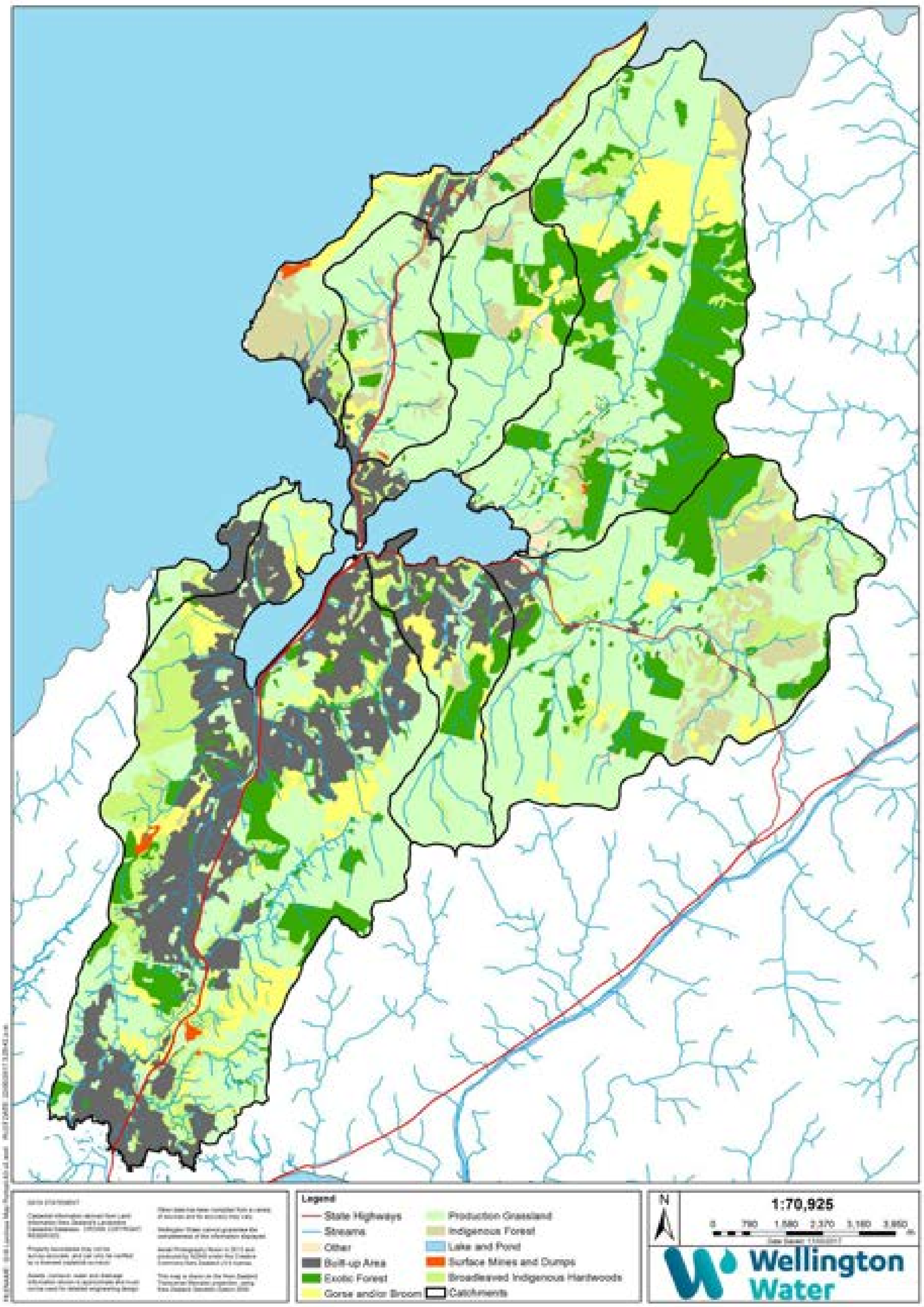

Figure 5-4: Land use categories within the Porirua Basin

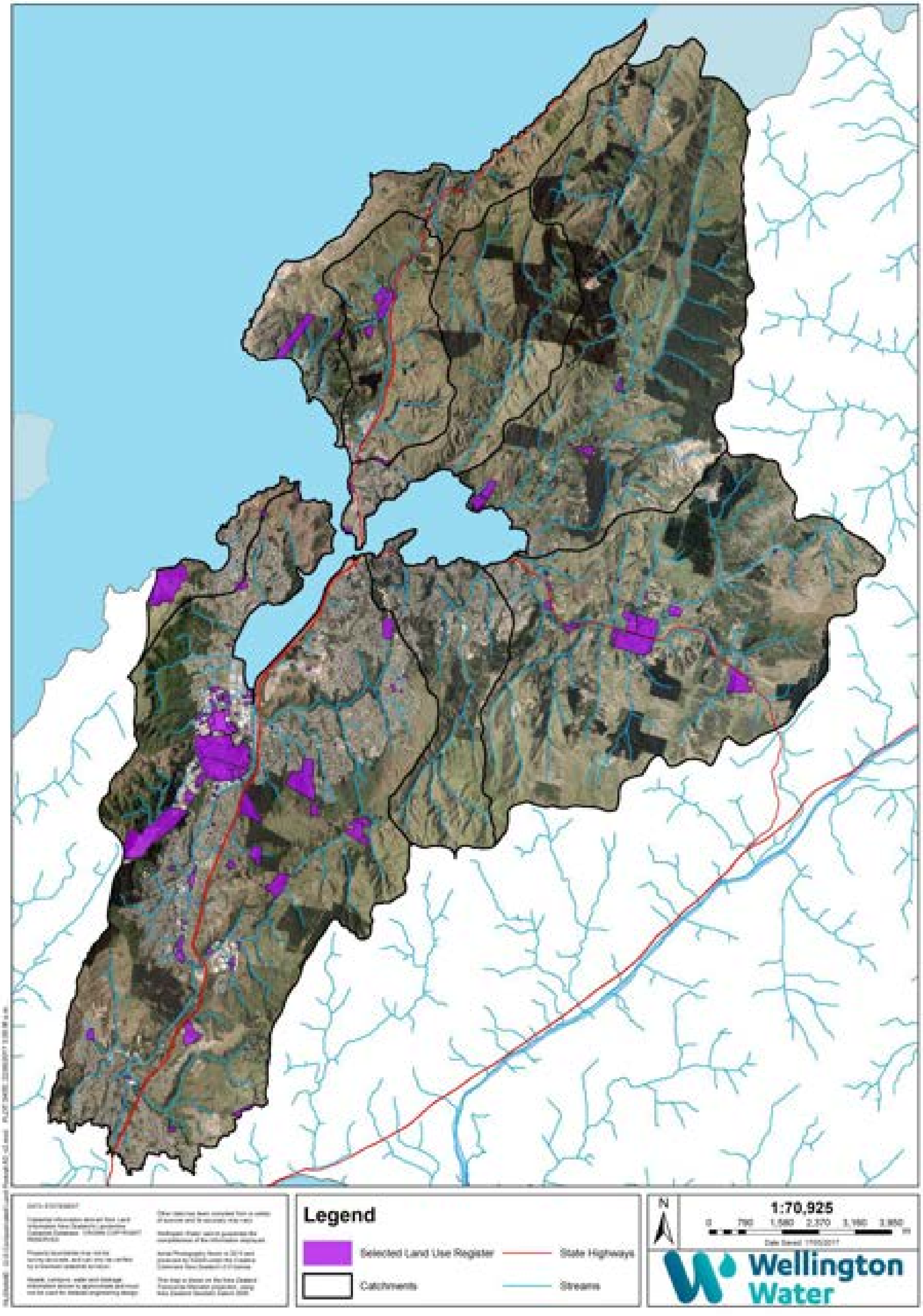

Figure 5-5: SLUR Sites that are known or suspected to have been involved in the use, storage, or disposal of hazardous substances and which may contain residues of these substances

6 Stormwater networks in Porirua

6.1 Overview

Prior to 1950 Plimmerton, Pukerua Bay, Paremata and parts of Titahi Bay were regarded as seaside settlements consisting mainly of holiday cottages. Before installation of water reticulation, the accepted method for disposal of stormwater was collection of water in storage tanks as a source for drinking and washing. After installation of water reticulation, stormwater was generally directed to soak pits constructed in the property grounds. This relied on good soakage available in many areas to disperse the water.

During the 1950s, 1960s and 1970s, major government housing development took place in Titahi Bay, Elsdon, Porirua East, Cannons Creek, Waitangirua and Ascot Park. In addition, from the 1970s to the present day, substantial private urban subdivision has taken place, predominantly in the Papakowhai, Camborne, Whitby and Aotea areas. In these developments, reticulation for stormwater disposal was required as a condition of subdivision and, as a result, over two thirds of the City's stormwater network was constructed to a high modern standard. The remainder, being in the original settlements, was reticulated for stormwater when necessary, or as part of road upgrading works.

Pipes connecting the stormwater network to individual properties (household laterals) are nominally 100mm diameter, while public pipework consists of 150mm and larger diameters. Modern standards dictate minimum pipe sizes of 300mm for sump leads and local reticulation. Sizes of up to 1050mm diameter are not uncommon in the lower reaches of larger catchments. The reticulation network by pipe size is shown below in Figure 6-1.

The age profile of the stormwater network reflects the various stages of Porirua City's development. Initially, Crown development started in Titahi Bay in the early 1950s, spreading through to Porirua and ultimately to Ascot Park by the mid-1970s. Steady growth in the last 15 years is attributed to private sector developments, particularly in the areas of Papakowhai, Camborne, Whitby and, more recently, Aotea. The reticulation network by composition and age profile is shown in Figure 6-2.

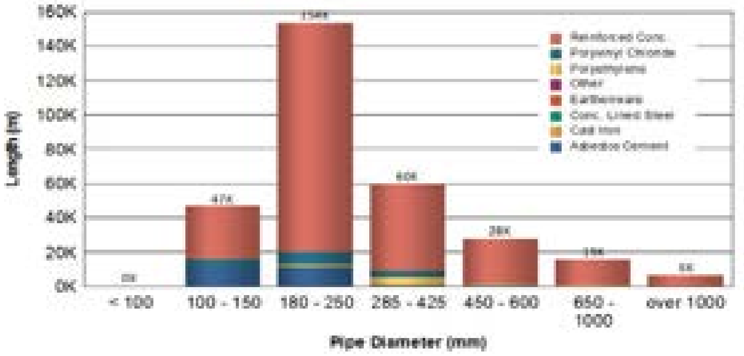

Figure 6-1: Stormwater reticulation – pipe material and sizes (Porirua City Council, 2015)

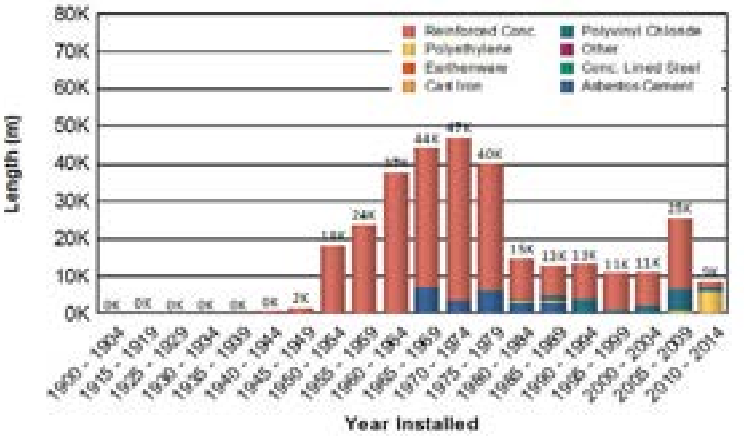

Figure 6-2: Stormwater pipe age profile (Porirua City Council, 2015)

6.2 Taupo

The Taupo Stream catchment contains parts of Plimmerton and SW1 to the north of Porirua City centre. The drainage area extends from near Pukerua Bay to Plimmerton Beach (Table 6-1).

Table 6-1: Taupo Stream stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Taupo Stream
Stream catchment area (km^2)	10.6
Stormwater catchment area (km^2)	0.79 (7.4% of total catchment)
Impervious surface area (km^2)	1.29 (12% of total catchment)
Number of outfalls to CMA (>600mm dia)	One stream outlet
Total public stormwater length (km)	5.9
Age of stormwater system	Circa 1945s onwards. Mostly constructed in the 1950s, 1960s and 1970s.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Taupo Stream and swamp
REC stream length (km)	17.6
Landfills	None
Contamination sources	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. In addition, as State Highway 1 runs through the catchment for a distance of 6.5 km, vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source.
Contamination hot spots	No significant contamination sources are anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment.

6.3 Kakaho

The Kakaho Stream catchment lies to the northwest of Porirua City. The drainage area extends from the western side of the Paekakariki Hill to the Pauatahanui Inlet (Table 6-2).

Table 6-2: Kakaho Stream stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Kakaho Stream
Stream catchment area (km^2)	14.76
Stormwater catchment area (km^2)	1.42 (10% of total catchment)
Impervious surface area (km^2)	1.17 (8% of total catchment)
Number of outfalls to CMA	One stream outlet
Total public stormwater length (km)	14.1
Age of stormwater system	Circa 1945s onwards. Mostly constructed in the 1950s, 1960s and 1970s.
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Kakaho Stream
REC stream length (km)	18.8
Landfills	None
Contamination sources	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance, vegetation as well as wild and domestic animals.
Contamination hot spots	No significant contamination sources are anticipated.
Contaminant loads	Contaminant load predictions are not available.

Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment however one overflow location has been confirmed.

6.4 Horokiri

The Horokiri Stream catchment lies to the northwest of Porirua City. The drainage area extends from the Wainui saddle (at around 500m a.s.l) to the Pauatahanui Inlet, draining from north to south into the Inlet (Table 6-3).

Table 6-3: Horokiri stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Horokiri Stream
Stream catchment area (km^2)	41.0
Stormwater catchment area (km^2)	0.00 (0.00% of total catchment)
Impervious surface area (km^2)	0.23 (0.55% of total catchment)
Number of outfalls to CMA (>600mm dia)	One stream outlet
Total public stormwater length	0.00
Age of stormwater system	There is no sign cant stormwater network in the catchment
Constructed wastewater overflows	0
Pump station overflows	0
System type	N.A.
Open water courses	Horokiri Stream, partially modified
REC stream length (km)	61.8
Landfills	None
Contamination sources	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance, vegetation as well as wild and domestic animals.
Contamination hot spots	No significant contamination sources are anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	No constructed wastewater overflows are located in the catchment.

6.5 Pauatahanui

The Pauatahanui Stream catchment lies to the east of Cannons Creek and Whitby. The drainage area extends from the western face of Haywards Hill to the eastern end of the Pauatahanui Inlet (Table 6-4).

Table 6-4: Pauatahanui stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Pauatahanui Stream
Stream catchment area (km^2)	41.6
Stormwater catchment area (km^2)	1.17 (2.8% of total catchment)
Impervious surface area (km^2)	1.98 (4.8% of total catchment)
Number of outfalls to CMA (>600mm dia)	One stream outlet
Total public stormwater length (km)	13.5
Age of stormwater system	Circa 1945s onwards. Mostly constructed in the 1950s, 1960s and 1970s
Constructed wastewater overflows	0
Pump station overflows	0
System type	100% separate
Open water courses	Pauatanui Stream, partially modified
REC stream length (km)	68
Landfills	None
Contamination sources	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance, vegetation as well as wild and domestic animals. As State Highway 56 runs through the catchment, vehicles (tyres, brake linings, oil leakage, exhaust) are a secondary generic source.

Contamination hot spots	No significant contamination sources are anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment however four overflow locations have been confirmed.

6.6 Duck

The Duck Creek catchment lies to the east of the Pauatahanui Inlet. The drainage area extends from the northern face of Round Knob through Whitby to the southern side of Pauatahanui Inlet Table 6-5).

Table 6-5: Hulls Creek stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Duck Creek
Stream catchment area (km^2)	11.98
Stormwater catchment area (km^2)	5.23 (44% of total catchment)
Impervious surface area (km^2)	4.05 (34% of total catchment)
Number of outfalls to CMA (>600mm dia)	One stream outlet
Total public stormwater length (km)	64
Age of stormwater system	Mostly constructed in the 1980s, 1990s and 2000s
Constructed wastewater overflows	0
Pump station overflows	2
System type	100% separate
Open water courses	Duck Creek, partially modified
REC stream length (km)	18.64
Landfills	None
Contamination sources	Catchment-wide sources include roofs and other building materials found in residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a significant generic source.
Contamination hot spots	No significant contamination sources are anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment however two pump station overflow structures have been identified in this catchment.

6.7 Porirua

Porirua Stream catchment lies to the south and west of Porirua Harbour. The drainage area extends from Glenside and the Takapu Valley, through Tawa and Porirua City to the western end of Porirua Harbour (Table 6-6). Adjacent minor watercourses draining to the Onepoto Inlet are also included in this catchment description.

Table 6-6: Porirua Stream stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Porirua, Paparangi, Churton, Kenepuru, Onepoto
Stream catchment area (km^2)	66.5
Stormwater catchment area (km^2)	36.4 (55% of total catchment)
Impervious surface area (km^2)	19.3 (29% of total catchment)
Number of outfalls to CMA (>600mm dia)	Porirua Stream outlet, minor stream outlets and numerous minor stormwater outlets
Total public stormwater length (km)	367
Age of stormwater system	Circa 1945s onwards. Mostly constructed in the 1950s, 1960s and 1970s.
Constructed wastewater overflows	1

Pump station overflows	20
System type	100% separate
Open water courses	The main stem of Porirua Stream and Kenepuru Stream flow through an open channel, as do the upper reaches of some minor tributaries. However, most tributaries are piped through urban areas.
REC stream length (km)	98
Landfills	Spicers Landfill (operating) and closed landfills at Porirua Hospital, Northern Landfill, Sievers Grove and Churton Park.
Contamination sources	Catchment-wide sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from the Porirua Motorway (SH1), major city streets, and parking lots.
Contamination hot spots	Potential hotspots include the Wellington to Porirua motorway and the rail network. One large operating landfill (Spicers Landfill) and closed landfills at Porirua Hospital, Northern Landfill, Sievers Grove and Churton Park are potential hot spots.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. One constructed wastewater overflow is located beside Porirua Stream immediately upstream of Pump Station 20 (PS20). Nearly 40 other overflow locations have been identified in the Porirua Stream catchment (refer to Table 6-7 and Appendix M for details).

Table 6-7: Porirua Stream constructed wastewater overflows and pump station overflows

Asset ID	Location	Description	Average annual frequency	Average annual volume (m^3)
Available in GIS but not yet extracted.	Shown in the map series attached as Appendix N.	Available in GIS but not yet extracted.	No information	No information

6.8 Porirua coast

The Porirua Coast 'catchment' is a series of minor catchments, often with separate stormwater networks draining to a minor watercourse or the coast between Pukerua Bay and Rukatane Point (Table 6-8).

Table 6-8: Porirua coast stormwater catchment characteristics

Catchment characteristics	Description
Sub-catchments:	Porirua coastal area outside of the harbour
Stream catchment area (km^2)	14.4
Stormwater catchment area (km^2)	2.25 (16% of total catchment)
Impervious surface area (km^2)	2.91 (20% of total catchment)
Number of outfalls to CMA (>600mm dia)	Numerous minor stormwater outfalls
Total public stormwater length (km)	24
Age of stormwater system	Mostly constructed in the 1950s, 1960s and 1970s
Constructed wastewater overflows	None
System type	100% separate
Open water courses	Minor fragments, modified
REC stream length (km)	9.7
Landfills	None
Contamination sources	Catchment-wide sources include roofs and other building materials found in residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild

	and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a minor generic source.
Contamination hot spots	No significant contamination sources are anticipated.
Contaminant loads	Contaminant load predictions are not available.
Wastewater contamination	Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. No constructed wastewater overflows are located in the catchment.

7 Current state summary

The results of selected indicators of water quality, sediment quality and invertebrate community health for freshwater and marine receiving environments Porirua, Wellington and the Hutt Valley are summarised in Table 7-1. A number of recognised bathing areas received a "Poor" suitability for recreation grade (SFRG) and have triggered the "amber/alert" or "red/action" tiers in the MfE/MoH (2003) management framework. In some but not all cases microbiological contaminants delivered via the stormwater network have contributed to these poor results. During the 2015/16 summer freshwater bathing sites on the lower reaches of the Akatarawa and Hutt rivers, and the middle reaches of Wainuiomata River, received a "Poor" grade for primary contact recreation. In addition, coastal water bathing sites at Owhiro Bay, Island Bay, Onepoto Inlet, Southern Titahi Bay and Plimmerton Beach received a "Poor" grade. Wellington Water is undertaking investigations within these catchments to identify specific sources of contamination. Several freshwater stream sites recorded annual median *E. coli* values greater than 1000 cfu/100 ml, there for not complying with the NPS-FN national bottom line for secondary contact recreation. These sites are located on Karori Stream, Hulls Creek, Stokes Valley Stream, Onepoto Drain, Porirua Stream and an unnamed stream at the south end of Titahi Bay.

Only one RSoE monitoring site, on the Waiwhetu Stream, received a "Poor" WQI grade, but most urban stream sites received a "Poor" MCI grade. It is notable that none of the stream sites with greater than 30% urban land-cover in the contributing catchment achieved the PNRP aquatic ecosystem objective of >100 MCI. Water column concentrations of dissolved Cu and Zn exceeded ANZECC (2000) 95% protection levels at almost all streams with more than 30% urban land-cover.

Sediment concentrations of Zn exceeded the ANZECC (2000) ISQG-Low trigger values in freshwater streams with more than 30% urban land-cover, whereas sediment Cu concentrations were relatively low. Marine sediment concentrations of Cu and Zn were low in exposed environments along Wellington's south coast but were elevated at depositional environments within Wellington Harbour and Porirua Harbour, especially those adjacent to the heavily urbanised catchments of Evans Bay and Lambton Harbour and Porirua CBD. Concentrations of PAH, DDT, Cu, Pb, Zn and Hg exceeded ISQG-Low trigger values at far field locations in Wellington and Porirua harbours. However, PAH, Pb, Hg and DDT are currently not being discharged in sufficient quantities in urban stormwater to have led to such high levels and are regarded as legacy contamination from past stormwater or industrial discharges.

Table 7-1: Summary of receiving water quality for Wellington Harbour and Hutt Valley catchments compared against relevant guidelines or trigger values (green = good; orange = fair; red = poor)

Catchment	Sub-catchment	Area (km²)	% Urban	S/W pipe length (km)	Primary contact recreation[1]	*E. coli* <1000 cfu/100 ml[2]	WQI[3]	MCI[4]	Water[5]		Sediment[6]	
									Cu	Zn	Cu	Zn
Karori	Karori	30.93	14	62	N.A	[red]	[orange]	[red]	[red]	[red]	[green]	[orange]
Owhiro Bay	Owhiro Stream	9.71	51	33	[red]	[orange]	No data	[red]	[red]	[red]	[green]	[orange]
Island/ Houghton	Island Bay	5.12	81	60	[red]	[green]	N.A.	N.A.	No data	No data	No data	No data
	Houghton Bay	0.88	54		Princess Bay [green]	[orange]	N.A.	N.A.	No data	No data	[green]	[green]
Lyall Bay	Lyall Bay	2.84	93	27	[orange]	[green]	N.A.	N.A.	No data	No data	[green]	[green]
East Coast	S'east coast	2.93	44	13	[green]	[green]	N.A.	N.A.	No data	No data	No data	No data
	Seatoun/ Karaka				[orange]	[green]	N.A.	N.A.	No data	No data	No data	No data
	Crawford				[green]	[green]	N.A.	N.A.	No data	No data	No data	No data
Evans Bay	Miramar/ Strathmore	4.40	92	108	[orange]	[green]	N.A.	N.A.	No data	No data	[red]	[red]
	Kilbirnie/ Rongotai	1.75	92		[orange]	[green]	N.A.	N.A.	No data	No data	[red]	[red]
	Hataitai	1.39	83		[orange]	[green]	N.A.	N.A.	No data	No data	No data	No data
	Grafton-Rata	0.84	82		[green]	[green]	N.A.	N.A.	No data	No data	No data	No data
Lambton	Oriental Bay	0.49	97	165	[green]	[green]	N.A.	N.A.	No data	No data	No data	No data
	Southern CBD	8.23	82		[green]	[green]	N.A.	N.A.	No data	No data	[red]	[red]
	Northern CBD	4.94	86		N.A.	No data	N.A.	N.A.	No data	No data	[red]	[red]
Kaiwhara-whara	Kaiwhara-whara	16.60	56	86	N.A.	[green]	[orange]	[red]	[red]	[red]	[green]	[red]

Catchment	Sub-catchment	Area (km²)	% Urban	S/W pipe length (km)	Primary contact recreation[1]	*E. coli* <1000 cfu/100 ml[2]	WQI[3]	MCI[4]	Water[5] Cu	Water[5] Zn	Sediment[6] Cu	Sediment[6] Zn
North harbour	Onslow	15.84	67	104	N.A.	No data	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
	Ngauranga				N.A.		No data					
	Horokiwi				N.A.	No data	No data	No data	No data	No data	No data	No data
Korokoro	Korokoro	15.70	2.6	4.9	N.A.		No data		No data	No data	No data	No data
Waiwhetu	Waiwhetu	18.65	59	120	N.A.							
Hutt - Spe	Speedys	11.61	12	7.5	N.A.		No data	No data	No data	No data	No data	No data
Hutt - Hul	Hulls Creek	16.58	43	30	N.A.		No data		No data	No data		
Hutt - Sto	Stokes Valley	11.96	39	52	N.A.		No data	No data	No data	No data		
Hutt River	Hutt - Lower	199	26	362							No data	No data
	Opahu Stm				N.A		No data	No data				
	Hutt - Upper										No data	No data
	Hutt - Headwater								No data	No data	No data	No data
Hutt -Wha	Whakatiki	81.84	0.5	1.9	N.A.				No data	No data	No data	No data
Hutt - Aka	Akatarawa	116.42	0.06	0.8					No data	No data	No data	No data
Hutt -Man	Mangaroa	104.10	0.89	3.9	N.A.				No data	No data	No data	No data
Hutt - Pak	Pakuratahi	81.38	0.00	0.0					No data	No data	No data	No data
Petone Beach	Petone	-	-	-			N.A	N.A	No data	No data		
Hutt Estuary	Hutt	655	12	578	No data		N.A	N.A	No data	No data		
East-bourne	Eastbourne	19.37	18	20			N.A	N.A	No data	No data		
Wainui-omata River	Black Creek	18.44	44	78	N.A.	N.A.	No data		No data	No data		
	Wainuiomata-iti	17.38	0.00	0.4	No data	No data	No data	No data	No data	No data	No data	No data
	Wainuiomata	57.85	3.1	12.4					No data	No data	No data	No data
	Morton	40.06	0.5	0.7	No data				No data	No data	No data	No data
Taupo	Taupo	10.58	7.5	5.9	Pauatahanui Inlet		No data	No data			No data	No data
Kakaho	Kakaho	17.76	9.6	14.1		No data	No data	No data	No data	No data	No data	No data
Horokiri	Horokiri	41.02	0.0	0.0					No data	No data		
Pauatahanui	Pauatahanui	41.56	2.8	13.5					No data	No data		
Duck	Duck/Browns	10.03	33	64			No data					
Porirua	Onepoto	10.71	67	367	Onepoto Inlet	Onepoto drain	No data	No data			No data	No data
	Porirua	31.59	59									
	Paparangi	8.99	12			No data	No data	No data	No data	No data	No data	No data
	Churton	15.25	61			No data	No data	No data				
Porirua coast	Porirua coast	14.4	16	24	Titahi Bay Plimmerton Beach	Stream southern Titahi Bay	No data	No data	No data	No data	No data	No data

Notes:

1. Primary contact recreation suitability for recreation grade (SFRG): green = good/very good, amber = fair, red = poor.

2. NPS-FM "national bottom line" for secondary contact recreations green = <1000 *E.coli* per 100ml, red >1000 *E. coli* per 100ml

3. WQI = GWRC water quality index: green = good/excellent, amber = fair, red = poor.

4. MCI = macroinvertebrate community index; green = >100, amber = <100 but >80, red = <80

5. Water concentrations of Cu or Zn: green = less than ANZECC (2000) 95% trigger, red = greater than 95% trigger.

6. Sediment concentrations of Cu or Zn: green = less than ANZECC (2000) ISQG-Low, amber = greater that ISQG-Low but less than ISQG-High, red = greater than ISQG-High

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Appendices

Appendix A Water quality guideline values

The water quality guideline values used in this report (Table A-1) generally follow the approach outlined by Milne & Morar (2017). In most instances the guideline values used are the ANZECC (2000) 'default' trigger values for lowland aquatic ecosystems or (chronic) toxicity. The trigger values for lowland aquatic ecosystems are intended to be compared against the median values from independent samples at a site. As outlined by Perrie et al (2012) these trigger values are not legal standards and breaches do not necessarily mean an adverse effect would result (i.e., they are not effects based). Rather, they can be considered 'nominal thresholds' that provide an 'early warning' mechanism to alert resource managers to a potential problem or emerging change that may warrant site specific investigation or remedial action (ANZECC 2000).

Table A-1: Water quality guideline values

Variable	Guideline value	Reference
Water temperature (°C)	≤19	Quinn and Hickey (1990) & Hay et al (2007
Dissolved oxygen (%sat)	≥80	RMA 1991 Third Schedule
pH	6.5-9.0	ANZECC (1992)
Visual clarity (m)	≥1.6	MfE (1994) – guideline for recreation
Turbidity (NTU)	annual median ≤5.6	ANZECC (2000) lowland TV
Nitrate-nitrogen (mg/L)	annual median ≤0.444	ANZECC (2000) lowland TV
Nitrate-nitrogen (mg/L)	annual median <6.9	NPS-FM national bottom line
Ammoniacal nitrogen (mg/L)	annual median ≤0.021	ANZECC (2000) lowland TV
	annual median <1.3	NPS-FM national bottom line
	Varies	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved inorganic nitrogen (mg/L)	annual median ≤0.465	ANZECC (2000) by addition of the nitrate, nitrite & ammonia TVs
Total nitrogen (mg/L)	annual median ≤0.614	ANZECC (2000) lowland TV
Dissolved reactive phosphorus (mg/L)	annual median ≤0.010	ANZECC (2000) lowland TV
Total phosphorus (mg/L)	annual median ≤0.033	ANZECC (2000) lowland TV
E. coli. (cfu/100 ml)	95th percentile ≤540	PNRP Primary contact recreation (rivers and estuaries)
E. coli. (cfu/100 ml)	annual median <1000	PNRP secondary contact rec. & NPS-FM National bottom line
Enterococci (cfu/100ml)	95Th percentile ≤ 500	PNRP Primary contact recreation (coastal waters)
Dissolved arsenic (mg/L)	annual median <0.0013	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved boron (mg/L)	annual median <0.37	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved cadmium (mg/L)	annual median <0.0002	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved copper (mg/L)	annual median <0.0014	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved chromium (mg/L)	annual median< 0.001	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved lead (mg/L)	annual median <0.0034	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved nickel (mg/L)	annual median <0.011	ANZECC (2000) freshwater toxicity TV (95% protection level)
Dissolved zinc (mg/L)	annual median <0.008	ANZECC (2000) freshwater toxicity TV (95% protection level)
MCI	3 year median ≥100 3 year median ≥110	PNRP aquatic ecosystem outcome for small lowland streams PNRP aquatic ecosystem outcome for large lowland rivers

Appendix B Freshwater recreational water quality results

The freshwater recreational water quality monitoring programme in the Wellington region is a joint effort involving GWRC, the Kapiti Coast District Council, PCC, Hutt City Council, Wellington City Council and Wellington Water. The programme includes 24 river sites which are recognised freshwater contact recreation areas including 7 sites in the Hutt River catchment and 1 in the Wainuiomata River catchment. There are no freshwater recreational water quality sites in the Porirua area where the watercourses are mostly small streams.

The recreational monitoring programme is conducted in accordance with the MfF/MoH recreational water quality guidelines (MfE/MoH, 2003). The guidelines provide trigger values which underpin a three-tier management framework analogous to traffic lights (Green/Surveillance, Amber/Alert and Red/Action).

The guidelines also outline a process to grade the suitability for recreational use (SFRG) of coastal waters from a public health perspective. This includes a sanitary Inspection Category (SIC) and Microbiological Assessment Category (MAC).

The SIC allows the principal source of faecal contamination in a catchment (e.g. sewage overflow, stormwater discharges, agricultural runoff, wildlife, etc.) to be identified and assigns a category (value) according to risk. This value is 'very high', 'high', 'moderate', 'low' or 'very low', and is found for a specific water body by use of a SIC flow chart. The MAC component of the SFRG is based on the 95th percentile of sample results from a five year period (typically around 100 data points). MAC are updated each year at the end of the bathing season. There are five SFRGs ranging from 'very good', to 'very poor' with risk to human health from contact with contaminated water increasing as the grades decline.

Table C1: Freshwater microbiological water quality results for the 2015/16 summer. The Microbiological Assessment Category (MAC) values and Suitability for Recreation Grades (SGRGs) have been determined from the 2011/12 to 2015/16 microbiological water quality results (Morar & Greenfeild, 2016)

Bathing Sites	No. sample results in 2015-2016 season (*E. coli.* cfu/100 ml)				Beach grading (2011/12-2015/16 data)		
	n	Surveillance (≤ 140)	Alert (141-280)	Action (>280)	SIC grade	MAC grade (95th %ile)	2015/16 SFRG
Pakuratahi – Hutt Forks	20	19	1	0	moderate	B (253)	Good
Akatarawa – Hutt Confluence	5	5	0	0	moderate	D (570)	Poor
Hutt - Birchville	20	20	0	0	moderate	C (350)	Fair
Hutt – Maoribank Cr	20	20	0	0	moderate	B (200)	Good
Hutt – Poets Pk	20	20	0	0	low	B (159)	Good
Hutt - Silverstream	20	20	0	0	moderate	C (440)	Fair
Hutt – Melling Bridge	20	19	1	0	moderate	D (835)	Poor
Wainuiomata – RP Park	20	19	0	1	moderate	D (770)	Poor

Appendix C Coastal recreational water quality results

GWRC's recreational water quality monitoring programme includes 63 coastal sites which are monitored once each week during the bathing season between mid-November and 31 March. On each sampling occasion a single water sample is collected from just below the water surface in 0.5m water depth and analysed for enterococci indicator bacteria. Weather observations and daily rainfall records are also recorded.

The results for the 2015/16 summer are summarised in Tables C-1, C-2 and C-3 for the Porirua, Wellington and Eastern Bays, respectively. Table C-4 presents summary statistics for faecal coliform counts for all water quality monitoring conducted during the year to June 2016 at a Porirua Harbour and Wellington Harbour recreational shellfish gathering sites. The Porirua Harbour Rowing Club site and Wellington Harbour at Sorrento Bay both failed to achieve the MfE/MoH (2003) median threshold (14 MPN/100 ml) or 90%ile threshold (43 MPN/100 ml)

Table C-1 Microbiological water quality results for the 2015 summer. The Microbiological Assessment Category (MAC) values and Suitability for Recreation Grades (SGRGs) have been determined from the 2011/12 to 2015/16 microbiological water quality results (from Morar & Greenfeild, 2016)

Coastal Sites	No. sample results in 2015-2016 season (Enterococci cfu/100 ml)				Beach grading (2011/12-2015/16 data)		
	n	Surveillance (≤ 140)	Alert (141-280)	Action (>280)	SIC grade	MAC grade (95th %ile)	2015/16 SFRG
Pukerua Bay	20	19	1	0	moderate	B (180)	good
Karehana –Cluny Rd	20	20	0	0	moderate	B (125)	good
Onehunga Bay	18	18	0	0	low	B (82)	good
Plimmerton – Bath St	20	17	1	2	moderate	D (530)	poor
Plimmerton - South	20	18	0	2	moderate	D (825)	poor
Pauatahanui – Water ski club	20	20	0	0	moderate	C (205)	fair
Pauatahanui – Paremata. Br	20	20	0	0	moderate	B (175)	good
Porirua – Rowing Club	20	19	1	0	moderate	D (820)	poor
Titahi Bay - Dr	20	18	1	1	moderate	C (235)	fair
Titahi Bay – Toms Rd	20	20	0	0	moderate	C (255)	fair
Titahi Bay – Access Rd	20	18	1	1	moderate	D (630)	poor

Table C-2: Wellington City microbiological water quality results for the 2015/16 summer. The Microbiological Assessment Category (MAC) values and Suitability for Recreation Grades (SGRGs) have been determined from the 2011/12 to 2015/16 microbiological water quality results (Morar & Greenfield, 2016)

Bathing Site	No. sample results in 2015-2016 season (*Enterococci* cfu/100 ml)				Beach grading (2011/12-2015/16 data)		
	n	Surveillance (≤ 140)	Alert (141-280)	Action (>280)	SIC grade	MAC grade (95th %ile)	2015/16 SFRG
Aotea Lagoon	20	20	0	0	Moderate	B (98)	Good
Taranaki St Dive Platform[1]	20	19	0	1	N/A	C (210)	N/A
Oriental - Freyberg	20	20	0	0	Moderate	B (76)	Good
Oriental – Well	20	20	0	0	Moderate	B (125)	Good
Oriental - Rotunda	20	20	0	0	Moderate	B (130)	Good
Balaena Bay	20	20	0	0	Low	B (70)	Good
Hataitai Beach	20	20	0	0	Moderate	C (315)	Fair
Shark Bay	20	19	0	1	Moderate	C (460)	Fair
Mahanga Bay	20	20	0	0	Low	B (109)	Good

Bathing Site	No. sample results in 2015-2016 season (*Enterococci* cfu/100 ml)				Beach grading (2011/12-2015/16 data)		
	n	Surveillance (≤ 140)	Alert (141-280)	Action (>280)	SIC grade	MAC grade (95th %ile)	2015/16 SFRG
Scorching Bay	20	20	0	0	Low	C (265)	Fair
Worser Bay	20	20	0	0	Moderate	B (185)	Good↑
Seatoun – Wharf	20	19	0	1	Moderate	C (270)	Fair
Seatoun - Inglis St	20	19	0	1	Moderate	C (250)	Fair
Breaker Bay	20	20	0	0	Low	B (42)	Good↓
Lyall - Tirangi Rd	20	17	1	2	Moderate	C (405)	Fair
Lyall - Onepu Rd	20	19	0	1	Moderate	B (140)	Good
Lyall - Queens Dr	20	19	0	1	Moderate	C (215)	Fair↓
Princess Bay	20	20	0	0	Low	A (28)	Very Good
Island - Reef St	20	20	0	0	Moderate	D (1,440)	Poor
Island -Surf Club	20	19	0	1	Moderate	D (620)	Poor
Island - Derwent St	20	20	0	0	Moderate	D (700)	Poor
Owhiro Bay	20	19	0	1	Moderate	D (2,650)	Poor

Table C-3 Petone & Eastbourne microbiological water quality results for the 2015/16 summer. The Microbiological Assessment Category (MAC) values and Suitability for Recreation Grades (SGRGs) have been determined from the 2011/12 to 2015/16 microbiological water quality results (Morar & Greenfeild, 2016)

Bathing Site	No. sample results in 2015-2016 season (*Enterococci* cfu/100 ml)				Beach grading (2011/12-2015/16 data)		
	n	Surveillance (≤ 140)	Alert (141-280)	Action (>280)	SIC grade	MAC grade (95th %ile)	2015/16 SFRG
Petone - Water Ski Club	20	19	1	0	Moderate	C (335)	Fair
Petone - Sydney St	20	19	0	1	Moderate	C (285)	Fair
Petone – Kiosk	20	19	1	0	Moderate	C (330)	Fair
Sorrento Bay	20	20	0	0	Low	C (375)	Fair
Lowry - Cheviot Rd	20	19	0	1	Moderate	C (335)	Fair
York Bay	20	20	0	0	Low	B (94)	Good
Days – Wellesley	20	20	0	0	Moderate	B (130)	Good
Days – Wharf	20	20	0	0	Moderate	B (100)	Good
Days - Moana Rd	20	20	0	0	Moderate	B (130)	Good
Rona - CB Pk	20	20	0	0	Moderate	C (475)	Fair↑
Rona – Wharf	20	20	0	0	Moderate	C (240)	Fair
Robinson - HWS Rec Gd	20	19	0	1	Moderate	B (185)	Good
Robinson - Nikau St	20	19	0	1	Moderate	B (195)	Good

Table C-4: Analysis of faecal coliform counts obtained from routine weekly monitoring during the 2015/16 summer months against the MfE/MoH (2003) guideline criteria for recreational shellfish-gathering waters. Values in bold font indicate non-compliance with guideline criteria (Morar & Greenfield, 2016)

Site	Median (cfu/100 ml)	Maximum (cfu/100 ml)	No. (and percentage) of results >43 cfu/100 ml	Total no. of samples
Porirua				

Porirua Harbour – Rowing Club	**16**	240	5 (**25%**)	20
Wellington City				
Shark Bay	2	460	2 (10%)	20
Mahanga Bay	2	150	1 (5%)	20
Hutt				
Sorrento Bay	2	150	3 (**15%**)	20

Appendix D RSoE water quality monitoring results

GWRC's River State of the Environment (RSoE) monitoring programme includes monthly monitoring of water quality, periphyton cover and sediment deposition at 53 river and stream sites across the Wellington Region, including sites on the Horokiri, Pauatahanui, Porirua, Makara, Karori, Kaiwharawhara and Waiwhetu streams, as well as the Hutt, Pakuratahi, Mangaroa, Akatarawa, Whakatikei and Wainuiomata Rivers (Table D-1). Samples collected at these locations are tested for a range of physico-chemical and microbiological variables.

A water quality index (WQI) is used in Table F-2 to classify water quality at each site as either 'excellent', 'good', 'fair' or 'poor'. The WQI is derived from the median values of the following six variables: visual clarity (black disc), dissolved oxygen (% saturation), dissolved reactive phosphorus (DRP), ammoniacal nitrogen, nitrate-nitrite nitrogen (NNN) and *Escherichia coli* (*E. coli.*).

For the 2015/16 year all four RSoE sites in the Porirua Harbour catchment were classified as having "fair" water quality, that is, the median values of 3 or 4 variables comply with guideline values (GWRC guidelines values are included in Appendix F). All four sites consistently exceeded the *E. coli.* guidelines and 3 of the 4 sites also exceeded the NNN and DRP guidelines. All four sites were ranked for the lower 40% for the region, and rankings were inversely related to % urban land cover.

In the Wellington Harbour catchment the urban sites at Karori and Kaiwharawhara were graded fair (due to elevated *E. coli.*, NNN and DRP) while the heavily urbanised Waiwhetu site was graded poor (due elevated *E. coli.*, NNN and DRP; reduced DO and clarity). Over the same period all sites Hutt River catchment were graded excellent, with the exception of Mangaroa River site which has more than 30 production pasture land use and which was graded fair. . The WQI regional rankings were inversely related to % urban land cover (or % pasture in the case of the Mangaroa River site).

Summary statistics for all routine water quality determinands are presented in Tables D-3 to D-20 (from Morar, Perrie & Greenfield (2016).

Table D-1: GWRC RSoE monitoring sites in the Wellington area

Site no	Site name	NZTM site coordinates		Substrate (hard or soft bottomed)	REC	Dominant land cover	% Urban land cover
		Easting	Northing				
RS13	Horokiri S at Snodgrass	1761804	5450653	Hard	CW/L/HS/P	Pasture	0.0
RS14	Pauatahanui S at Elmwood	1761097	5446783	Hard	CW/L/HS/P	Pasture	1.3
RS15	Porirua S at Glenside*	1753289	5438364	Hard	CW/L/HS/U	Urban	27.6
RS16	Porirua S at Wall Park *	1754366	5443031	Hard	WW/L/HS/U	Urban	30.6
RS18	Karori S at Makara Peak M.B.P*	1744213	5426874	Hard	CW/L/HS/U	Urban	50.7
RS19	Kaiwharawhara S at Ngaio G.*	1749069	5431077	Hard	CW/L/HS/U	Urban	38.6
RS20	Hutt R at Te Marua Intake Site	1780071	5450158	Hard	CX/H/HS/IF	Indigenous forest	0.1
RS21	Hutt R opp. Manor Park G.C.*	1766679	5442285	Hard	CW/H/HS/IF	Indigenous forest	4.2
RS22	Hutt R at Boulcott*	1760858	5437486	Hard	CW/L/HS/IF	Indigenous forest	6.1
RS23	Pakuratahi R 50m d/s Farm Ck	1784607	5451677	Hard	CX/H/HS/IF	Indigenous forest	0.0
RS24	Mangaroa R at Te Marua	1778543	5448643	Hard	CW/L/HS/P	Pasture	1.3
RS25	Akatarawa R at Hutt confl.	1776183	5449184	Hard	CW/L/HS/IF	Indigenous forest	0.0
RS26	Whakatikei R at Riverstone	1772256	5446748	Hard	CW/L/HS/S	Indigenous forest	0.1
RS57	Waiwhetu S at Whites Line East	1760977	5434510	Soft	WW/L/HS/U	Urban	52.3
RS28	Wainuiomata R at Manuka Track	1768242	5430634	Hard	CW/L/HS/IF	Indigenous forest	0.0
RS29	Wainuiomata R d/s of White Br	1757316	5415724	Hard	CW/L/HS/IF	Indigenous forest	6.2

Table D-2: Water Quality Index grades for RSoE sites in the Wellington Harbour/Hutt Valley catchments (July 2015-June 2016) based on compliance of median dissolved oxygen (DO), visual clarity (clarity), *E. coli.*, nitrate-nitrite N (NNN), ammoniacal nitrogen (Amm. N), and dissolved reactive phosphorus (DRP) values with guideline values.

Site no	Site name	Guideline compliance (median values)						WQI Grade	Regional rank (of 53)
		DO	Clarity	*E. coli.*	NNN	Amm. N	DRP		
RS13	Horokiri S at Snodgrass	✓	✓	×	×	✓	✓	Fair	34
RS14	Pauatahanui S at Elmwood	✓	✓	×	✓	✓	×	Fair	36
RS15	Porirua S at Glenside*	✓	✓	×	×	✓	×	Fair	39
RS16	Porirua S at Wall Park *	✓	✓	×	×	✓	×	Fair	45
RS18	Karori S at Makara Peak M.B.P*	✓	✓	×	×	✓	×	Fair	46
RS19	Kaiwharawhara S at Ngaio G.*	✓	✓	×	×	✓	×	Fair	44
RS20	Hutt R at Te Marua Intake Site	✓	✓	✓	✓	✓	✓	Excellent	1
RS21	Hutt R opp. Manor Park G.C.*	✓	✓	✓	✓	✓	✓	Excellent	17
RS22	Hutt R at Boulcott*	✓	✓	✓	✓	✓	✓	Excellent	16
RS23	Pakuratahi R 50m d/s Farm Ck	✓	✓	✓	✓	✓	✓	Excellent	5
RS24	Mangaroa R at Te Marua	✓	✓	×	×	✓	✓	Fair	35
RS25	Akatarawa R at Hutt confl.	✓	✓	✓	✓	✓	✓	Excellent	3=
RS26	Whakatikei R at Riverstone	✓	✓	✓	✓	✓	✓	Excellent	3=
RS57	Waiwhetu S at Whites Line East	×	×	×	✓	×	×	Poor	50
RS28	Wainuiomata R at Manuka Track	✓	✓	✓	✓	✓	×	Good	25
RS29	Wainuiomata R d/s of White Br	✓	✓	✓	✓	✓	×	Good	27

Table D-3: Water temperature (°C)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	*n*
RS13	Horokiri S at Snodgrass	12.6	6.2	7.4	18.1	18.3	11
RS14	Pauatahanui S at Elmwood Br	13.0	5.1	6.7	17.9	18.1	12
RS15	Porirua S at Glenside	14.0	5.9	6.8	17.9	18.0	12
RS16	Porirua S at Wall Park (Milk Depot)	14.5	5.8	6.7	18.7	18.9	12
RS17	Makara S at Kennels	15.8	5.6	6.3	20.2	20.9	12
RS18	Karori S at Makara Peak	13.6	8.4	8.9	18.2	18.5	12
RS19	Kaiwharawhara S at Ngaio Gorge	14.2	7.6	7.9	19.4	20.6	12
RS20	Hutt R at Te Marua Intake Site	11.7	6.2	6.3	18.2	18.5	12
RS21	Hutt R opp. Manor Park G.C.	14.0	8.1	8.2	20.7	22.1	12
RS22	Hutt R at Boulcott	14.3	8.1	8.4	21.4	22.6	12
RS23	Pakuratahi R 50m d/s Farm Ck	12.6	6.8	7.0	17.8	18.9	12
RS24	Mangaroa R at Te Marua	13.2	7.3	7.6	18.1	18.2	12
RS25	Akatarawa R at Hutt confl.	12.3	6.8	7.0	18.8	19.2	12
RS26	Whakatikei R at Riverstone	12.3	7.2	7.3	18.5	18.7	12
RS28	Wainuiomata R at Manuka Track	10.9	6.7	7.4	13.9	14.6	12
RS29	Wainuiomata R d/s of White Br	14.3	9.0	9.2	20.1	21.9	12
RS57	Waiwhetu S at Whites Line East	13.8	9.7	9.9	19.1	20.2	12

Table D-4: Dissolved oxygen (% saturation)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	*n**
RS13	Horokiri S at Snodgrass	100.6	92.7	93.2	110.1	114.1	11
RS14	Pauatahanui S at Elmwood Br	96.1	82.1	82.4	100.0	101.4	12
RS15	Porirua S at Glenside	105.1	99.7	100.2	114.2	116.8	11
RS16	Porirua S at Wall Park (Milk Depot)	102.5	91.8	96.3	114.0	114.7	12
RS17	Makara S at Kennels	99.3	83.3	87.4	107.6	110.6	11
RS18	Karori S at Makara Peak	99.3	89.3	92.4	104.8	104.9	11
RS19	Kaiwharawhara S at Ngaio Gorge	101.9	96.4	98.0	111.1	113.8	11
RS20	Hutt R at Te Marua Intake Site	101.1	99.7	100.1	103.5	104.5	12
RS21	Hutt R opp. Manor Park G.C.	103.8	101.1	101.7	114.0	119.7	12
RS22	Hutt R at Boulcott	102.9	99.8	100.1	111.3	113.8	12
RS23	Pakuratahi R 50m d/s Farm Ck	97.1	94.8	94.8	102.2	103.4	12
RS24	Mangaroa R at Te Marua	105.1	98.9	99.0	115.1	119.6	12
RS25	Akatarawa R at Hutt confl.	101.7	101.0	101.1	104.0	104.2	12
RS26	Whakatikei R at Riverstone	103.1	101.3	101.5	106.6	107.0	12
RS28	Wainuiomata R at Manuka Track	98.9	95.7	95.8	102.1	102.8	12
RS29	Wainuiomata R d/s of White Br	101.9	89.6	90.3	117.5	125.0	12
RS57	Waiwhetu S at Whites Line East	78.6	38.0	40.7	135.5	148.5	12

Table D-5: Dissolved oxygen (mg/L)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	*n**
RS13	Horokiri S at Snodgrass	10.7	8.8	8.8	13.2	13.3	11
RS14	Pauatahanui S at Elmwood Br	10.1	7.8	7.8	12.2	12.6	12
RS15	Porirua S at Glenside	11.1	9.6	9.9	12.4	12.7	11
RS16	Porirua S at Wall Park (Milk Depot)	10.9	8.5	9.3	12.5	12.9	12
RS17	Makara S at Kennels	9.7	7.6	8.0	12.4	12.7	11
RS18	Karori S at Makara Peak	10.1	9.2	9.3	11.6	11.7	11
RS19	Kaiwharawhara S at Ngaio Gorge	10.5	9.7	9.7	12.0	12.2	11
RS20	Hutt R at Te Marua Intake Site	10.9	9.7	9.7	12.4	12.5	12
RS21	Hutt R opp. Manor Park G.C.	10.8	9.9	10.0	12.1	12.2	12
RS22	Hutt R at Boulcott	10.4	9.4	9.5	11.9	12.0	12
RS23	Pakuratahi R 50m d/s Farm Ck	10.3	9.2	9.4	12.0	12.1	12
RS24	Mangaroa R at Te Marua	11.0	10.5	10.5	11.8	12.0	12
RS25	Akatarawa R at Hutt confl.	10.8	9.6	9.7	12.4	12.5	12
RS26	Whakatikei R at Riverstone	10.8	9.9	10.0	12.4	12.4	12
RS28	Wainuiomata R at Manuka Track	11.1	9.7	9.9	12.0	12.4	12
RS29	Wainuiomata R d/s of White Br	10.8	7.9	8.9	11.9	12.2	12
RS57	Waiwhetu S at Whites Line East	8.4	3.7	4.0	11.9	12.1	12

Table D-6: pH – field meter

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	*n**
RS13	Horokiri S at Snodgrass	7.3	7.0	7.1	7.5	7.5	11
RS14	Pauatahanui S at Elmwood Br	7.3	6.8	6.8	7.6	7.7	12
RS15	Porirua S at Glenside	7.5	7.3	7.3	8.0	8.1	12
RS16	Porirua S at Wall Park (Milk	7.3	7.0	7.1	8.0	8.2	12
RS17	Makara S at Kennels	7.3	7.1	7.1	7.6	7.7	12
RS18	Karori S at Makara Peak	7.1	6.8	6.9	7.4	7.4	12
RS19	Kaiwharawhara S at Ngaio Gorge	7.6	7.4	7.5	8.0	8.2	11
RS20	Hutt R at Te Marua Intake Site	7.1	6.8	6.8	7.4	7.5	12
RS21	Hutt R opp. Manor Park G.C.	7.1	6.9	6.9	7.4	7.5	12
RS22	Hutt R at Boulcott	7.0	6.7	6.8	7.3	7.3	12
RS23	Pakuratahi R 50m d/s Farm Ck	6.7	6.1	6.3	7.0	7.0	12
RS24	Mangaroa R at Te Marua	7.1	6.6	6.7	7.4	7.6	12
RS25	Akatarawa R at Hutt confl.	7.0	6.6	6.8	7.5	7.6	12
RS26	Whakatikei R at Riverstone	7.3	6.8	6.9	7.7	7.7	12
RS28	Wainuiomata R at Manuka Track	7.2	6.7	6.9	7.4	7.4	11
RS29	Wainuiomata R d/s of White Br	7.3	6.9	7.0	8.1	8.3	11
RS57	Waiwhetu S at Whites Line East	6.6	6.3	6.3	7.0	7.0	11

Table D-7: Visual clarity (m)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	2.62	1.71	4.14	11
RS14	Pauatahanui S at Elmwood Br	2.07	1.27	3.03	12
RS15	Porirua S at Glenside	3.07	0.46	5.39	12
RS16	Porirua S at Wall Park (Milk Depot)	2.64	0.23	5.42	12
RS17	Makara S at Kennels	1.64	0.32	2.59	12
RS18	Karori S at Makara Peak	3.76	0.94	6.80	12
RS19	Kaiwharawhara S at Ngaio Gorge	5.64	0.66	8.00	11
RS20	Hutt R at Te Marua Intake Site	5.61	1.67	8.70	12
RS21	Hutt R opp. Manor Park G.C.	4.38	1.01	8.25	12
RS22	Hutt R at Boulcott	4.60	0.76	8.04	12
RS23	Pakuratahi R 50m d/s Farm Ck	5.84	1.96	9.98	12
RS24	Mangaroa R at Te Marua	2.26	0.92	3.86	12
RS25	Akatarawa R at Hutt confl.	5.68	3.17	8.45	12
RS26	Whakatikei R at Riverstone	5.47	3.25	7.52	12
RS28	Wainuiomata R at Manuka Track	2.90	2.22	3.53	12
RS29	Wainuiomata R d/s of White Br	2.92	1.02	4.96	12
RS57	Waiwhetu S at Whites Line East	0.95	0.24	2.04	12

Table D-8: Turbidity (NTU)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	1.3	0.5	2.8	11
RS14	Pauatahanui S at Elmwood Br	1.9	1.1	5.4	12
RS15	Porirua S at Glenside	1.3	0.7	16.4	12
RS16	Porirua S at Wall Park (Milk Depot)	2.0	1.3	82.0	12
RS17	Makara S at Kennels	3.0	1.9	32.0	12
RS18	Karori S at Makara Peak	1.0	0.5	6.1	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.8	0.3	11.4	12
RS20	Hutt R at Te Marua Intake Site	0.6	0.3	2.3	12
RS21	Hutt R opp. Manor Park G.C.	0.7	0.4	5.3	12
RS22	Hutt R at Boulcott	0.6	0.4	11.1	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.5	0.2	2.0	12
RS24	Mangaroa R at Te Marua	1.3	0.6	5.4	12
RS25	Akatarawa R at Hutt confl.	0.3	0.3	1.7	12
RS26	Whakatikei R at Riverstone	0.5	0.3	1.2	12
RS28	Wainuiomata R at Manuka Track	0.8	0.6	1.6	12
RS29	Wainuiomata R d/s of White Br	1.2	0.7	4.3	12
RS57	Waiwhetu S at Whites Line East	6.2	2.3	50.0	12

Table D-9: Total suspended solids (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n*
RS13	Horokiri S at Snodgrass	1.0	<2	<2	11
RS14	Pauatahanui S at Elmwood Br	1.0	<2	4.0	12
RS15	Porirua S at Glenside	1.0	<2	14.0	12
RS16	Porirua S at Wall Park (Milk Depot)	1.0	<2	230.0	12
RS21	Hutt R opp. Manor Park G.C.	1.0	<2	3.0	12
RS22	Hutt R at Boulcott	1.0	<2	5.0	12

Table D-10: Suspended sediment concentration (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n*
RS13	Horokiri S at Snodgrass	5.0	<10	<11	11
RS14	Pauatahanui S at Elmwood Br	5.3	<10	<11	12
RS15	Porirua S at Glenside	5.0	<10	<11	12
RS16	Porirua S at Wall Park (Milk Depot)	5.0	<10	250.0	12
RS21	Hutt R opp. Manor Park G.C.	5.0	<10	<11	12
RS22	Hutt R at Boulcott	5.0	<10	<11	11

Table D-11: Electrical conductivity – field meter (μS/cm)

Site no.	Site name	Median	Minimum	5th percentile	95th percentile	Maximum	*n**
RS13	Horokiri S at Snodgrass	201	184	189	213	214	11
RS14	Pauatahanui S at Elmwood Br	182	167	170	209	210	12
RS15	Porirua S at Glenside	268	181	193	276	278	12
RS16	Porirua S at Wall Park (Milk Depot)	260	185	202	276	278	12
RS17	Makara S at Kennels	299	235	251	351	362	12
RS18	Karori S at Makara Peak	231	195	201	243	248	12
RS19	Kaiwharawhara S at Ngaio Gorge	305	236	260	315	315	12
RS20	Hutt R at Te Marua Intake Site	76	66	66	86	86	12
RS21	Hutt R opp. Manor Park G.C.	97	79	82	109	110	12
RS22	Hutt R at Boulcott	97	87	87	112	113	12
RS23	Pakuratahi R 50m d/s Farm Ck	89	77	80	94	95	12
RS24	Mangaroa R at Te Marua	110	97	100	123	127	12
RS25	Akatarawa R at Hutt confl.	87	53	67	96	96	12
RS26	Whakatikei R at Riverstone	118	106	109	127	127	12
RS28	Wainuiomata R at Manuka Track	111	97	98	120	121	11
RS29	Wainuiomata R d/s of White Br	142	124	127	151	151	11
RS30	Orongorongo R at Orongorongo Stn	146	121	124	170	172	11
RS57	Waiwhetu S at Whites Line East	242	84	131	261	266	11

Table D-12: Total organic carbon (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	1.9	1.3	2.2	11
RS14	Pauatahanui S at Elmwood Br	3.1	2.6	5.7	12
RS15	Porirua S at Glenside	2.7	1.6	5.7	12
RS16	Porirua S at Wall Park (Milk Depot)	2.8	2.1	14.5	12
RS17	Makara S at Kennels	4.0	3.4	8.0	12
RS18	Karori S at Makara Peak	1.8	1.3	5.6	12
RS19	Kaiwharawhara S at Ngaio Gorge	2.7	2.0	4.7	12
RS20	Hutt R at Te Marua Intake Site	1.6	0.9	4.0	12
RS21	Hutt R opp. Manor Park G.C.	1.6	0.8	4.2	12
RS22	Hutt R at Boulcott	1.6	1.1	4.1	12
RS23	Pakuratahi R 50m d/s Farm Ck	1.8	1.2	4.5	12
RS24	Mangaroa R at Te Marua	3.8	1.4	8.5	12
RS25	Akatarawa R at Hutt confl.	1.7	0.8	2.6	12
RS26	Whakatikei R at Riverstone	1.4	0.8	2.2	12
RS28	Wainuiomata R at Manuka Track	1.6	1.2	3.7	12
RS29	Wainuiomata R d/s of White Br	1.6	0.7	2.2	12
RS57	Waiwhetu S at Whites Line East	2.8	1.4	10.0	12

Table D-13: Ammoniacal nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	0.003	<0.005	0.012	11
RS14	Pauatahanui S at Elmwood Br	0.009	<0.005	0.022	12
RS15	Porirua S at Glenside	0.003	<0.005	0.013	12
RS16	Porirua S at Wall Park (Milk Depot)	0.013	<0.005	0.089	12
RS17	Makara S at Kennels	0.010	<0.005	0.037	12
RS18	Karori S at Makara Peak	0.015	<0.005	0.034	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.003	<0.005	0.052	12
RS20	Hutt R at Te Marua Intake Site	0.003	<0.005	0.006	12
RS21	Hutt R opp. Manor Park G.C.	0.003	<0.005	0.009	12
RS22	Hutt R at Boulcott	0.003	<0.005	<0.005	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.003	<0.005	<0.005	12
RS24	Mangaroa R at Te Marua	0.003	<0.005	0.015	12
RS25	Akatarawa R at Hutt confl.	0.003	<0.005	<0.005	12
RS26	Whakatikei R at Riverstone	0.003	<0.005	0.006	12
RS28	Wainuiomata R at Manuka Track	0.003	<0.005	0.005	12
RS29	Wainuiomata R d/s of White Br	0.009	<0.005	0.013	12
RS57	Waiwhetu S at Whites Line East	0.068	<0.005	0.300	12

Table D-14: Nitrite-nitrate nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	0.640	0.070	0.970	11
RS14	Pauatahanui S at Elmwood Br	0.305	<0.001	0.720	12
RS15	Porirua S at Glenside	0.795	0.300	1.550	12
RS16	Porirua S at Wall Park (Milk Depot)	0.770	0.270	1.480	12
RS17	Makara S at Kennels	0.155	<0.001	1.120	12
RS18	Karori S at Makara Peak	1.300	0.960	1.600	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.195	0.940	1.490	12
RS20	Hutt R at Te Marua Intake Site	0.075	0.043	0.126	12
RS21	Hutt R opp. Manor Park G.C.	0.208	0.122	0.350	12
RS22	Hutt R at Boulcott	0.205	0.089	0.330	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.204	0.150	0.350	12
RS24	Mangaroa R at Te Marua	0.485	0.390	0.670	12
RS25	Akatarawa R at Hutt confl.	0.067	0.012	0.177	12
RS26	Whakatikei R at Riverstone	0.118	0.027	0.300	12
RS28	Wainuiomata R at Manuka Track	0.060	0.017	0.091	12
RS29	Wainuiomata R d/s of White Br	0.091	0.002	0.360	12
RS57	Waiwhetu S at Whites Line East	0.265	0.003	0.630	12

Table D-15: Total Kjeldahl nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	0.13	0.05	0.20	11
RS14	Pauatahanui S at Elmwood Br	0.19	0.13	0.28	12
RS15	Porirua S at Glenside	0.20	0.13	0.32	12
RS16	Porirua S at Wall Park (Milk Depot)	0.22	0.16	3.60	12
RS17	Makara S at Kennels	0.30	0.18	0.60	12
RS18	Karori S at Makara Peak	0.23	0.14	0.46	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.19	0.13	0.37	12
RS20	Hutt R at Te Marua Intake Site	0.05	<0.10	0.10	12
RS21	Hutt R opp. Manor Park G.C.	0.05	<0.10	0.15	12
RS22	Hutt R at Boulcott	0.05	<0.10	0.21	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.05	<0.10	0.14	12
RS24	Mangaroa R at Te Marua	0.16	<0.10	0.34	12
RS25	Akatarawa R at Hutt confl.	0.05	<0.10	<0.10	12
RS26	Whakatikei R at Riverstone	0.05	<0.10	<0.10	12
RS28	Wainuiomata R at Manuka Track	0.05	<0.10	0.11	12
RS29	Wainuiomata R d/s of White Br	0.08	<0.10	0.16	12
RS57	Waiwhetu S at Whites Line East	0.34	0.19	0.64	12

Table D-16: Total nitrogen (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	0.75	0.19	1.17	11
RS14	Pauatahanui S at Elmwood Br	0.51	0.16	0.97	12
RS15	Porirua S at Glenside	0.98	0.61	1.72	12
RS16	Porirua S at Wall Park (Milk Depot)	1.14	0.44	4.70	12
RS17	Makara S at Kennels	0.46	0.25	1.42	12
RS18	Karori S at Makara Peak	1.52	1.33	1.76	12
RS19	Kaiwharawhara S at Ngaio Gorge	1.39	1.20	1.75	12
RS20	Hutt R at Te Marua Intake Site	0.15	0.11	0.20	12
RS21	Hutt R opp. Manor Park G.C.	0.28	0.20	0.50	12
RS22	Hutt R at Boulcott	0.29	0.20	0.54	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.29	0.22	0.45	12
RS24	Mangaroa R at Te Marua	0.65	0.48	0.87	12
RS25	Akatarawa R at Hutt confl.	0.13	<0.11	0.24	12
RS26	Whakatikei R at Riverstone	0.17	0.10	0.38	12
RS28	Wainuiomata R at Manuka Track	0.12	<0.11	0.18	12
RS29	Wainuiomata R d/s of White Br	0.19	<0.11	0.53	12
RS57	Waiwhetu S at Whites Line East	0.64	0.25	1.12	12

Table D-17: Dissolved reactive phosphorus (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	0.008	0.003	0.016	11
RS14	Pauatahanui S at Elmwood Br	0.014	0.008	0.021	12
RS15	Porirua S at Glenside	0.017	0.001	0.027	12
RS16	Porirua S at Wall Park (Milk Depot)	0.017	0.011	0.031	12
RS17	Makara S at Kennels	0.031	0.013	0.081	12
RS18	Karori S at Makara Peak	0.042	0.025	0.063	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.054	0.028	0.082	12
RS20	Hutt R at Te Marua Intake Site	0.004	0.002	0.005	12
RS21	Hutt R opp. Manor Park G.C.	0.003	<0.001	0.007	12
RS22	Hutt R at Boulcott	0.004	<0.001	0.007	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.004	0.002	0.005	12
RS24	Mangaroa R at Te Marua	0.008	0.002	0.013	12
RS25	Akatarawa R at Hutt confl.	0.003	0.002	0.006	12
RS26	Whakatikei R at Riverstone	0.008	0.006	0.011	12
RS28	Wainuiomata R at Manuka Track	0.012	0.009	0.014	12
RS29	Wainuiomata R d/s of White Br	0.011	0.008	0.015	12
RS57	Waiwhetu S at Whites Line East	0.026	0.014	0.052	12

Table D-18: Total phosphorus (mg/L)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	0.011	0.006	0.021	11
RS14	Pauatahanui S at Elmwood Br	0.024	0.013	0.041	12
RS15	Porirua S at Glenside	0.026	0.018	0.053	12
RS16	Porirua S at Wall Park (Milk Depot)	0.028	0.020	0.230	12
RS17	Makara S at Kennels	0.072	0.025	0.110	12
RS18	Karori S at Makara Peak	0.056	0.031	0.106	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.058	0.037	0.102	12
RS20	Hutt R at Te Marua Intake Site	0.006	<0.004	0.008	12
RS21	Hutt R opp. Manor Park G.C.	0.007	<0.004	0.014	12
RS22	Hutt R at Boulcott	0.008	<0.004	0.014	12
RS23	Pakuratahi R 50m d/s Farm Ck	0.007	<0.004	0.009	12
RS24	Mangaroa R at Te Marua	0.014	0.005	0.024	12
RS25	Akatarawa R at Hutt confl.	0.006	<0.004	0.009	12
RS26	Whakatikei R at Riverstone	0.010	0.005	0.015	12
RS28	Wainuiomata R at Manuka Track	0.013	0.011	0.016	12
RS29	Wainuiomata R d/s of White Br	0.019	0.010	0.023	12
RS57	Waiwhetu S at Whites Line East	0.053	0.024	0.154	12

Table D-19: *E. coli.* (cfu/100 ml)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	300	40	1,100	11
RS14	Pauatahanui S at Elmwood Br	185	93	360	12
RS15	Porirua S at Glenside	785	140	3,800	12
RS16	Porirua S at Wall Park (Milk Depot)	1,450	300	4,900	12
RS17	Makara S at Kennels	350	130	900	12
RS18	Karori S at Makara Peak	1,350	200	4,300	12
RS19	Kaiwharawhara S at Ngaio Gorge	600	60	4,700	12
RS20	Hutt R at Te Marua Intake Site	13	5	70	12
RS21	Hutt R opp. Manor Park G.C.	55	24	150	12
RS22	Hutt R at Boulcott	50	22	100	12
RS23	Pakuratahi R 50m d/s Farm Ck	65	16	220	12
RS24	Mangaroa R at Te Marua	160	60	650	12
RS25	Akatarawa R at Hutt confl.	35	11	90	12
RS26	Whakatikei R at Riverstone	16	8	32	12
RS28	Wainuiomata R at Manuka Track	4	<1	15	12
RS29	Wainuiomata R d/s of White Br	75	12	390	12
RS57	Waiwhetu S at Whites Line East	700	220	3,600	12

Table D-20: Faecal coliforms (cfu/100 ml)

Site no.	Site name	Median	Minimum	Maximum	*n**
RS13	Horokiri S at Snodgrass	360	60	1,200	11
RS14	Pauatahanui S at Elmwood Br	205	110	430	12
RS15	Porirua S at Glenside	830	210	3,800	12
RS16	Porirua S at Wall Park (Milk Depot)	1,800	300	11,000	12
RS17	Makara S at Kennels	410	130	900	12
RS18	Karori S at Makara Peak	1,600	200	5,500	12
RS19	Kaiwharawhara S at Ngaio Gorge	600	60	4,700	12
RS20	Hutt R at Te Marua Intake Site	14	5	80	12
RS21	Hutt R opp. Manor Park G.C.	85	24	200	12
RS22	Hutt R at Boulcott	73	27	110	12
RS23	Pakuratahi R 50m d/s Farm Ck	75	20	240	12
RS24	Mangaroa R at Te Marua	175	60	650	12
RS25	Akatarawa R at Hutt confl.	36	15	90	12
RS26	Whakatikei R at Riverstone	18	11	42	12
RS28	Wainuiomata R at Manuka Track	4	<1	16	12
RS29	Wainuiomata R d/s of White Br	85	12	470	12
RS57	Waiwhetu S at Whites Line East	850	260	4,300	12

Table D-21: Annual median E. coli (cfu/100ml) values for small urban streams

Site no.	Site name	2011/12	201/13	2013/14	2014/15	2015/16
RS13	Horokiri S at Snodgrass	360	260	465	395	300
RS14	Pauatahanui S at Elmwood Br	315	285	370	345	185
RS16	Porirua S at Wall Park (Milk Depot)	225	840	3200	1500	1450
RS18	Karori S at Makara Peak	1550	1950	1450	900	1350
RS19	Kaiwharawhara S at Ngaio Gorge	595	185	600	295	600
RS57	Waiwhetu S at Whites Line East	850	495	410	550	700

Table D-22: Summary of dissolved Cu (mg/L) concentrations measured at 7 RSoE sites between July 2015 and June 2016 (D.L.= detection limit). The percentages of samples exceeding the ANZECC (2000) default and hardness-modified trigger values (TVs) are also presented

Site no.	Site name	Median	Min	Maximum	*n*	*n* <D.L.	% of samples (*n*) or median compliance with ANZECC (2000)[1]	
							Default TV (≤ *0.0014*)	Hardness modified TV
RS15	Porirua S at Glenside	0.0009	0.0006	0.0015	12	0	8.3	0
RS16	Porirua S at Wall Park	0.0012	0.0007	0.0141	12	0	41.7	33.3
RS18	Karori S at Makara Peak	0.0017	0.0008	0.0131	12	0	75	41.7
RS19	Kaiwharawhara S at Ngaio Gorge	0.0015	0.0009	0.0033	12	0	58.3	16.7
RS21	Hutt R opp. Manor Park G.C.	0.0003	<0.000	0.0006	12	10	Med. complies	Med. complies
RS22	Hutt R at Boulcott	0.0003	<0.000	<0.0005	12	12	Med. complies	Med. complies
RS57	Waiwhetu S at Whites Line East	0.0011	0.0005	0.0035	12	0	25	16.7

Table D-23: Summary of dissolved Zn (mg/L) concentrations measured at 7 RSoE sites between July 2015 and June 2016 (D.L.= detection limit). The percentages of samples exceeding the ANZECC (2000) default and hardness-modified trigger values (TVs) are also presented

Site no.	Site name	Median	Min	Maximum	*n*	*n* <D.L.	% of samples (*n*) or median compliance with ANZECC (2000)[1]	
							Default TV (≤ *0.008*)	Hardness modified TV
RS15	Porirua S at Glenside	0.0036	0.0028	0.0149	12	0	16.7	16.7
RS16	Porirua S at Wall Park	0.0094	0.0043	0.33	12	0	58.3	41.7
RS18	Karori S at Makara Peak	0.02500	0.0128	0.082	12	0	100	100
RS19	Kaiwharawhara S at Ngaio Gorge	0.0061	0.0022	0.0161	12	0	33.3	8.3
RS21	Hutt R opp. Manor Park G.C.	0.0005	<0.001	0.0027	12	10	Med.	Med. complies

RS22	Hutt R at Boulcott	0.0005	<0.001	0.0042	12	10	Med.	Med. complies
RS57	Waiwhetu S at Whites Line East	0.0176	0.005	0.064	12	0	66.7	66.7

Table D-24: Summary of total recoverable Cu (mg/L) concentrations measured at 5 RSoE sites between July 2015 and June 2016

Site no.	Site name	Median	Minimum	Maximum	*n*
RS15	Porirua S at Glenside	0.0011	0.0006	0.0019	12
RS16	Porirua S at Wall Park (Milk Depot)	0.0015	0.0008	0.0310	12
RS18	Karori S at Makara Peak	0.0019	0.0009	0.0158	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.0018	0.0010	0.0043	12
RS57	Waiwhetu S at Whites Line East	0.0017	0.0008	0.0114	12

Table D-25: Summary of total recoverable Zn (mg/L) concentrations measured at 5 RSoE sites between July 2015 and June 2016

Site no.	Site name	Median	Minimum	Maximum	*n*
RS15	Porirua S at Glenside	0.0049	0.0032	0.0240	12
RS16	Porirua S at Wall Park (Milk Depot)	0.0134	0.0058	0.3900	12
RS18	Karori S at Makara Peak	0.0245	0.0149	0.0880	12
RS19	Kaiwharawhara S at Ngaio Gorge	0.0063	0.0042	0.0197	12
RS57	Waiwhetu S at Whites Line East	0.0183	0.0062	0.1200	12

Appendix E RSoE macroinvertebrate metric scores

QMCI, %EPT* taxa and taxa richness scores for RSoE sites sampled in summer 2015/16, (Morar, Perrie, & Greenfield, 2016)

Site no.	Site name	QMCI	%EPT* taxa	Taxa richness
RS13	Horokiri S at Snodgrass	5.98	52	23
RS14	Pauatahanui S at Elmwood Br	4.04	33	27
RS15	Porirua S at Glenside	6.39	40	25
RS16	Porirua S at Wall Park (Milk Depot)	4.32	18	28
RS18	Karori S at Makara Peak	2.92	22	23
RS19	Kaiwharawhara S at Ngaio Gorge	2.52	5	21
RS20	Hutt R at Te Marua Intake Site	8.08	68	22
RS21	Hutt R opp. Manor Park G.C.	5.26	52	23
RS22	Hutt R at Boulcott	5.53	43	23
RS23	Pakuratahi R 50m d/s Farm Ck	6.15	42	26
RS24	Mangaroa R at Te Marua	5.98	46	26
RS25	Akatarawa R at Hutt confl.	7.64	67	33
RS26	Whakatikei R at Riverstone	6.61	61	28
RS28	Wainuiomata R at Manuka Track	6.68	58	33
RS29	Wainuiomata R d/s of White Br	4.91	44	25
RS57	Waiwhetu S at Whites Line East	3.96	0	15

*Pollution tolerant EPT taxa (*Oxyethira* and *Paroxythira*) were excluded from this calculation.

MCI from annual RSoE surveys in summer 2013/14, 2014/15 and 2015/16

Site no.	Site name	2013/14	2014/15	2015/16	Mean
RS13	Horokiri S at Snodgrass	115	98.3	109.6	108
RS14	Pauatahanui S at Elmwood Br	105.6	92.5	90.9	96
RS15	Porirua S at Glenside	104.4	94.4	100.0	100
RS16	Porirua S at Wall Park (Milk Depot)	87	80.9	80.7	83
RS18	Karori S at Makara Peak	91.8	84.8	85.2	87
RS19	Kaiwharawhara S at Ngaio Gorge	95.7	81.9	71.4	83
RS20	Hutt R at Te Marua Intake Site	128	138.3	138.2	135
RS21	Hutt R opp. Manor Park G.C.	127.7	126.0	121.7	125
RS22	Hutt R at Boulcott	111	109.1	113.0	111
RS23	Pakuratahi R 50m d/s Farm Ck	124.8	120.7	113.6	120
RS24	Mangaroa R at Te Marua	127.5	105.9	115.2	116
RS25	Akatarawa R at Hutt confl.	134.6	124.4	130.0	130
RS26	Whakatikei R at Riverstone	138.5	120.0	131.4	130
RS28	Wainuiomata R at Manuka Track	143.6	137.6	130.3	137
RS29	Wainuiomata R d/s of White Br	109.5	113.6	111.2	111
RS57	Waiwhetu S at Whites Line East	68	76	60.0	68

Note: PNRP aquatic ecosystem criteria: Green = achieved, Amber = moderate effect, Red = acute effect

Appendix F Microbiological contamination in WCC S/W consent sites

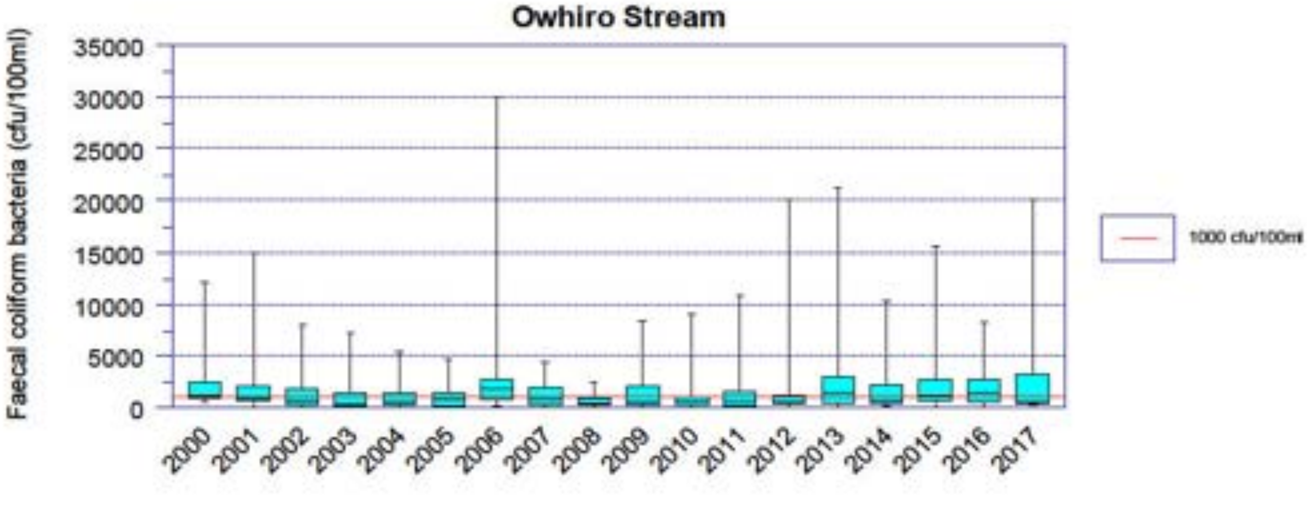
The locations of WCC's 20 stormwater monitoting sites are shown in Table F-1 and summary statistics are shown in Table F-2. Results of monthly monitoring for each site by year are shown by box plot; the red line indicates faecal coliform values of 1000 cfu/100ml.

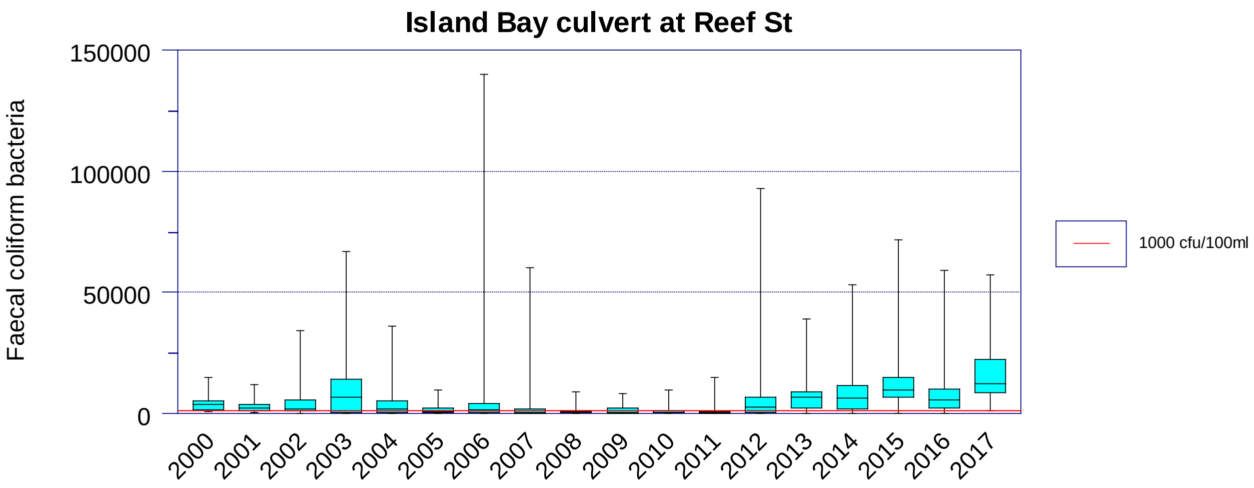
Table F-1: Location of WCC stormwater consent culvert and stream outlet monitoring locations

Site	NZMG		NZTM	
	Easting	Northing	Easting	Northing
Owhiro Stream at Owhiro Bay (B22-017)	2657128	5983233	1747105	5421522
Island Bay (G26-070)	2658133	5983367	1748110	5421655
Houghton Bay (C31-040)	2659389	5983457	1749366	5421745
Lyall Bay East Culvert (G37-050)	2660768	5984942	1750745	5423230
Lyall Bay West Culvert (F34-014)	2660107	5984730	1750084	5423018
Hataitai Culvert (Evans Bay) (K35-037)	2660448	5986727	1750426	5425015
Miramar Culvert (Evans Bay) (J40-010)	2661636	5986473	1751613	5424761
Kilbirnie Culvert (Evans Bay) (K36-001)	2660540	5986635	1750518	5424923
Cobham Culvert (Evans Bay) (J37-001)	2660775	5986424	1750753	5424712
Overseas Passenger Terminal Culvert (Q32-035)	2659536	5989100	1749514	5427388
Tory Street Culvert (Q30-026)	2659222	5988978	1749200	5427266
Taranaki Culvert (Q30-01)	2659084	5989208	1749062	5427496
Te Aro Culvert (Q29-110)	2658970	5989209	1748948	5427497
Harris Street Culvert (R29-028)	2658950	5989460	1748928	5427748
Waring Taylor Culvert	2658983	5990042	1748961	5428330
Bowen Culvert (S29-091)	2659032	5990120	1749010	5428408
Davis Culvert (V32-022)	2659723	5991090	1749701	5429378
Thorndon Culvert (W31-010)	2659523	5991624	1749501	5429912
Kaiwharawhara Stream Culvert	2659987	5992444	1749965	5430732
Ngauranga Stream Culvert	2661954	5994112	1751933	5432399

Table F-2: Summary statistics for WCC S/W Consents sites, monthly monitoring.

Site Name	Faecal coliform bacteria cfu/100 ml			
	n	Median	Min	Max
Cobham Culvert	569	260	0	77300
Evans Bay Culvert	570	370	0	290000
Houghton Bay Culvert	569	600	0	590000
Island Bay Cnr Parade/Reef Street	567	2200	0	140000
Lyall Bay West Culvert	510	350	0	430000
Miramar Culvert	568	335	0	250000
Owhiro Bay Stream Outlet	564	765	0	30000
Bowen Street Culvert	565	1640	0	4300000
Davis Street Culvert	500	640	0	130000
Harris Street Culvert	565	480	0	2000000
Kaiwharawhara Stream	562	690	0	180000
Ngauranga Stream near Harbour	568	1100	4	190000
Overseas Terminal	538	4100	4	6900000
Taranaki Street Culvert	570	3200	2	2000000
Te Aro Culvert at Jervois Quay	561	1550	0	1500000
Thorndon Quay Culvert	568	650	0	212000
Tory Street Culvert	574	4000	2	2480000
Waring Taylor Street Culvert	538	1000	4	2900000
Lyall Bay East Manhole	406	455	0	4700000
Kilbirne Outlet Culvert	226	120	0	152000

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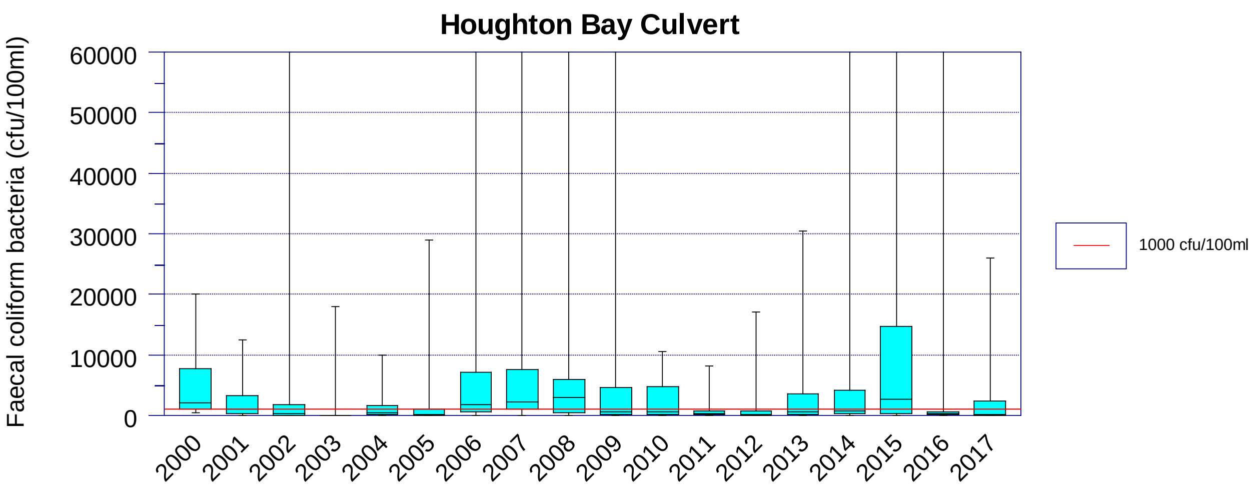
2015
2016
2017
1000 cfu/100ml


Houghton Bay Culvert
Faecal coliform bacteria (cfu/100ml)
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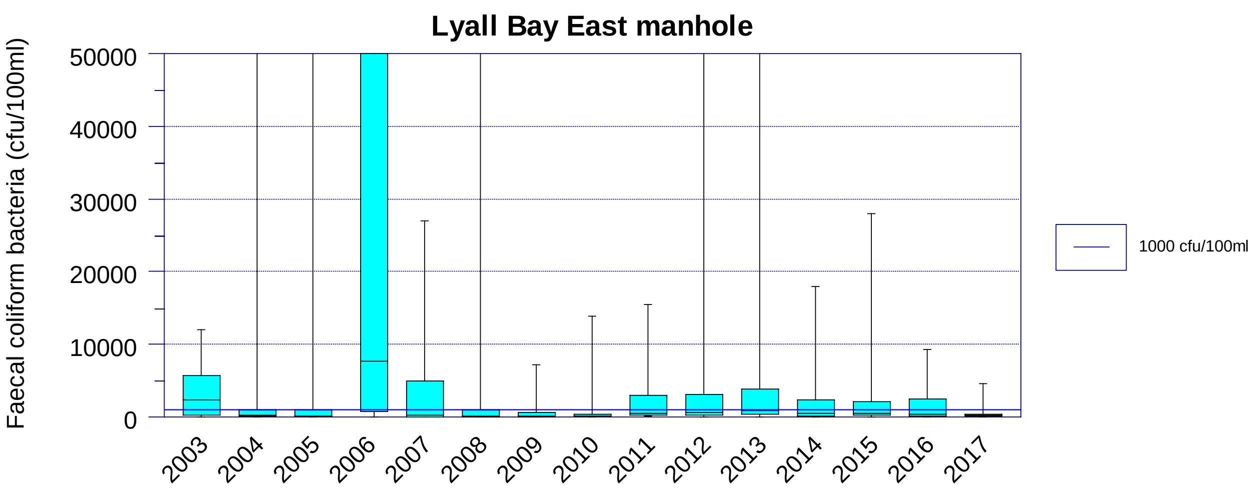
2015
2016
2017
1000 cfu/100ml


Lyall Bay East manhole
Faecal coliform bacteria (cfu/100ml)
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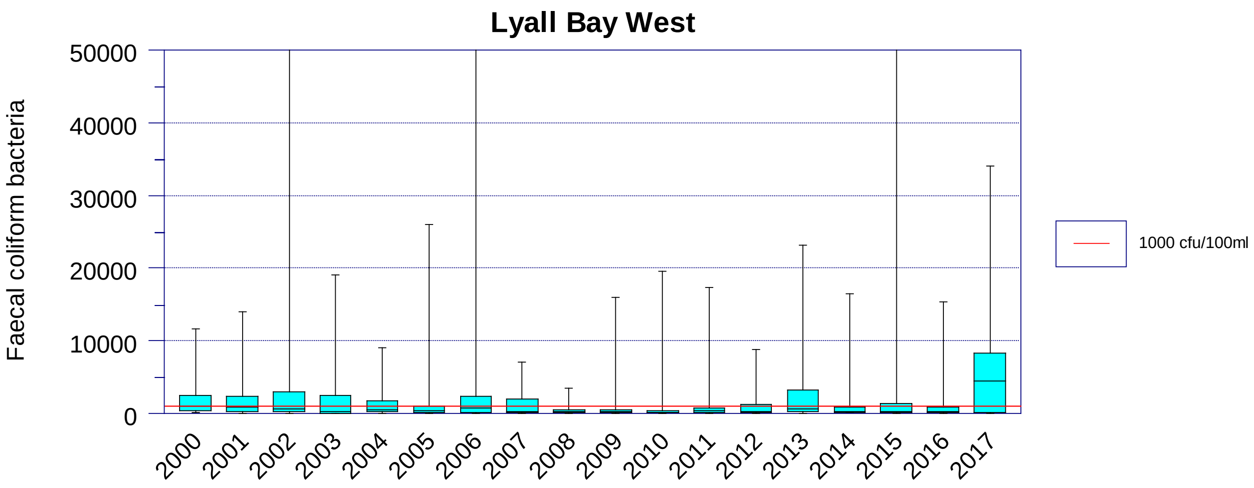
2015
2016
2017
1000 cfu/100ml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Faecal coliform bacteria
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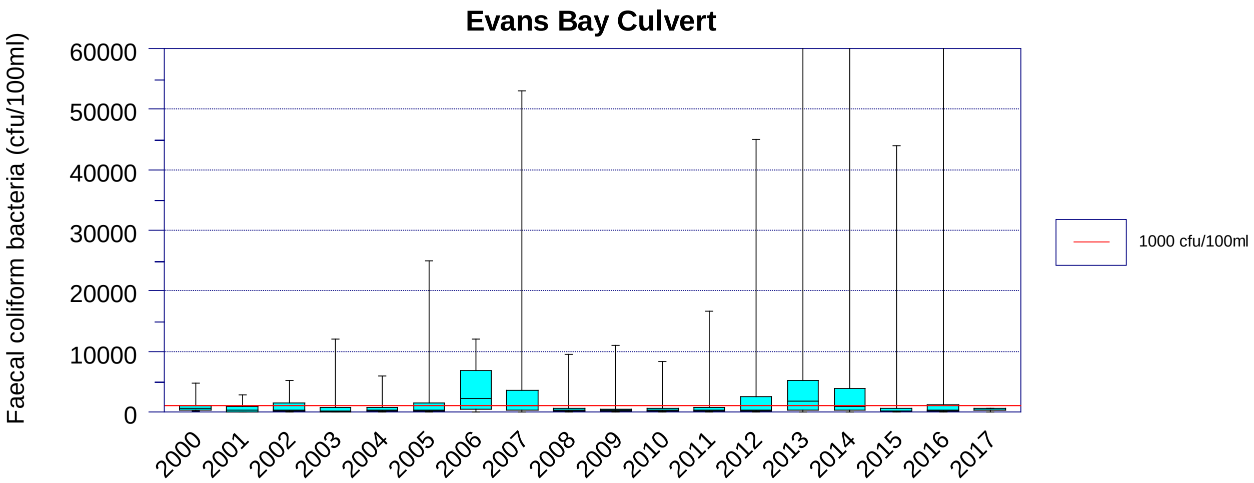
2015
2016
2017
1000 cfu/100ml


Evans Bay Culvert
Faecal coliform bacteria (cfu/100ml)
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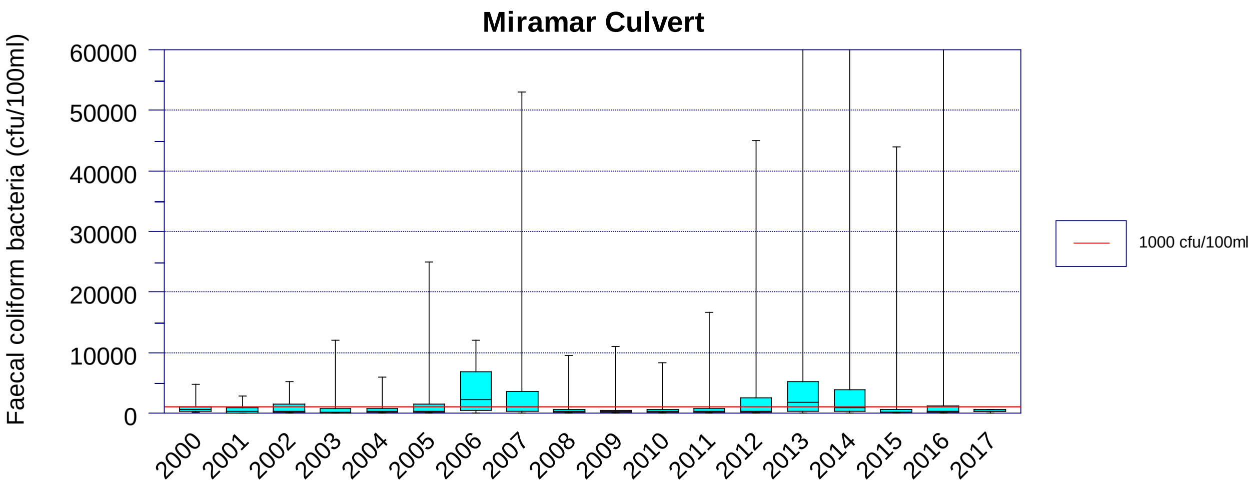
2015
2016
2017
1000 cfu/100ml


Miramar Culvert
Faecal coliform bacteria (cfu/100ml)
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20000
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2002
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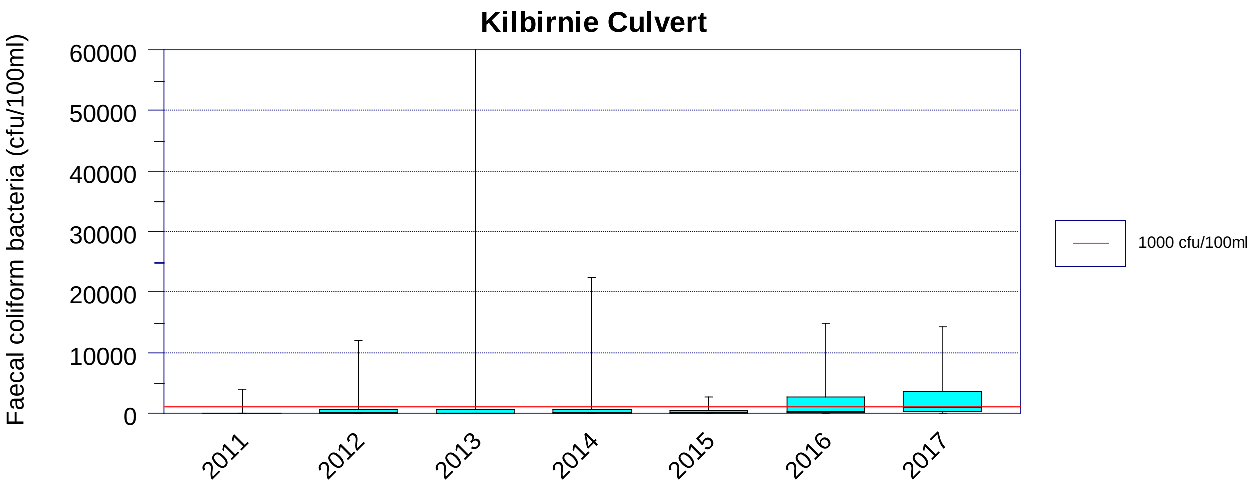
2015
2016
2017
1000 cfu/100ml


Kilbirnie Culvert
Faecal coliform bacteria (cfu/100ml)
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30000
20000
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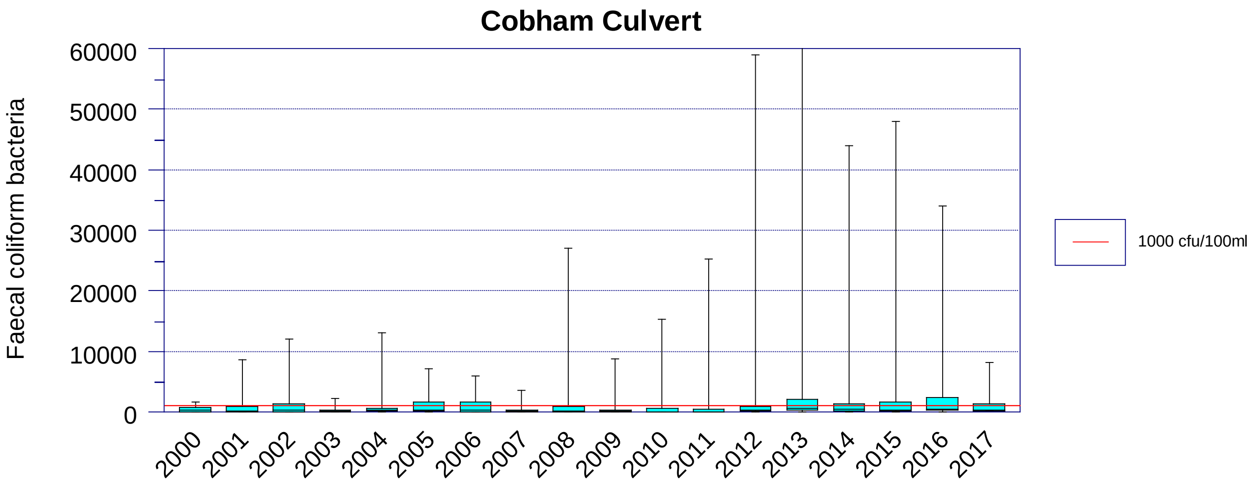
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Cobham Culvert
Faecal coliform bacteria
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20000
10000
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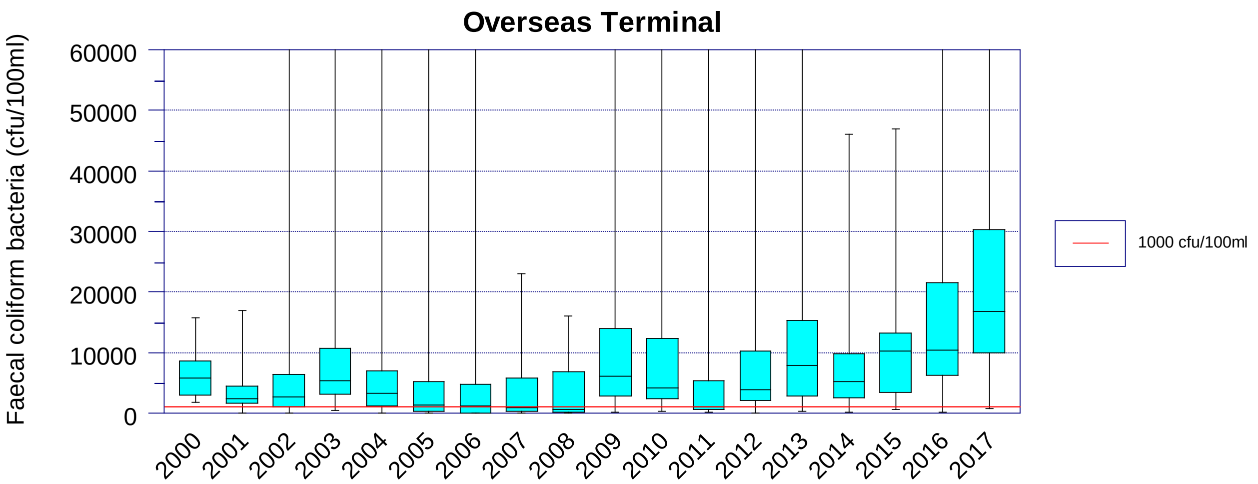
2015
2016
2017
1000 cfu/100ml


Overseas Terminal
Faecal coliform bacteria (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
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2001
2002
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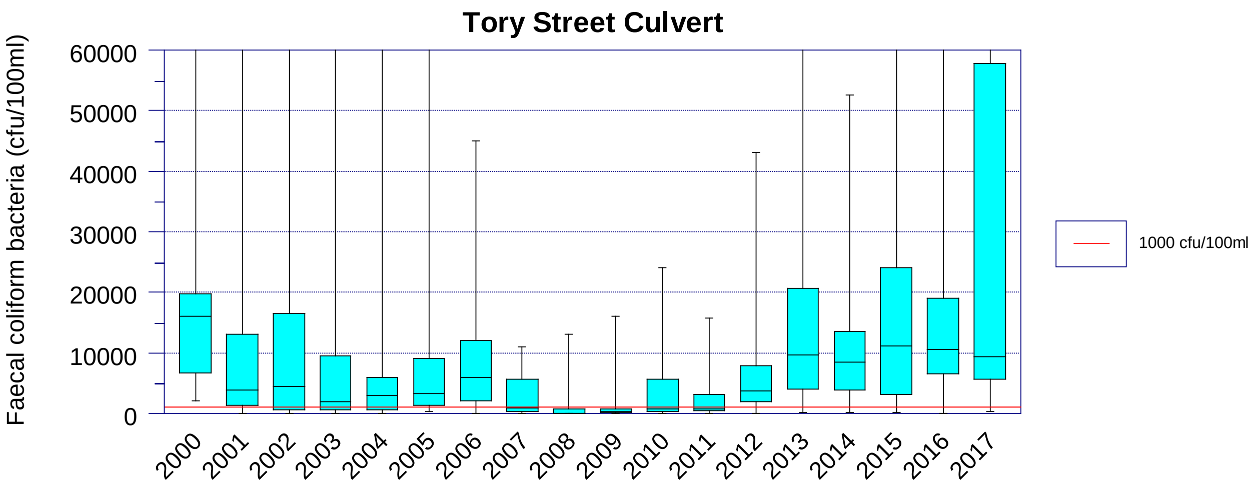
2015
2016
2017
1000 cfu/100ml


Tory Street Culvert
Faecal coliform bacteria (cfu/100ml)
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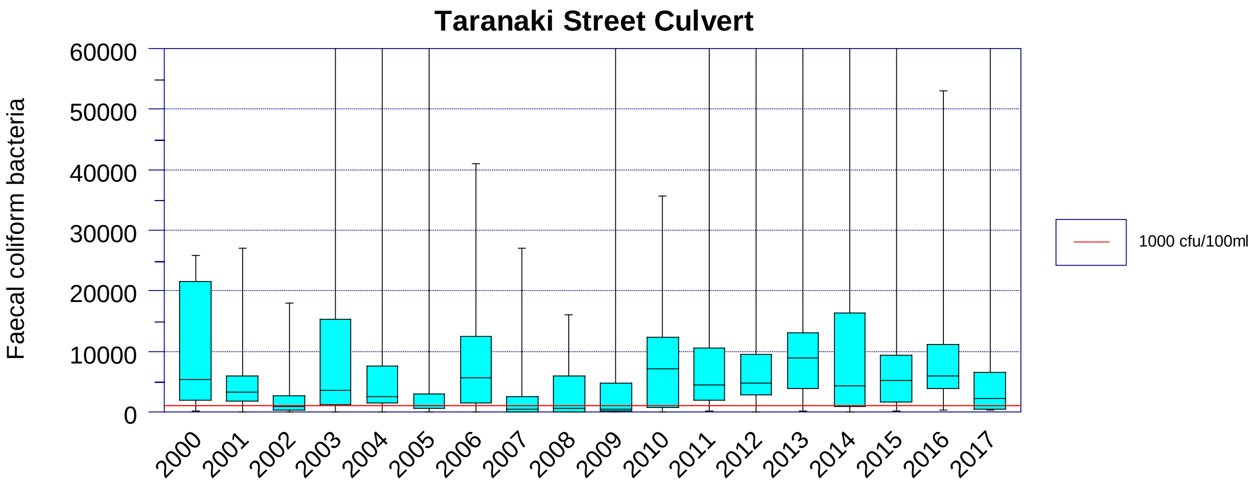
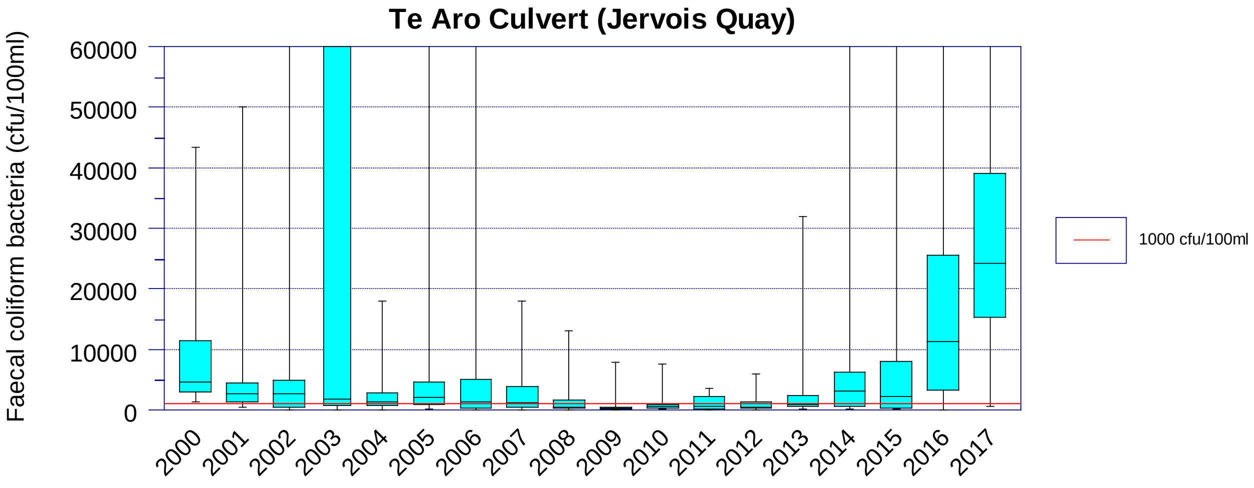
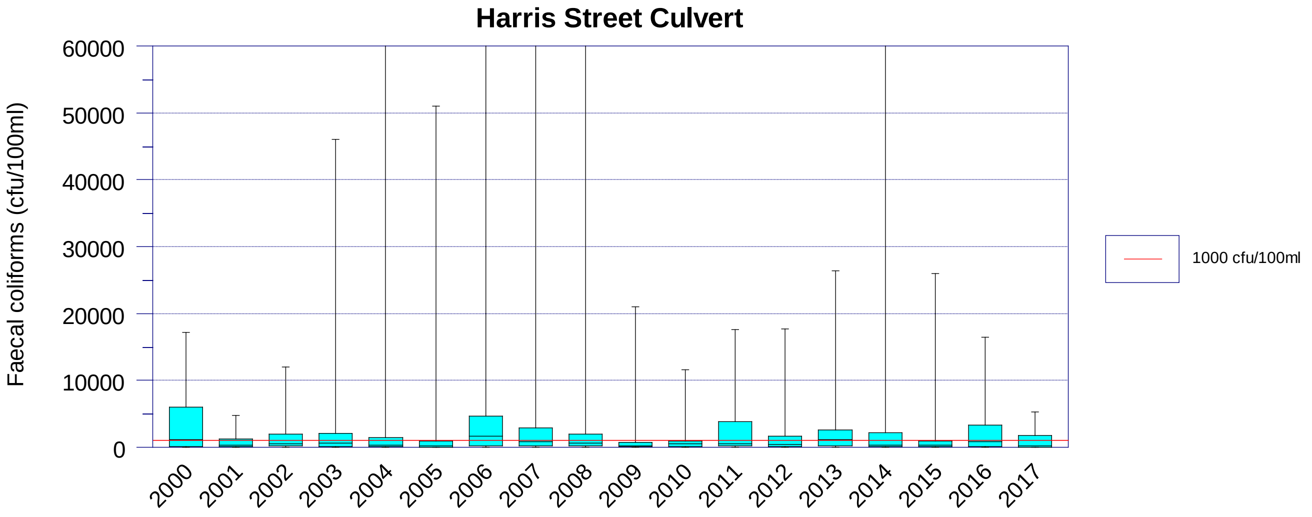
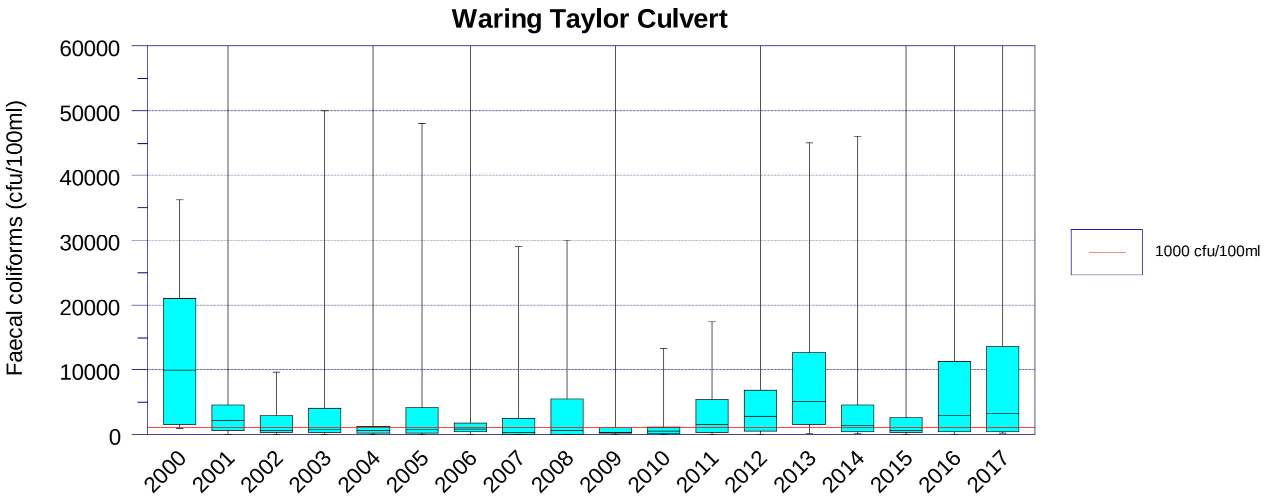
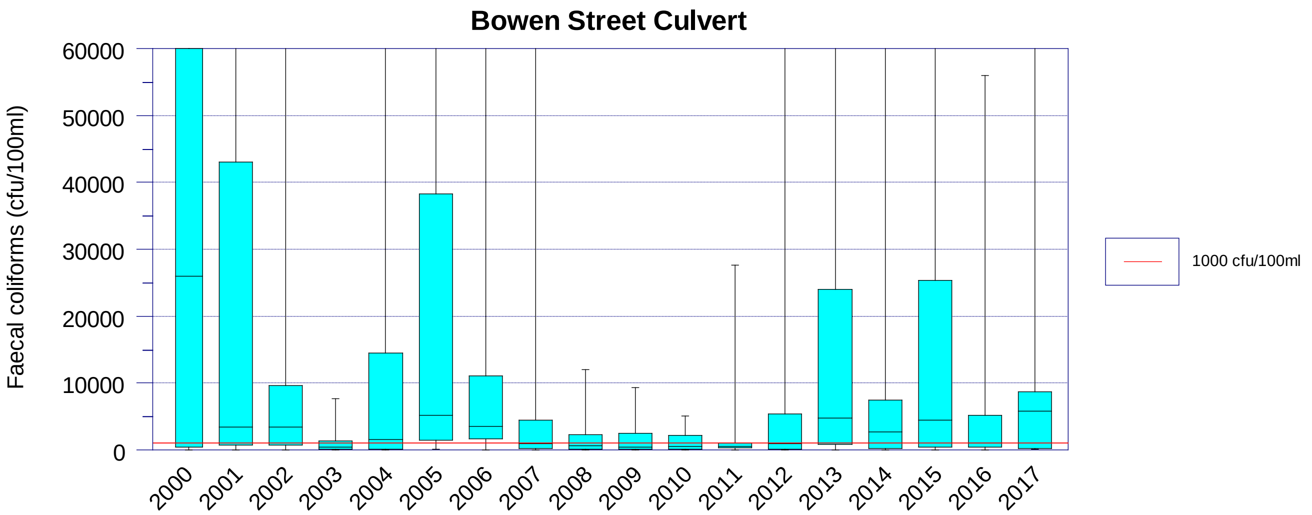
50000
40000
30000
20000
10000
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
1000 cfu/100ml

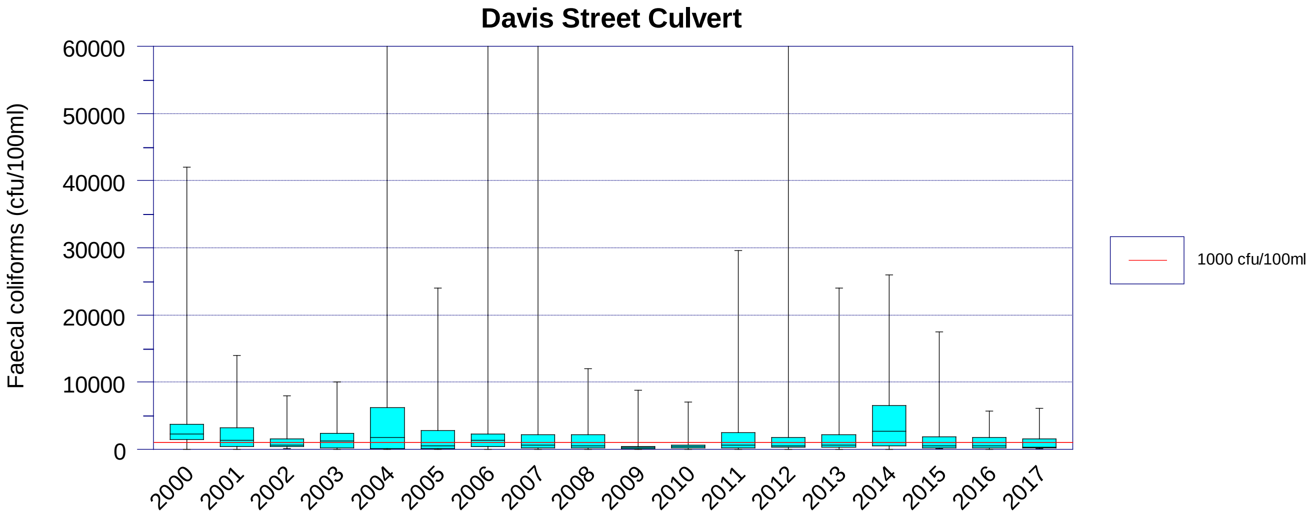

Taranaki Street Culvert
Faecal coliform bacteria
60000
50000
40000
30000
20000
10000
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
1000 cfu/100ml

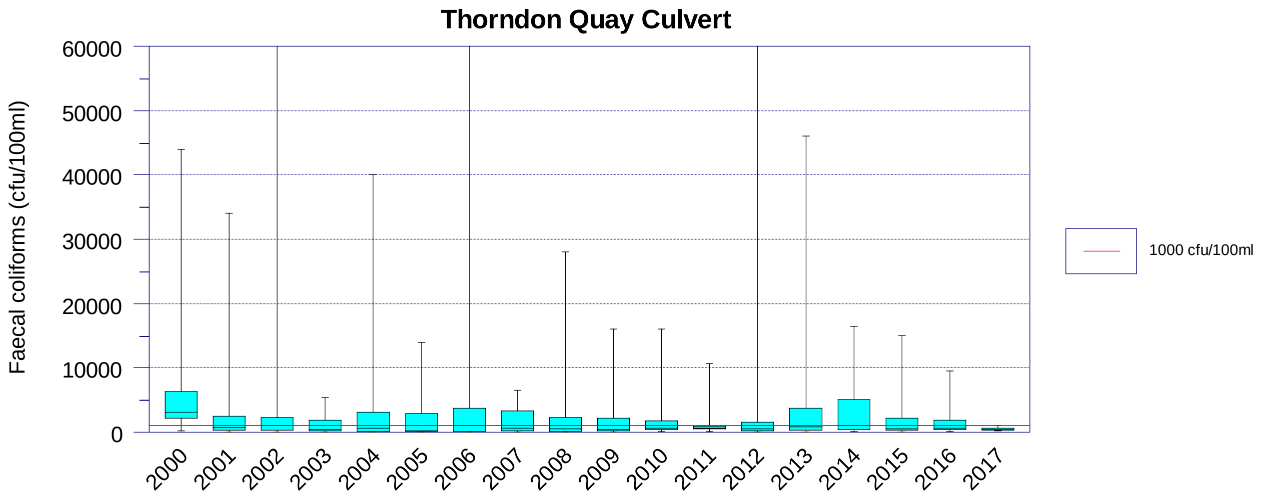

Te Aro Culvert (Jervois Quay)
Faecal coliform bacteria (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
1000 cfu/100ml

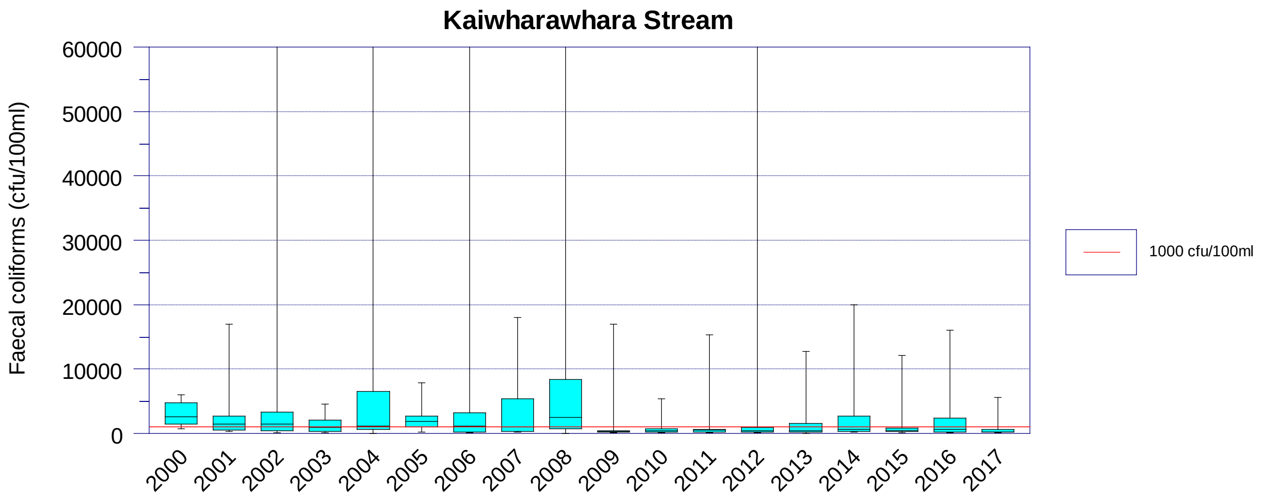

Harris Street Culvert
Faecal coliforms (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml

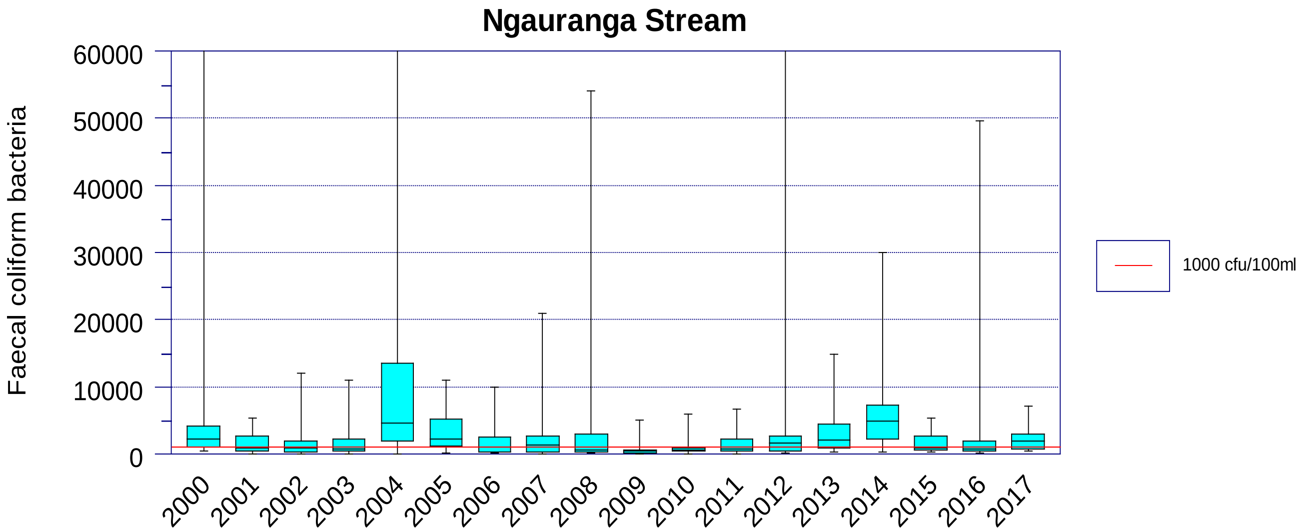

Waring Taylor Culvert
Faecal coliforms (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Bowen Street Culvert
Faecal coliforms (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Davis Street Culvert
Faecal coliforms (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Thorndon Quay Culvert
Faecal coliforms (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Kaiwharawhara Stream
Faecal coliforms (cfu/100ml)
60000
50000
40000
30000
20000
10000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Ngauranga Stream
Faecal coliform bacteria
60000
50000
40000
30000
20000
10000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml

Appendix G Microbiological contamination in minor streams and culverts: WCC

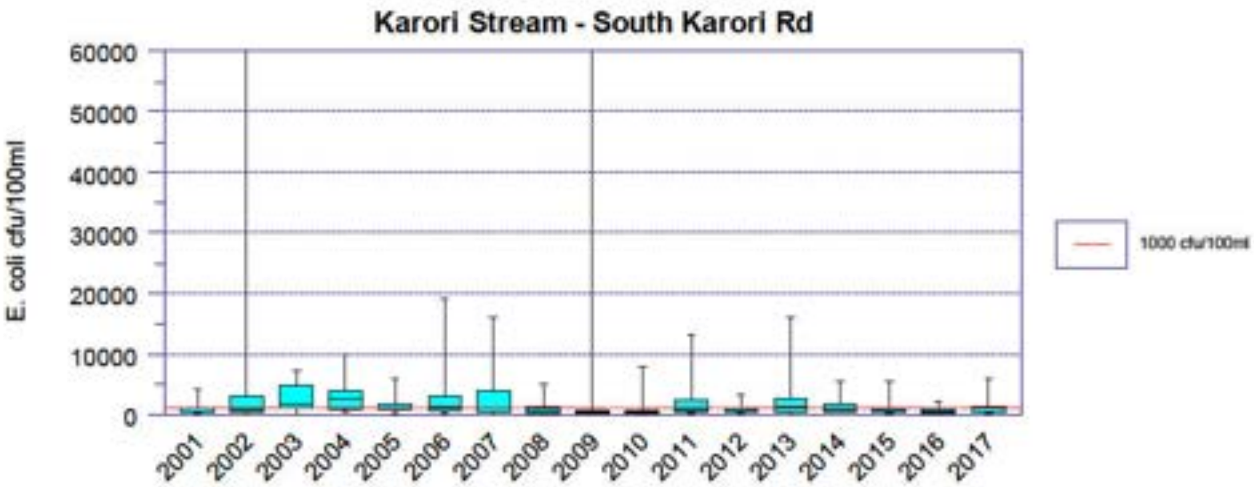
The locations of WCC's minor stream and culvert monitoring sites are shown in Table G-1. These sites are additional to the 20 sites monitored under the stormwater consent. Summary statistics from monthly (or fortnightly) monitoring are shown in Table G-2. Results of monthly monitoring for each site by year are shown by box plot. Box plots of selected stream sites by year follow; the red dashed line indicates the NPS-FM 'bottom line' for secondary contact recreation of <1000 *E. coli.* cfu per 100 ml.

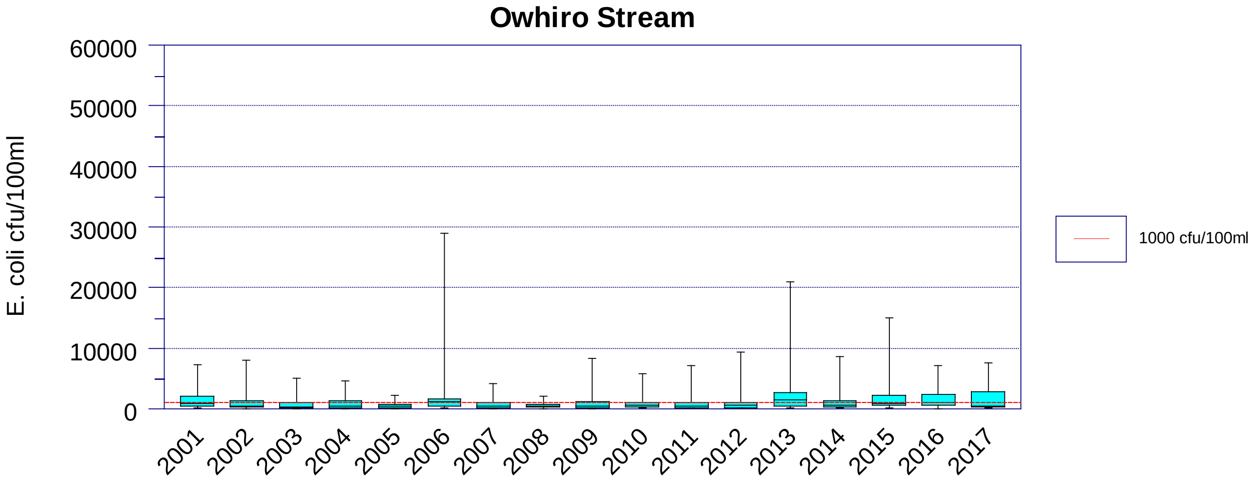
Table G-1: Location of WCC minor stream and culvert monitoring locations (additional to consent sites)

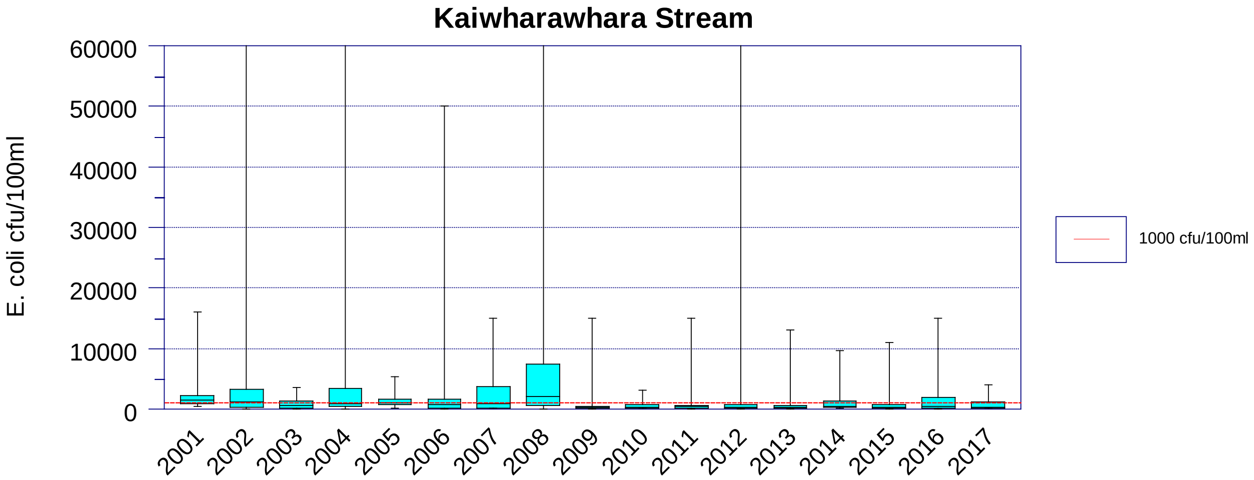
Site No.	Site Name	NZMG		NZTM	
		Easting	Northing	Easting	Northing
1	Belmont Gully				
2	Cummings Park	2658636	5993873	1748614	5432161
3	Houghton Bay Culvert	2659388	5983475	1749365	5421763
4	Johnsonville at Glenside	2662090	5998430	1752069	5436717
5	Johnsonville at Gorge (No. 03)	2661594	5996097	1751573	5434384
6	Johnsonville at Gorge True Left (No. 01)	2661588	5996105	1751567	5434392
7	Johnsonville at Gorge True Right (No.02)	2661587	5996104	1751566	5434391
8	Kaiwharawhara Stream	2659987	5992444	1749965	5430731
9	Karori Stream at Campbell Street Bridge	2655430	5989990	1745408	5428278
10	Karori Stream at Friend Street	2655442	5990147	1745421	5428435
13	Lower Careys Gully Stream	2657068	5984663	1747046	5422951
14	Maori Gully Stream	2657116	5985110	1747093	5423398
15	Newlands at Gorge	2661877	5995672	1751856	5433959
16	Ngauranga Stream near Harbour	2661954	5994112	1751933	5432400
17	Otari Park Stream	2657662	5992224	1747640	5430512
18	Owhiro Bay Stream Outlet	2657128	5983233	1747106	5421522
19	Owhiro Stream at Happy Valley Tip Bridge	2657098	5984417	1747076	5422706
20	**Owhiro Stream at Kingston**	2657112	5985106	1747090	5423394
21	Owhiro Stream below Happy Valley Tip	2657306	5984053	1747284	5422341
22	Porirua Stream at Linden Park	2663835	6004303	1753814	5442590
23	South Karori Road	2654244	5988727	1744222	5427015
24	Stebbings Gully	2662217	5998842	1752196	5437129
25	Takapu Stream at Boscobel Lane	2663416	6000798	1753396	5439085
26	Tawa Stream at Boscobel Lane	2663386	6000790	1753365	5439077
27	Tyers Stream at Gorge	2661848	5994489	1751827	5432776

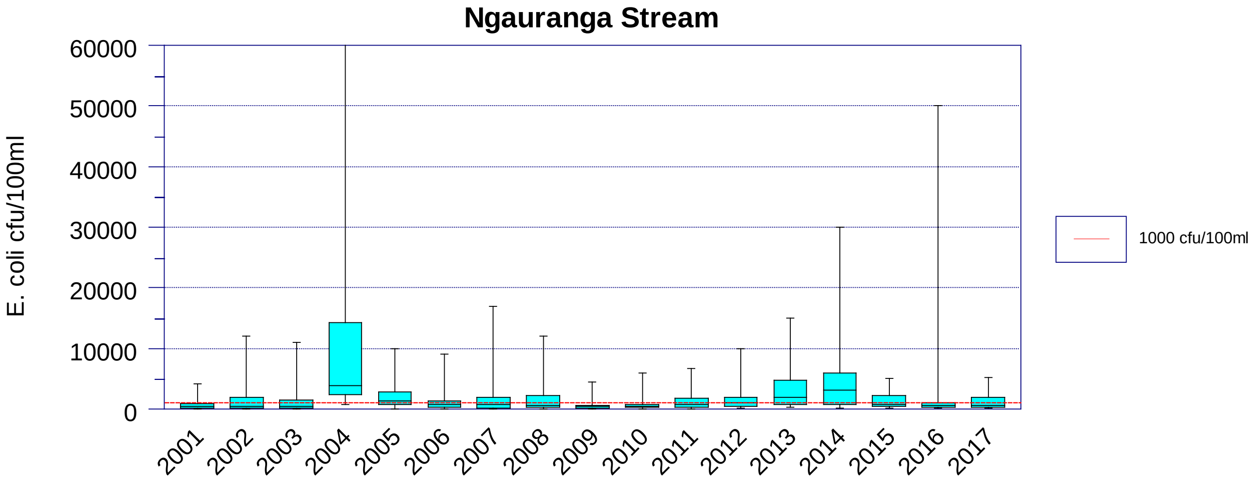
Table G-2: *E. coli.* summary statistics for WCC minor streams (quarterly, Mar 2001 to Mar 2017)

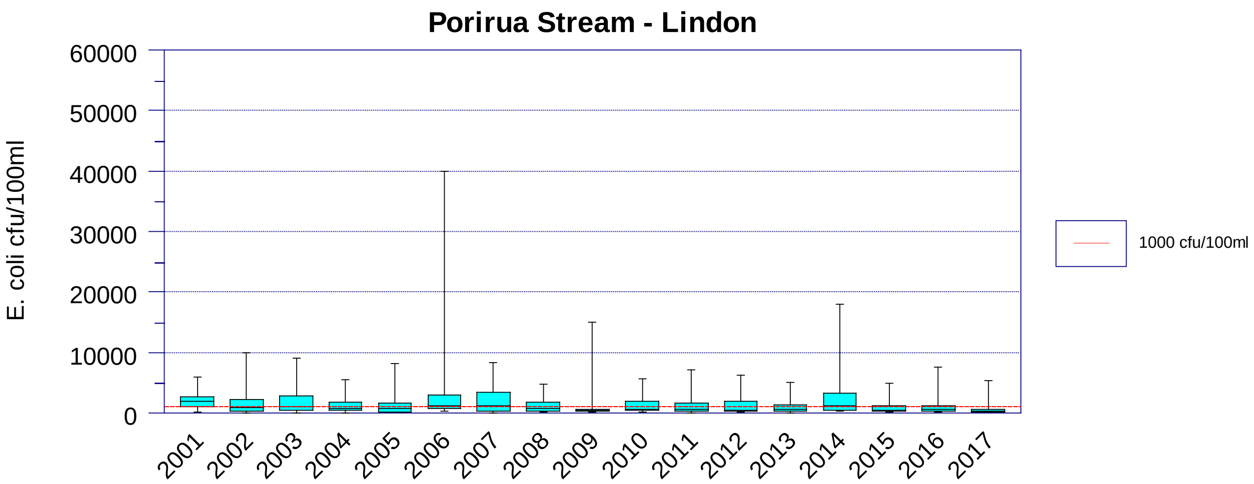
Site No.	Site Name	E. coli. cfu/100 ml			
		n	Median	Min	Max
1	Belmont Gully	453	470	2	40000
2	Cummings Park	452	855	0	85000
3	Houghton Bay Culvert	460	395	0	220000
4	Johnsonville at Glenside	454	650	2	85000
5	Johnsonville at Gorge (No. 03)	448	1200	0	140000
6	Johnsonville at Gorge True Left	455	900	2	95000
7	Johnsonville at Gorge True Right	452	940	2	800000
8	Kaiwharawhara Stream	453	550	4	140000
9	Karori Stream at Campbell Street	459	500	2	91000
10	Karori Stream at Friend Street	458	870	2	150000
13	Lower Careys Gully Stream	464	160	4	80000
14	Maori Gully Stream	464	220	2	85000
15	Newlands at Gorge	449	1100	0	150000
16	Ngauranga Stream near Harbour	461	750	2	170000
17	Otari Park Stream	451	200	2	34000
18	Owhiro Bay Stream Outlet	464	600	0	29000
19	Owhiro Stream at Happy Valley	465	250	4	60000
20	Owhiro Stream at Kingston	461	190	4	57000
21	Owhiro Stream below Happy	459	270	4	32000
22	Porirua Stream at Linden Park	453	650	2	40000
23	South Karori Road	456	710	2	160000
24	Stebbings Gully	453	480	4	26000
25	Takapu Stream at Boscobel Lane	450	600	2	120000
26	Tawa Stream at Boscobel Lane	452	600	2	76000
27	Tyers Stream at Gorge	451	600	2	470000




Owhiro Stream
E. coli cfu/100ml
60000
50000
40000
30000
20000
10000
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Kaiwharawhara Stream
E. coli cfu/100ml
60000
50000
40000
30000
20000
10000
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Ngauranga Stream
E. coli cfu/100ml
60000
50000
40000
30000
20000
10000
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml


Porirua Stream - Lindon
E. coli cfu/100ml
60000
50000
40000
30000
20000
10000
0
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
1000 cfu/100ml

Appendix H Microbiological contamination in minor streams and culverts: HCC

The locations of HCC's minor stream and culvert monitoring sites are shown in Table G-1. Summary statistics from monthly monitoring are shown in Table G-2. Results of monthly monitoring for each site by year are shown by box plot. The red dashed line indicates the NPS-FM 'bottom line' for secondary contact recreation (<1000 E. coli. cfu per 100 ml).

Table H-1: Location of HCC minor stream and culvert monitoring locations

Site No.	Site Name	NZMG		NZTM	
		Easting	Northing	Easting	Northing
1	Awamutu Stream at Hutt Park	2669643	5995214	1759621	5433500
2	Black Creek at Moohan St.	2673605	5991198	1763582	5429484
3	Block Road	2669803	5998513	1759782	5436799
4	Brunswick Street	2670203	5998593	1760182	5436879
5	Glen Catchment, Stokes Valley	2676414	6002351	1766393	5440636
6	Harcourt Werry Drive at Percy	2673086	6000694	1763064	5438980
7	Harcourt Werry Drive at Taita Drive	2673422	6001141	1763401	5439427
8	Harcourt Werry Drive upstream of	2672254	5999904	1762233	5438189
9	Korokoro Stream at The Esplanade	2666007	5996307	1755985	5434594
10	Marsden Street				
11	Nash Street	2674108	6001771	1764087	5440056
12	Normandale Road	2668746	5998040	1758725	5436326
13	Opahu Stream at Penrose St.	2670247	5997417	1760225	5435703
14	Opahu Stream at Whites Line West	2669439	5996684	1759417	5434970
15	Rawhiti St, Stokes Valley	2676174	6001982	1766153	5440267
16	Speedy's Stream at Western Hutt	2671775	5999993	1761754	5438279
17	Stokes Valley at Eastern Hutt Road	2676283	6003296	1766262	5441581
18	Te Mome Stream at Bracken St	2668813	5996509	1758791	5434795
19	Te Mome Stream at The Esplanade	2669078	5995417	1759056	5433704
20	Wainuiomata Stream at Reservoir	2674748	5990913	1764725	5429199
21	Waiwhetu Stream at Rishworth St	2670587	5995855	1760565	5434141
22	Waiwhetu Stream at Tilbury Street	2672366	5998115	1762345	5436401
23	West Hills Culvert	2668627	5996340	1758605	5434627
24	Williams St P.S.	2668510	5996476	1758488	5434762

Table H-2: *E. coli.* summary statistics for HCC minor streams (monthly, Jan 1995 to Nov 2016)

Site No.	Site Name	E. coli. cfu/100 ml			
		n	Median	Min	Max
1	Awamutu Stream at Hutt Park	42	528.5	32	8700
2	Black Creek at Moohan St.	42	402	62	6800
3	Block Road	42	57	8	3200
4	Brunswick Street	42	1600	2	300000
5	Glen Catchment, Stokes Valley	42	454	44	6600
6	Harcourt Werry Drive at Percy	14	260	28	16300
7	Harcourt Werry Drive at Taita	23	116	32	6600
8	Harcourt Werry Drive upstream of	29	64	2	14200
9	Korokoro Stream at The	42	43	8	904
10	Marsden Street	3	377	242	2500
13	Nash Street	7	1700	144	11200
14	Normandale Road	42	238	8	8200
15	Opahu Stream at Penrose St.	39	292	2	5300
16	Opahu Stream at Whites Line	42	563.5	80	16200
17	Rawhiti St, Stokes Valley	42	688.5	60	22000
18	Speedy's Stream at Western Hutt	42	69	8	3400
19	Stokes Valley at Eastern Hutt	42	1050	88	10900
20	Te Mome Stream at Bracken St	42	342.5	20	65000
21	Te Mome Stream at The	42	200	23	5100
22	Wainuiomata Stream at	42	321	56	3800
23	Waiwhetu Stream at Rishworth St	13	704	124	1600
24	Waiwhetu Stream at Tilbury	42	1550	192	13200

Waiwhetu Stream

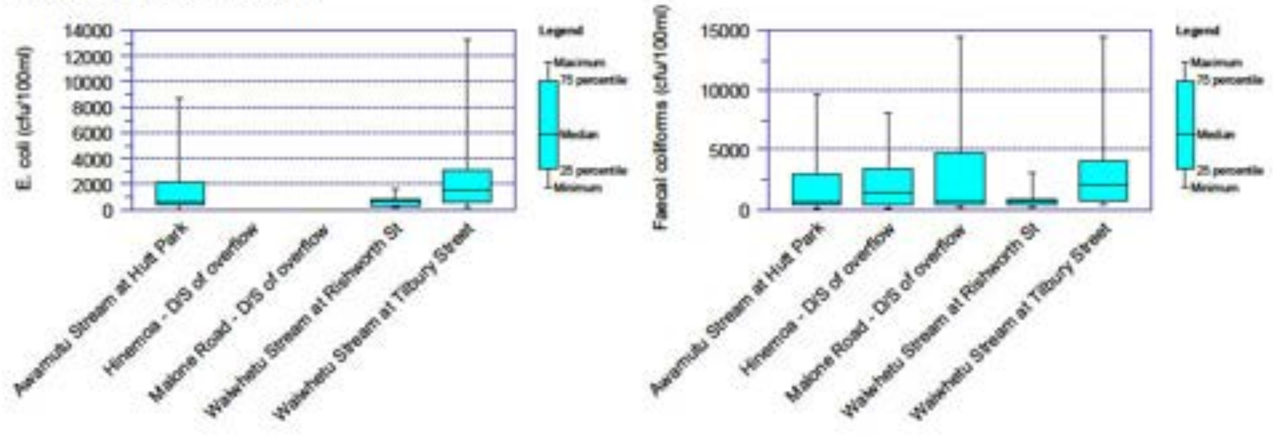


Figure H-1: Box plot summaries of indicator bacteria results at Waiwhetu Stream sites 2013-2016

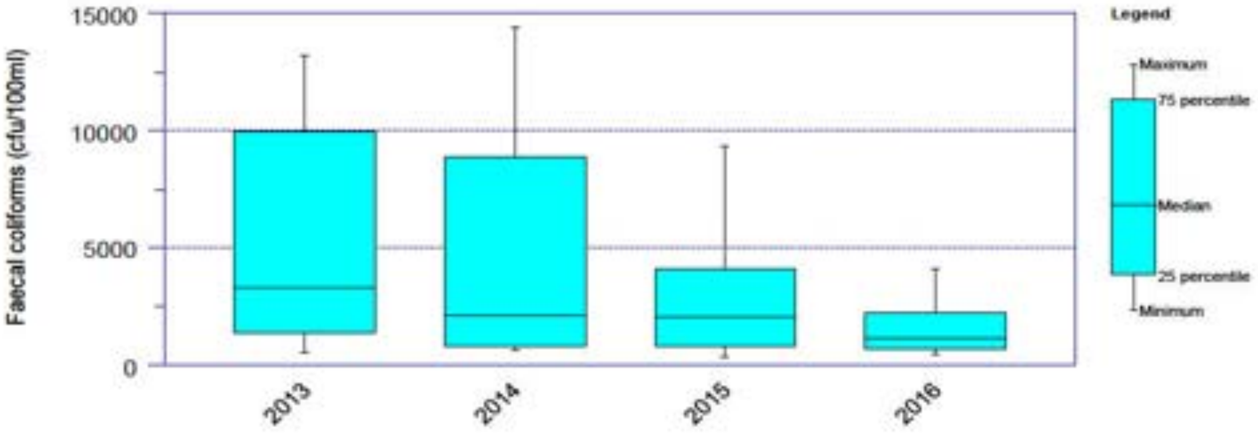


Figure H-2: Box plot summaries of faecal coliform results for Waiwhetu Stream atTilbury Street

Korokoro, Speedys and Stokes Valley streams

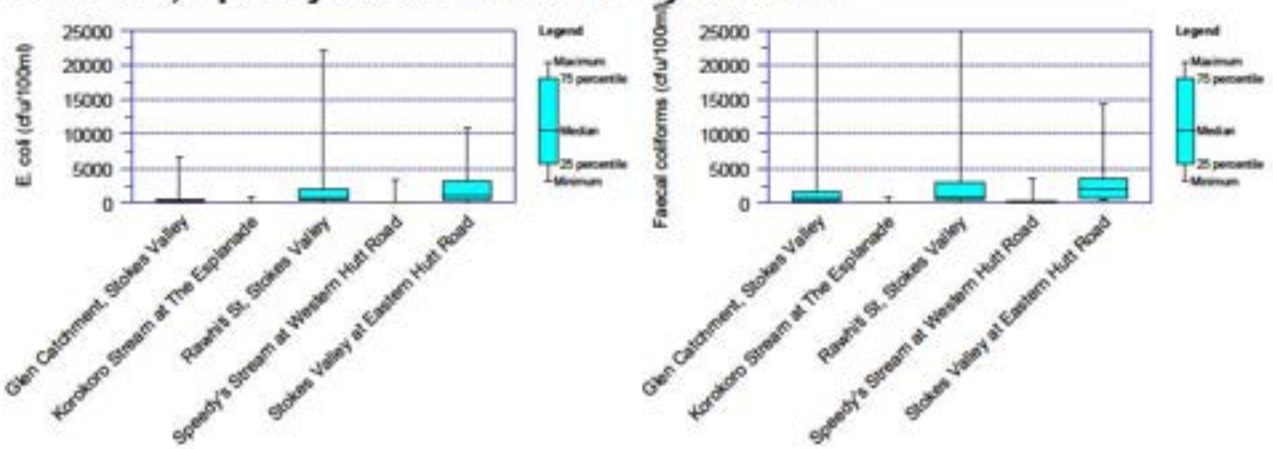


Figure H-3: Box plot summary of indicator bacteria results at 5 stream sites 2013-2016 (samples size varies between 42 and 185)

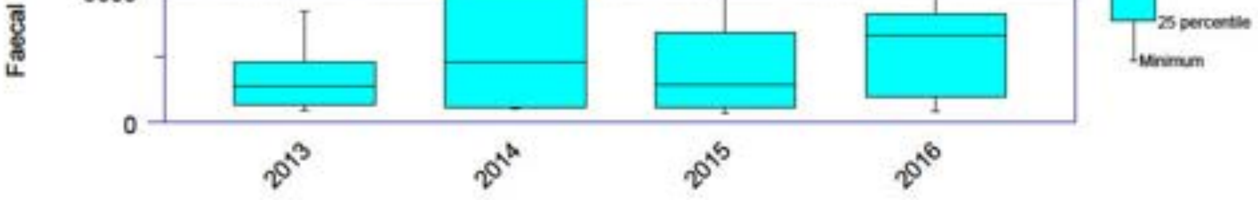


Figure H-4 Box plot summary of faecal coliform counts for Stokes Valley Stream at Eastern Hutt Rd (sample size = 42)

Other minor tributaries of Hutt River

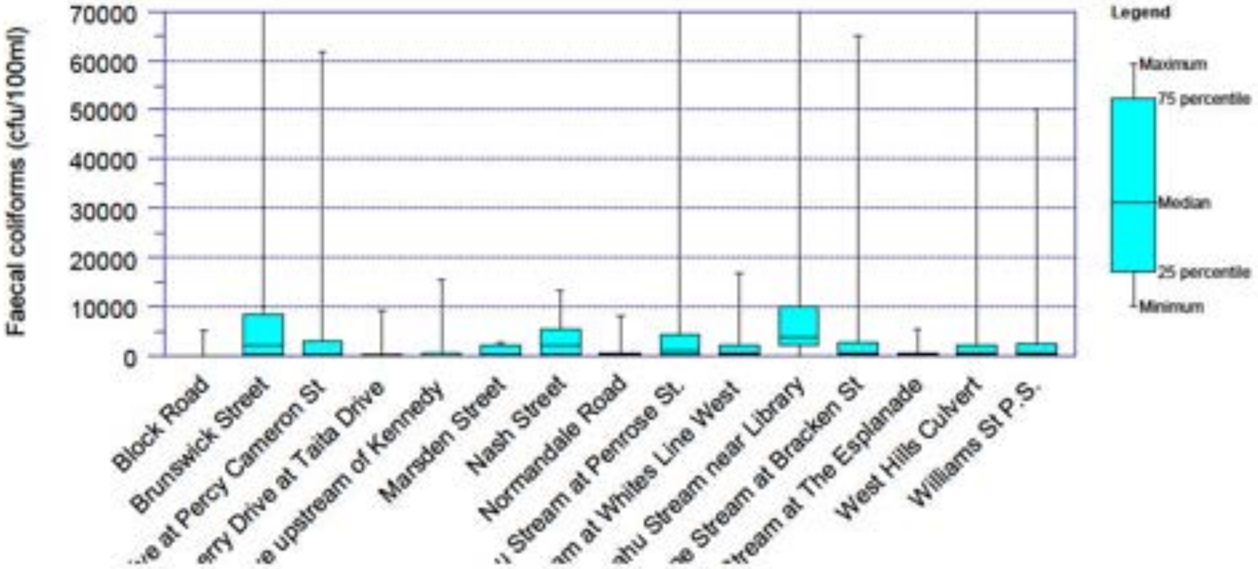


Figure H-5: Box plot summary of faecal coliform counts in minor triburaries of the Hutt River

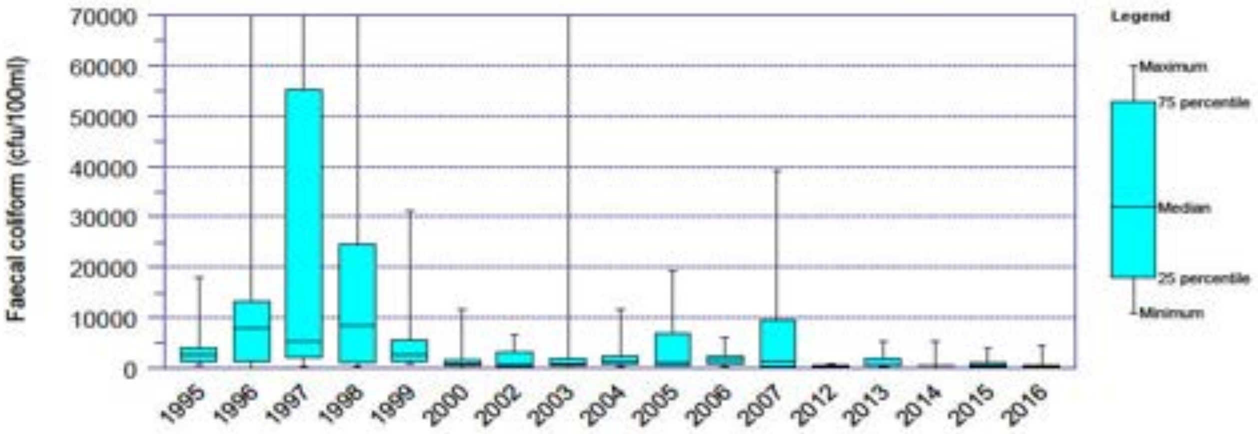


Figure H-6 Box plot summary of faecal coliform counts for Opahu Stream at Whites Line West

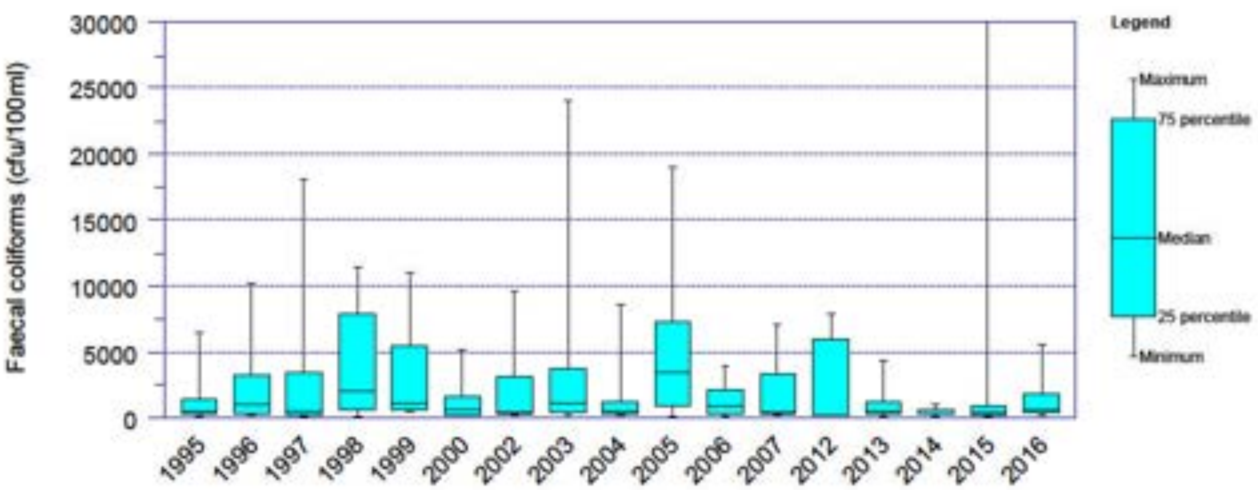


Figure H-7 Box plot summary of faecal coliform counts for Te Mome Stream at Bracken St

Wainuiomata River and tributaries

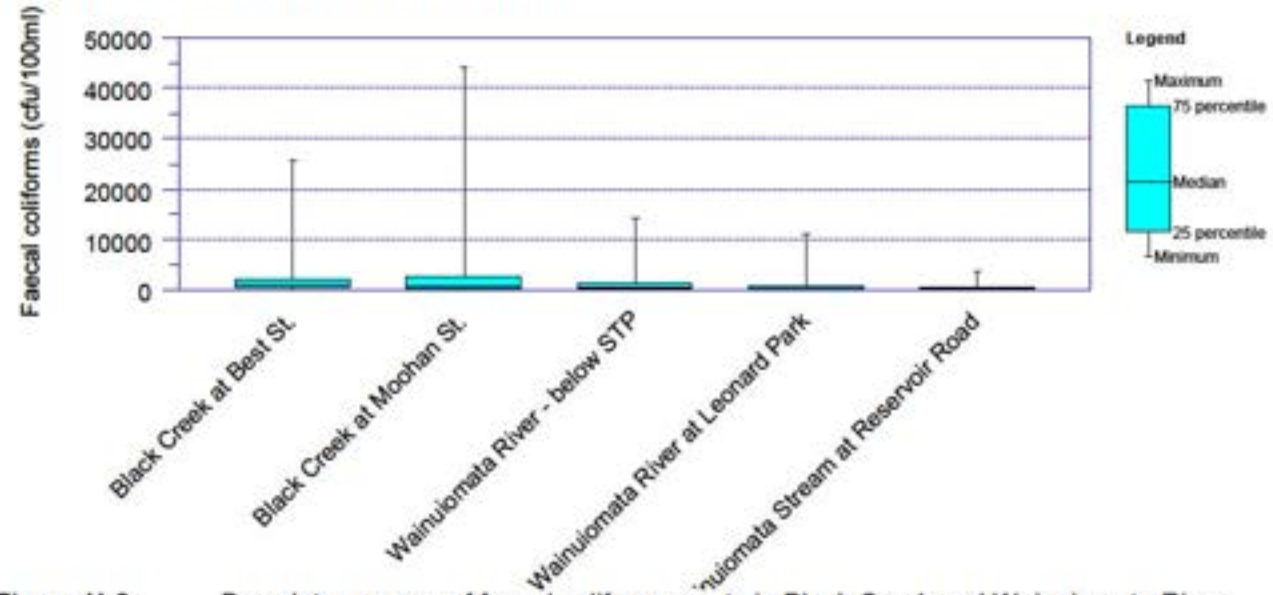


Figure H-8: Box plot summary of faecal coliform counts in Black Creek and Wainuiomata River

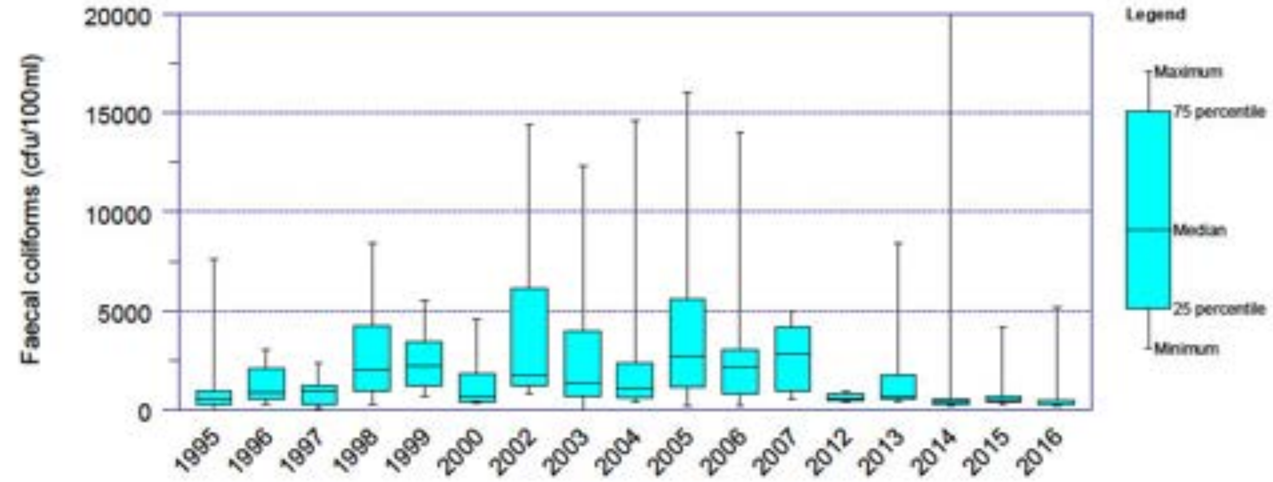


Figure H-9: Box plot summary of faecal coliform counts for Black Creek at Moohan St (sample size = 186)

Appendix I Microbiological contamination in minor streams and culverts: PCC

Porirua has commissioned additional monthly monitoring at the nine sites shown in Table I-1. Water samples collected at these locations are tested for the indicator bacteria *E. coli* to monitor the level of microbiological contamination in these watercourses. Summary statistics for the period January 2015 to August 2016 show that median values at four sites achieved the recommended *E. coli.* guideline while the other five stream sites were significantly in excess of the guideline, possibly indicating faults in or overflows from adjacent sewer pipes (Table I-2).

Table I-1: Location of WCC stormwater culvert and stream outlet monitoring locations

Site No.	Site Name	NZMG		NZTM	
		Easting	Northing	Easting	Northing
PCCSWM-01	Taupo Stream	2666939	6011854	1756920	5450140
PCCSWM-02	Duck Creek	2669605	6009390	1759585	5447675
PCCSWM-03	Browns Bay Stream	2668020	6009445	1758000	5447731
PCCSWM-04	Kenepuru Stream	2664838	6006204	1754817	5444490
PCCSWM-05	Semple Street culvert	2664529	6006928	1754509	5445215
PCCSWM-06	Te Hiko culvert	2664246	6007516	1754226	5445803
PCCSWM-07	Onepoto Drain	2664798	6009058	1754778	5447344
PCCSWM-08	Gloaming Hill	2665106	6008711	1755086	5446997
PCCSWM-09	Titahi Bay South Access	2663912	6009297	1753892	5447583

Table I-2: *E. coli.* (cfu/100 ml) summary statistics for minor streams (monthly, Jan 2015 - Aug 2016)

Site No.	Site Name	Guideline*	minimum	Median*	95%ile	maximum	n
PCCSWM-01	Taupo Stream	≤1000	52	350	21,300	23,000	21
PCCSWM-02	Duck Creek	≤1000	88	240	8,585	17,000	21
PCCSWM-03	Browns Bay Stream	≤1000	310	3,000	24,400	31,000	21
PCCSWM-04	Kenepuru Stream	≤1000	110	1,700	11,470	14,000	21
PCCSWM-05	Semple Street	≤1000	410	16,000	266,000	420,000	21
PCCSWM-06	Te Hiko	≤1000	12	110	5,815	6,200	21
PCCSWM-07	Onepoto	≤1000	35	380	24,850	32,000	21
PCCSWM-08	Gloaming Hill	≤1000	56	1,100	6,895	8,600	21
PCCSWM-09	Titahi Bay South Access	≤1000	56	2,200	12,885	18,000	21

*Median *E. coli.* value <1000 cfu/100 ml (PNRP & NPS-FM for secondary contact recreation)

Appendix J Owhiro Stream quarterly monitoring data

Table H-1: Summary statistics for Owhiro Stream (OSU) water quality below the urban area of Brooklyn, based on dry weather quarterly sampling from January 2011 to December 2016 (data from T&T Landfills monitoring program). ANZECC 90% trigger values are default and (hardness adjusted)

Parameter	Unit	n sample	Site OSU			ANZECC 90%
			Median	95%ile	maximum	
pH	pH	19	7.6	7.8	7.8	6-9
Alkalinity (as $CaCO_3$)	g/m^3	19	51	62	63	NA
Hardness (as $CaCO_3$)	g/m^3	19	63	73	74	NA
Electrical conductivity	mS/m	19	34.7	51.7	64	NA
Dissolved calcium	g/m^3	19	14.3	16.5	16.7	NA
Dissolved magnesium	g/m^3	19	6.6	7.7	7.8	NA
TSS	g/m^3	19	<3	3	5	NA
COD	g/m^3	19	<6	10	22	NA
Total ammonia-N	g/m^3	19	<0.01	0.099	0.099	1.43 (2.34)
Arsenic (Total)	g/m^3	20	<0.002	<0.002	<0.002	NA
Arsenic (dissolved)	g/m^3	10	<0.002	<0.002	<0.002	0.042
Cu (Total)	g/m^3	25	0.002	0.004	0.004	NA
Cu (Dissolved)	g/m^3	10	0.002	0.004	0.004	0.0018 (0.0028)
Chromium (total)	g/m^3	20	<0.002	<0.002	<0.002	NA
Chromium (Dissolved)	g/m^3	10	<0.002	<0.002	<0.002	0.006
Iron (Total)	g/m^3	25	0.033	0.282	0.840	NA
Iron (Dissolved)	g/m^3	10	0.015	0.004	0.090	1.00*
Manganese (Total)	g/m^3	25	0.003	0.005	0.005	NA
Manganese (Diss.)	g/m^3	10	0.003	0.006	0.006	2.5
Pb (Total)	g/m^3	25	<0.002	0.003	0.005	NA
Pb (Dissolved)	g/m^3	10	<0.002	<0.002	<0.002	0.0056 (0.011)
Zn (Total)	g/m^3	25	0.016	0.024	0.037	NA
Zn (Dissolved)	g/m^3	10	0.020	0.032	0.032	0.015 (0.027)

Appendix K Gracefield stormwater monitoring programme

Discharge permit WGN070053 [25551] authorises the discharge of stormwater from the lower Gracefield area (within the Waiwhetu Catchment) to the Waiwhetu Stream. Conditions of the consent require preparation of a stormwater monitoring plan and submission of annual report presenting results of monitoring required by that plan. Over the last six years intensive stormwater quality and quantity monitoring has been undertaken at 13 sites including 11 sites within the stormwater network and two streams site above the urban edge. The monitoring locations are shown in Figure I-1.

Stormwater samples are collected during the initial phase of four rainfall events and twice during dry weather in each monitoring year. The monitoring includes:

- In situ field measurements for pH, dissolved oxygen (DO), electrical conductivity (EC), and water temperature, and
- Laboratory analysis of grab samples for suspended solids (SS), faecal coliforms (FC), as well as total and dissolved Pb (Pb), chromium (Cr), Cu (Cu), Zn (Zn) and antimony (Sb) and
- Measurement of stormwater flows and rainfall during each sample collection.

The results of metal and indicator bacteria monitoring for the year ending 30 June 2016 are detailed in annual reports (see Wellington Water 2016) and summarised below in Tables I-1 and I-2. Possible sources of contamination and site rankings are summarised in Table I-3. The monitoring results indicate that the quality of stormwater runoff from the Gracefield catchment is comparable to other light industrial and commercial catchments elsewhere in New Zealand, with Zn and suspended solids concentrations mostly towards the lower end of the expected range, while Cu and Pb were mostly towards the upper end of the range.

Having characterised the quality and quantity of stormwater discharges from the Gracefield area, Wellington Water are now seeking to rationalise the monitoring and focus more strongly on mitigation.

Gracefield has separate wastewater and stormwater networks, how stormwater inflow and infiltration into the wastewater network causes increases wastewater flows in the wet weather, at times resulting in overflows. A box plot summary of wet weather faecal coliform results at 13 sites across the Gracefield network is shown in Figure I-2. In Figure I-3 the combined results from sites 1A and 2A, near the bottom of the catchment, indicate the microbiological quality of stormwater before it discharges into Waiwhetu Stream. 2013 stands out as the worst year with a median value of around 11,000 cfu/100 ml whereas the 2016 results are encouraging with a median of around 3,000 cfu/100 ml. It is noted that these results are from targeted wet weather monitoring when wastewater overflows are most likely to occur.

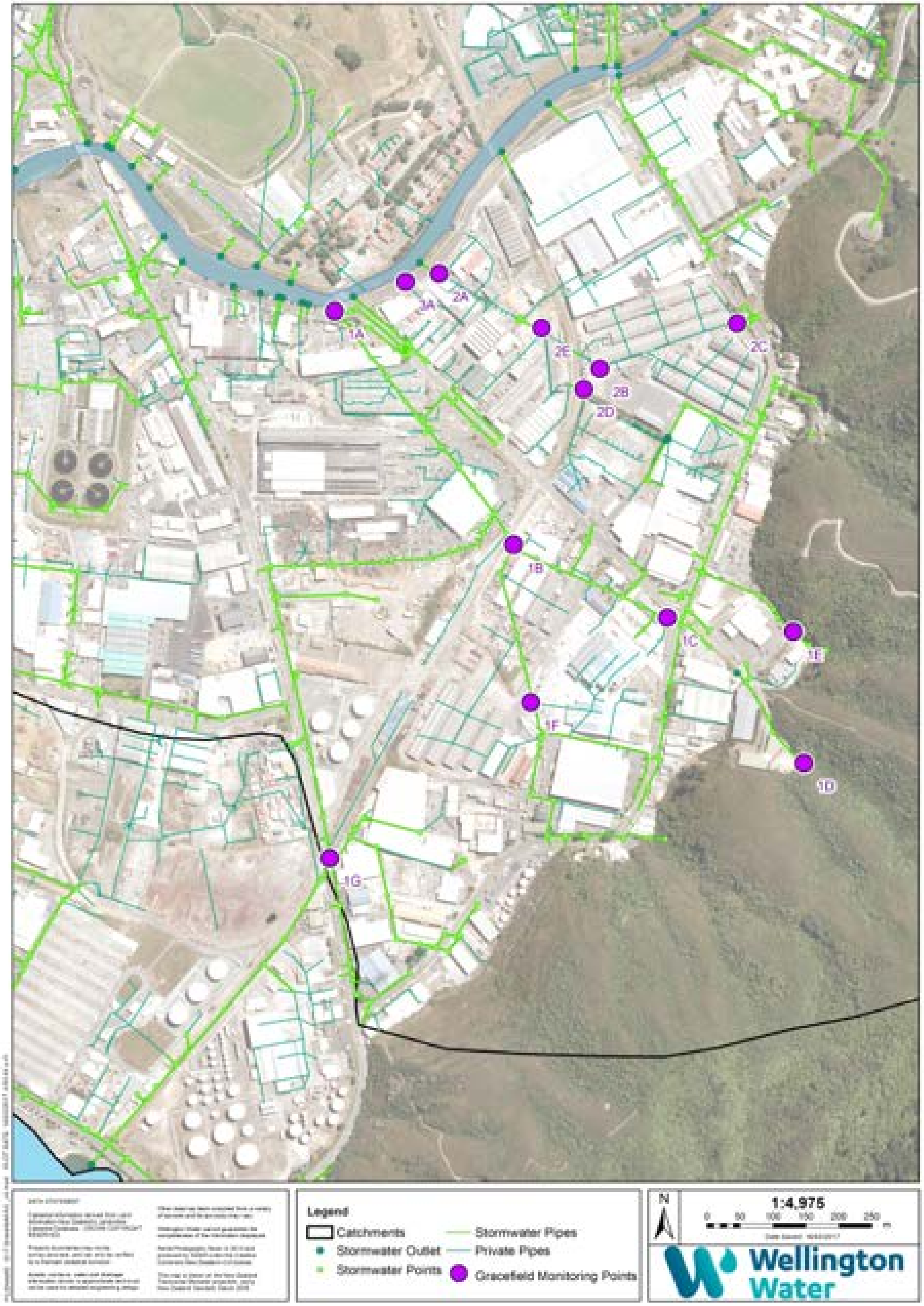


Figure I-1: Stormwater sampling locations in the Gracefield catchment (red/while dots)

Table I-1 Stormwater sampling locations in the Garacefield catchment

Sample Point	Sample Point Name	GPS Co-ordinates	Location
1A	Your Kitchen Ltd @ Park Rd Car Park	-41.237082,174.909548	Entranceway in from 50 Parkside Rd into Your Kitchen Ltd Building (lots of other companies on site). Manhole for sampling located in yard.
1B	Turners Auctions Inside Yard	-41.240228,174.912885	120 Hutt Park Rd. Manhole in Turners Auctions yard.
1C	At Dulux Manhole Inside yard on Corner	-41.241182,174.915701	Drive into Dulux on Hutt Park Rd. Manhole next to Cafe in cnr in yard.
1D	By Tunnel Grove	-41.243131,174.918233	Tunnel Grove Rd. Open culvert to sample point pipe. Park vehicle as far up as you can drive up to then walk a further approx 100m.
1E	Behind Trucks and Trailers (about to change occupant again though)	-41.241336,174.917986	13 & 15 Tunnel Grove Rd. 2 different companies on the 1 site. Sample site is a grided manhole in cnr of yard.
1F	At Dulux Manhole Inside yard on Corner near TW Site	-41.242384,174.91325	Drive into Dulux on Hutt Park Rd.
1G	By Wind Turbine in Seaview Rd	-41.244575,174.909672	Manhole at Wind Turbine on Seaview Rd. Manhole marked blue paint 'x' [Does this system drains to the marina? Not to Waiwhetu?]
2A	55 Heberley Park	-41.236535,174.911426	55 Parkside Rd. Manhole in cnr of yard. Notify owners you are there.
2B	Anderson Flowers B	-41.237792,174.914373	101/119 Gracefield Rd. Drive down towards end of building, just before the end is sample site - manhole. Sometimes there are vehicles parked over manhole.
2C	Anderson Flowers A	-41.237128,174.916846	101/119 Gracefield Rd. Manhole on footpath just before entranceway.
2D	Rear of Mainfreight Stream	-41.238074,174.914089	101/119 Gracefield Rd. Drive down driveway towards end of building. Sample from stream at the end - this runs through the property.
2E	Galvanising Plant in Hutt Park Rd	-41.237251,174.913301	123 Hutt Park Rd. Manhole in yard. Drive down to Galvanising Plant & sign in before & out after sampling.
3A	Former Komatsu Yard Manhole on Parkside Road	-41.236658,174.91082	51 Parkside Rd. Manhole in cnr of yard. Always lots of vehicles parked over manhole. Have been told to take sample from DS from manhole in yard to 1 out on road (same stormwater line).

Table I-2: *Wet weather* dissolved and total metals, TSS and faecal coliform median values in Gracefield stormwater for **the year to June 2016** (n = 4) compared with URQIS-NZ statistics. Gracefield median values below ANZECC TVs (*or consent 'environmental targets') are shaded blue, values below the URQIS lower quartile are shaded green, values between the lower quartile and median are amber, values above the URQIS median are shaded red.

	1A	*1B*	*1C*	*1D*	*1E*	*1F*	*1G*	*2A*	*2B*	*2C*	*2D*	*2E*	*3A*	ANZECC 90% TV	URQIS - NZ Light Industry & Commercial		
															Lower quartile	*Median*	*Upper quartile*
Cu, dissolved	15	10	12	<0.5	2	2	42	4	4	3	5	4	7	1.8	3.3	6.0	13
Cu, total (µg/L)	26	18	18	1	4	4	90	6	5	7	8	7	11	-	7.9	15	32
Zn, dissolved	371	295	343	2	3	432	548	317	131	334	319	298	1,260	15	150	380	800
Zn, total (µg/L)	421	375	482	6	9	487	786	383	137	419	415	365	1,190	-	160	470	980
Pb, dissolved	8	2	1	<0.5	<0.5	1	9	2	2	1	2	7	1	5.6	0.18	0.38	0.75
Pb, total (µg/L)	35	28	8	1	2	5	67	15	7	8	12	48	7	-	1.6	3	6.7
TSS (mg/L)	23	19	35	<2	13	15	29	20	7	23	45	25	14	50*	7.0	21	58
FC (cfu/100 ml)	3,400	1,585	640	<2	1,372	2,850	285	6,800	2,790	345	13,750	23,100	1,395	1,000*	480	2,800	15,000
Mean flow (L/s)	63	23	15	0.4	-	7	16	15	5	0.5	4	16	1.5				

Table I-3: *Dry weather* dissolved and total metals, TSS and faecal coliform median values in Gracefield stormwater for **the year to June 2016** (n = 2), plus 4 additional samples for 1A, 2A and 3A). Gracefield median values below ANZECC TVs (*or consent 'environmental targets') are shaded blue, below the URQIS lower quartile are shaded green, between the lower quartile and median are amber, and values above the median are shaded red.

	1A	*1B*	*1C*	*1D*	*1E*	*1F*	*1G*	*2A*	*2B*	*2C*	*2D*	*2E*	*3A*	ANZECC 90% TV	URQIS - NZ Light Industry & Commercial		
															Lower quartile	*Median*	*Upper quartile*
Cu, dissolved	2	2	4	<1	1	1	2	3	No data	1	<1	<1	2	1.8	3.3	6.0	13
Cu, total (µg/L)	2	2	4	1	2	5	27	5		3	1	1	2	-	7.9	15	32
Zn, dissolved	37	26	11	1	2	82	28	91	No data	26	11	34	39	15	150	380	800
Zn, total (µg/L)	46	26	19	3	4	230	179	125		34	24	46	114	-	160	470	980
Pb, dissolved	3	3	<1	<1	<1	1	2	3	No data	<1	<1	1	2	5.6	0.18	0.38	0.75
Pb, total (µg/L)	6	4	1	1	1	179	170	20		1	2	26	13	-	1.6	3	6.7
TSS (mg/L)	<2	3	<2	<2	32	3	53	20	No data	4	14	11	9	50*	7.0	21	58
FC (cfu/100 ml)	190	2300	74	<2	25	405	465	108	No data	292	1160	210	210	1000*	480	2,800	15,000
Mean flow (L/s)	1.1	<1	<1	<1	2.8	0.15	0.25	<1	No data	1.4	2	5.5	1.1				

Table I-4: Contaminant load rankings for Gracefield Stormwater catchments (Wellington Water, 2016)

Catchment	Priority	Contaminant Load Ranking	Possible sources of contaminants
1A	**1 HIGH**	Cu (1) Zn (1) Pb (1) TSS (1) FC (2)	• Major source of Cu, Pb, Zn, TSS and FC. • Macaulay Metals (Cu, Zn, Pb). • ITM timber treatment yard (Cu) • Turners, large Znalume roof, wash pad (Cu, Zn, Pb) • Perry Metal Protection (Zn). • FC contamination
1B	**2 HIGH**	Cu (3) Zn (3) Pb (4) TSS (4) FC (3)	• Major source of Pb • Vehicle dismantler, battery storage (Cu, Zn, Pb) • Old Exide site now built on by large Masterpet building (Pb) • FC contamination
1G	**3 HIGH**	Cu (2) Zn (2) Pb (2) TSS (5) FC (8)	• Major source of Cu, Pb, Zn
2E	**4 HIGH**	Cu (5) Zn (6) Pb (3) TSS (6) FC (1)	• Moderate source of Pb, TSS and FC • Perry Metal Production (Cu, Pb and Zn) • Bob Thompson Spray Painting & Panel-beating (Cu, Pb and Zn) • FC contamination
1C	**5 MEDIUM**	Cu (4) Zn (5) Pb(5) TSS (3) FC (6)	• Major source of Cu and Zn – specific source not determined. • FC contamination
1F	**6 MEDIUM**	Cu (6) Zn (4) Pb (6) TSS (2) FC (7)	• Moderate source of Cu, Pb, Zn & FC • Linfox Logistic NZ – Zn roofs (Cu, Zn Pb) • Dulux (Cu, Zn, Pb) • FC contamination
2D	**7 MEDIUM**	Cu (7) Zn (8) Pb (8) TSS (7) FC (4)	• Moderate source of Cu, Pb, Zn, TSS and FC. • Former Exides Batteries yard (Pb) • Perry Metals Galvanising Plant (Zn) • Mainfreight Transport yard (Cu, Pb, Zn, TSS) • FC contamination
2A	**8 MEDIUM**	Cu (8) Zn (7) Pb (7) TSS (8) FC (5)	• Major source of Zn, Pb, TSS & FC • Lowes Automotive • Improper washing (Cu, Pb, Zn and TSS) • The Heavy Metal Company (Cu, Pb, Zn and TSS) • FC contamination
3A	**9 MEDIUM**	Cu (9) Zn (8) Pb (9) TSS (9) FC (9)	• High Zn concentrations (but low SW flows)" • Perry Metals Galvanising Plant (Zn) • The Heavy Metal Company (Zn) • Galvanised roofs (Zn) • Fire Services Truck Washing (Cu, Pb, Zn, TSS)
2B	**10 LOW**	Cu (10) Zn (10) Pb (10) TSS (11) FC (10)	• No significant contaminant sources
2C	**11 LOW**	Cu (11) Zn (9) Pb (11) TSS (10) FC (11)	• No significant contaminant sources
1D	**12 LOW**	Cu (12) Zn (12) Pb (13) TSS (12) FC (13)	• Upstream reference site – no significant contaminant sources
1E	**13 LOW**	Cu (13) Zn (13) Pb (12) TSS (13) FC (12)	• Upstream reference site – no significant contaminant sources

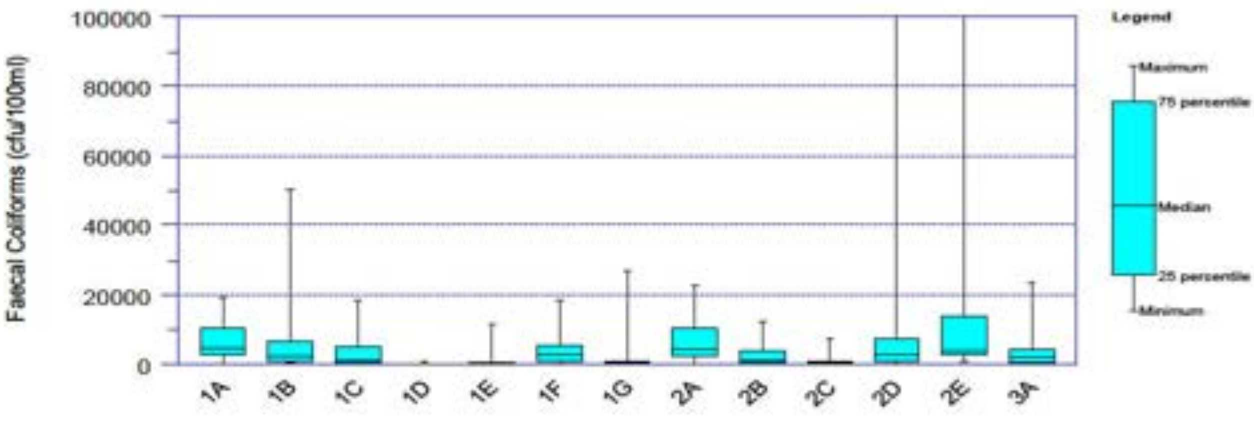


Figure I-2: Box plot of faecal coliforms (cfu/100 ml) in stormwater runoff at 13 sites across the Gracefield network (n= 31, June 2009 to June 2016)

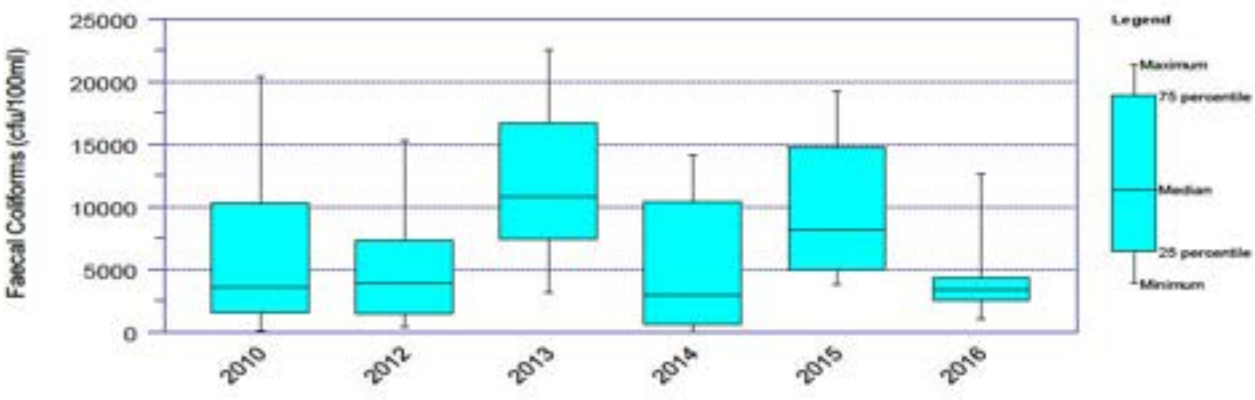


Figure I-3: Box plot of faecal coliforms (cfu/100 ml) in stormwater runoff at sites 1A and 2A (combined) by year

Appendix L Wastewater overflows to the Wellington stormwater network

Wellington City has separate wastewater and stormwater networks, however much of the wastewater system is aged and approximately 32% is in poor condition (MWH, 2008; Capacity, 2014). The current wastewater reticulation system is conveyed to the Interceptor Wastewater Network, which begins in Ngauranga Gorge, traverses the Kaiwharawhara and Ngaio foothills, passes through Thorndon and the western edge of the central business district, through Newtown and under Mount Victoria before passing through Kilbirnie and the airport to the Moa Point Waste Water Treatment Plant (WWTP). Most of the wastewater comes from domestic and commercial sources (approximately 70%). Industrial flows comprise less than 15% of the total. Approximately 10 to 15% of the dry weather flow comes from groundwater infiltration into the system.

While stormwater inflow and groundwater infiltration (I/I) account for about 12% of the dry weather flows reaching the Moa Point WWTP, the proportion of I/I increases significantly during or immediately after rainfall events, and in some wastewater catchments in the City the ratio of peak wet weather flows (PWWF) to average dry weather flows (ADWF) is as high as 10:1. One of the consequences of I/I is that the mixed flow of wastewater, stormwater and groundwater can exceed the capacity of pump stations and/or the main sewer interceptor or the reticulation network, particularly in the lower parts of the catchment.

To enable the system to cope with intense weather events, the wastewater networks have relief features, such as constructed overflow weirs or pumping station wet well weirs, resulting in wastewater overflows to the stormwater network, and hence to streams or the sea (Capacity, 2014). The location of these overflow structures in the Wellington urban area is shown in Figure L-1.

A six year staged wastewater overflow monitoring programme conducted by Wellington Water (then Capacity) from mid-2008 to mid-2014 included a total 59 overflow weir structures (constructed and pump station wet well have been included in the programme. The result of monitoring for the first five of those years are summarised in Figure L-2 and Table L-1

Wastewater pumps are located in low lying areas within the wastewater reticulation network to lift flows to the gravity network system. There are altogether more than 50 pump stations in the Wellington reticulation network. The majority of them are located along the coastline. All pump stations incorporate a small amount of overflow storage in wet wells and some include additional detention facilities which enable excess wastewater to be stored during peak flow conditions, thereby reducing the frequency of overflow events. Wastewater pump stations details are included in Table L-2

Monitoring data has recently been augmented by predictions of catchment overflows using a computer model of the main wastewater interceptor. The monitoring data and modelling output indicate that the most significant wastewater overflow point in the network is at Murphy Street where a constructed overflow provides significant relief for the downstream network. Modelling predictions for annual overflow frequencies and volumes at Murphy Street are summarised in Figure L-3.

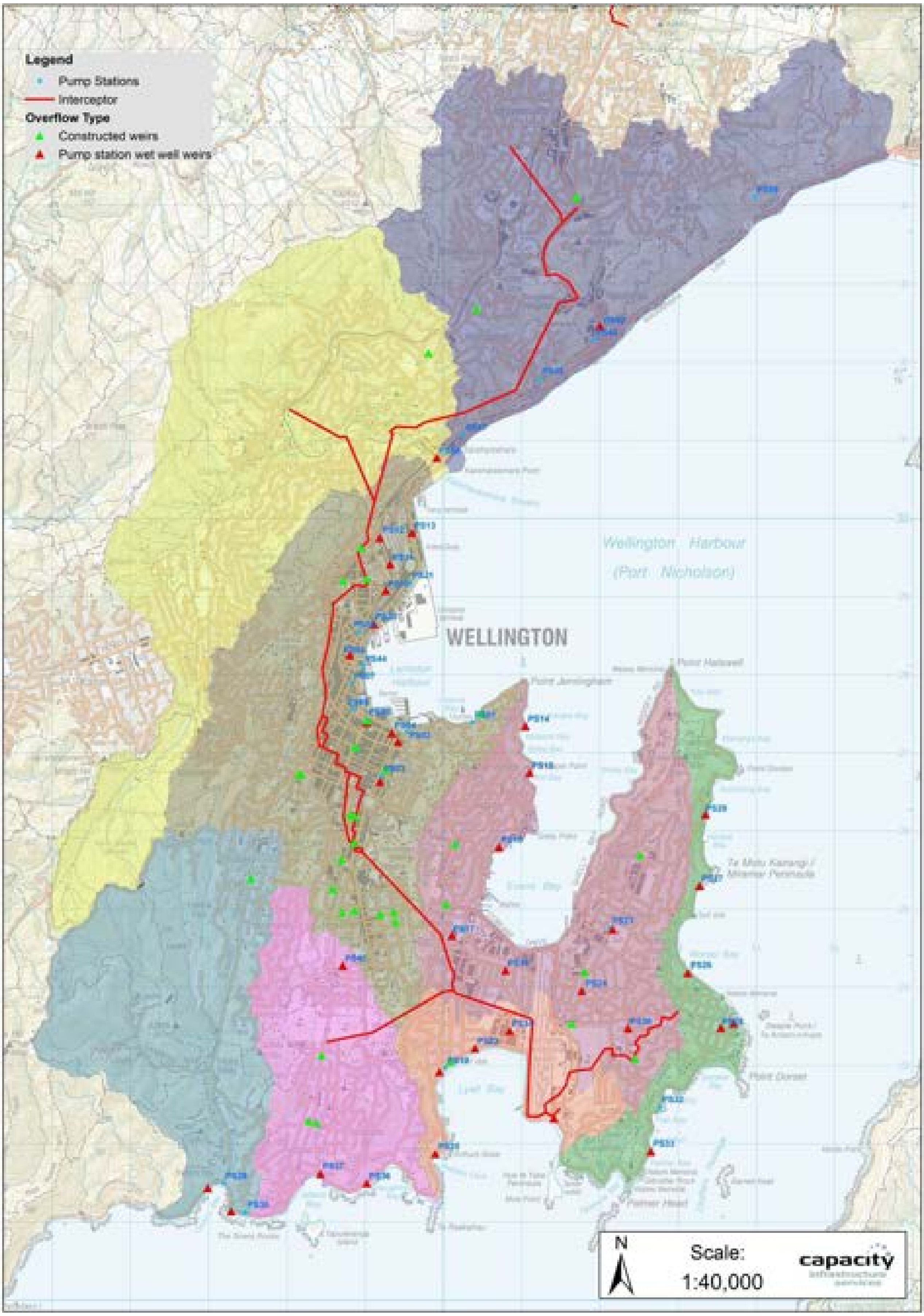


Figure L-1: Location of overflow weirs in the Wellington urban area (from Capacity, 2014)

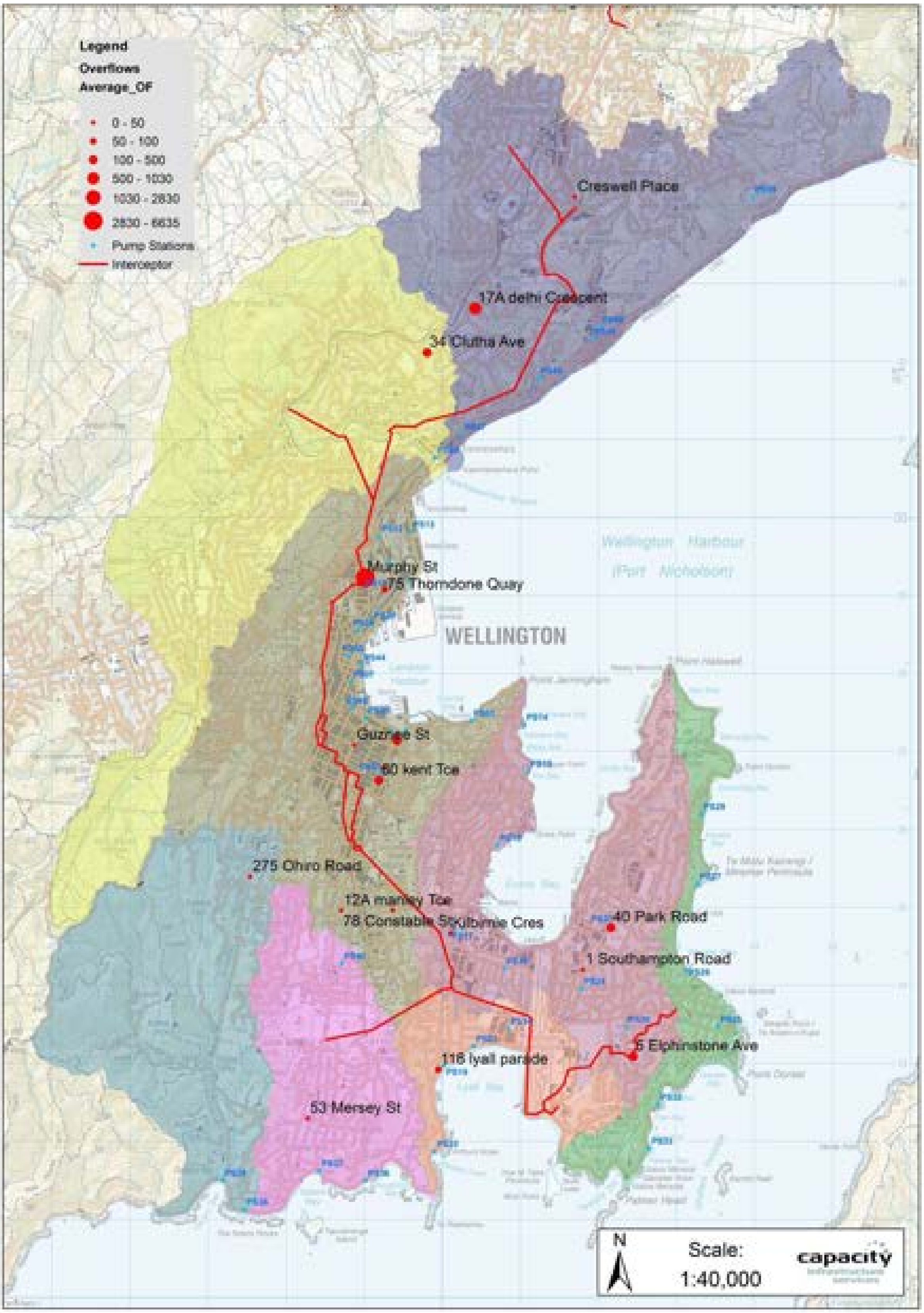


Figure L-2: Average annual overflow volumes from 2008/09 to 2012/13 (from Capacity, 2014)

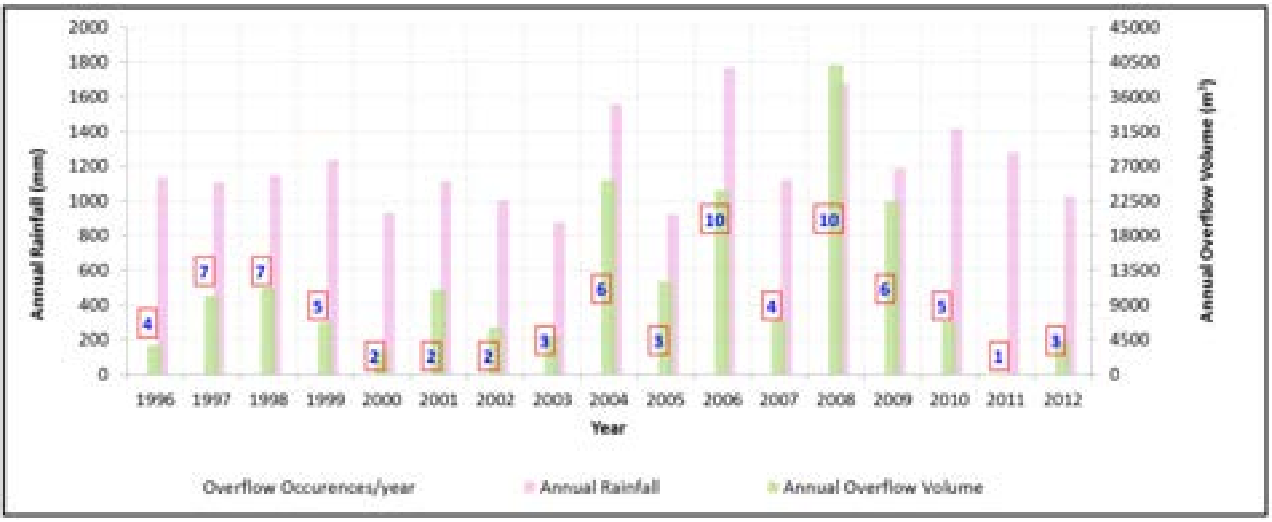


Figure L-3: Wastewater overflow volumes and frequency at the Murphy Street constructed overflow

Table L-1: Summary of monitoring results for the 2008/09 to 2012/13 monitoring years (from Capacity, 2014)

Overflow type	PS ID	Address	TOTAL VOLUME DISCHARGED					NO OF OVERFLOW INCIDENTS				
			2008/09	2009/10	2010/11	2011/12	2012/13	2008/09	2009/10	2010/11	2011/12	2012/13
Con	AC32042	34 Clutha Ave			245.21	203.95	209.77			16	35	9
Con	AD35026	17A Delhi Crescent	28.61	4109.4	419.64	580.56	0	12	15	9	13	-
PS	AD41017	Centennial Highway (PS49)			0	0	0			0	-	-
Con	AH40056	Creswell Pl		59.21	2.56	3.98	0		8	2	4	2
PS	A23026	Owhiro Bay Boat Ramp				0	0				-	-
PS	B22003	Owhiro Bay (PS39)		0	0.002	0	0		-	1	-	-
PS	B28027	230 The Esplanade (PS38)			0	0	0			3	-	-
PS	B30013	126 The Esplanade (PS36)			0	0	0.01			0	-	1
PS	C33007	398 Queens Drive (PS35)			0	0	0			0	-	-
PS	F34002	118 Lyall Parade (PS19)			0	178.39	0			1	1	-
Con	F43057	5 Elphinstone Ave		1291.1	8.41	0	6.37		10	3	-	3
Con	I41006	1 Southampton Road			37.78	4.13	0			4	9	-
PS	J42059	40 Park Road (PS23)	103	661	464.5	161.88	640.11	5	2	6	3	1
Con	K28037	12A Manley Tce		18.48	6.69	11.91	61.2		4	2	2	4
Con	K30090	47 Constable St		0	0	0	0		1	4	-	-
Con	K31051	78 Constable St		0	0	5.66	145.59		20	6	6	5
Con	K34008	Walmer St/Wellington Rd		9.14	94.63	52.68	43.91		4	5	8	5
Con	L24040	275 Ohiro Road		0.45	5.03	0	36.86		1	1	-	3
Con	O11060	115 South Karori Rd			5.88	0	0			12	-	-
Con	O30009	38 Kent Tce		0.55	114.82	0	81.78		1	2	-	6
PS	O30050	60 Kent Tce (PS03)		284.46	353.65	123.06	465.97		11	8	10	17
Con	P29009	Taranaki/Ghuznee St		5.48	4.71	0	9.98		2	2	-	3
PS	P31051	Kent & Wakefield (PS02)		229.92	732.5	500.57	453.17		3	6	7	7
Con	Q10005	62a South Karori Rd	1306.2	1440.9	1621.8	259.19	9506.6	4	5	3	4	8
Con	R17061	20 Scapa Tce			0	0	0			0	-	-
Con	R17082	29 Firth Tce			0	0	0			0	-	-
PS	S29009	152 Featherston St (PS08)			0	0	0			0	-	-
Con	U29081	Murphy Street			0	3313.26	16582.78			-	4	6
PS	U30057	75 Thorndon Quay (PS10)			96.47	3.16	187.22			2	1	3
Con	D27007	53 Mersey St		43.09					1			
Con	F28003	25 The Parade		0					-			

Overflow type	PS ID	Address	TOTAL VOLUME DISCHARGED					NO OF OVERFLOW INCIDENTS				
			2008/09	2009/10	2010/11	2011/12	2012/13	2008/09	2009/10	2010/11	2011/12	2012/13
PS	J34024	Kilbirnie Cres (PS17)		4.44					1			
Con	K28011	49 Hall St		0					-			
Con	K31071	91 Owen St		0					-			
Con	L28012	190 Tasman St	0	0				-	-			
Con	M34048	24 Moxham Rd		0					-			
Con	N29020	76 Tasman St		0.14					1			
Con	N29036	17 Douglas St		0					-			
Con	O26027	3 Brooklyn Rd		0					-			
PS	Q29023	Michael Fowler (PS6)		0					-			
Con	Q29218	19 Taranaki St		0					-			
PS	Q31041	Chaffers St (PS04)	0	0				-	-			
Con	Q35005	308 Oriental Pde		0					-			
Con	U28005	38 Hawkestone St		0					-			
Con	V29083	62A Tinakori Rd		0					-			
PS	Y33048	Old Hutt Rd (PS46)		0					-			
Con	G40034	386 Broadway	0					-				
Con	K29056	38 Rintoul St	0					-				
PS	V30058	157 Thorndon Quay	0					-				
PS	W30043	243 Thorndon Quay	0					-				

Table L-2: WCC wastewater pump station details

Pump Station Number	Pump Station Name	Address	Number of Pumps	ADWF (l/s)	Pump Capacity (l/s)	Year Constructed	Year of Last Major Rehab	Wet Well Volume (m^3)	Additional Storage (m^3)
PS 1*	Oriental Bay	opp. 260 Oriental Pde	3	6.14	30.88	1957	2002	5.00	88
PS 2	Oriental Pde	opp. 66 Oriental Pde	3	13.26	44.42	1957	1989	5.00	
PS 3	Kent Tce	opp. 54 Kent Tce	3	14.69	59.84	1957	1989	7.50	
PS 4	Chaffers St	outside New World	3	18.05	59.97	1957	1995	6.90	
PS 5*	Jervois Quay	Cnr Jervois Quay & Taranaki St	3	7.86	37.9	1961	2004	7.30	110
PS 6*	Wakefield St	Michael Fowler Centre	3	17.64	82.27	1961	2004	8.70	250
PS 7*	Willeston St	cnr Willeston St & Victoria St	3	21.19	61.49	1961	2007	8.00	300
PS 8	Featherston St	151 Featherston St	2	12.42	34.17	1910	2003	4.20	
PS 9	Whitmore St	cnr Whitmore St & Featherston St	3	21.83	78.59	1954	1999	6.00	
PS 10	Thorndon Quay, South	opp. 77 Thorndon Quay	3	5.42	43.6	1930	2001	5.10	
PS 11	Thorndon Quay, Middle	188 Thorndon Quay	3	1.8	21.3	1930	1988	5.10	
PS 12	Thorndon Quay, North	248 Thorndon Quay	3	3.24	67	1930	2001	5.60	
PS 13	Aotea Quay	warehouse in Tranz Rail yard	2	0.09	4.04	1993	1993	0.60	
PS 14	Balaena Bay	opp. 70 Evans Bay Pde	2	1.84	18.49	1950	1997	3.40	
PS 15	Kio Bay	194 Evans Bay Pde	2	0.5	17.27	1950	1996	2.00	
PS 16*	Rata Rd	cnr. Rata Rd & Evans Bay Pde	3	6.5	45	1940	1998	2.70	95
PS 17*	Tully St	2 Tully St	3	6.04	37.22	1964	1998	3.60	90
PS 18*	Salek St	2 Salek St	3	9.36	58.63	1964	2006	9.20	135
PS 19*	Lyall Bay, West	opp. 118 Lyall Pde	2	4.59	35.56	1954	2010	4.40	65
PS 20	Railway Station	cnr Bunny St & Waterloo Quay	3	0.76	8.48	1954	2008	1.50	
PS 21	Cornwell St	cnr Waterloo Quay & Cornwell St	2	0.36	13.16	1954	2000	2.30	

PS 22*	Lyall Bay, East	26 Lyall Pde	2	1.27	21.42	1940	1999	2.10	20
PS 23	Byron St	cnr Byron St & Park Rd	3	23.99	94.46	1958	1998	9.60	
PS 24	Devonshire Rd	cnr Devonshire Rd & Hobart St	3	15.47	76.27	1958	1999	6.80	
PS 25*	Seatoun Park	Hector St inside Seatoun Park	3	1.98	17.13	1958	2003	0.00	30
PS 26*	Ferry St	cnr Marine Pde & Ferry St	3	2.16	12.38	1964	2003	2.00	30
PS 27*	Worser Bay	opp. 305 Karaka Bay Rd	2	1.51	13.95	1950	2003	1.70	22
PS 29*	Karaka Bay Rd	455 Karaka Bay Rd	2	0.17	1.87	1935	2010	1.10	unknown
PS 30*	Strathmore Ave	17 Strathmore Ave	2	3.44	28.71	1940	2003	4.00	50
PS 31	Moa Point	near 33 Moa Point Rd	2	0.84	18.81	1996	1996	1.80	
PS 32*	Breaker Bay, North	opp. 126 Breaker Bay Rd	2	0.09	3.89	1994	2002	0.40	unknown
PS 33*	Breaker Bay, South	opp. 173 Breaker Bay Rd	2	0.84	4.85	1954	2002	1.90	12
PS 34*	Tirangi Rd	cnr Tirangi Rd & George Bolt St	2	0.93	15.55	1950	1999	1.20	15
PS 35	Arthur's Nose	opp. 398 Queens Dr	2	0.14	1.16	1987	1997	0.20	
PS 36*	Houghton Bay	opp 128 The Esplanade	2	2.38	13.18	1984	2001	1.10	35
PS 37*	Brighton St	cnr The Esplanade & Brighton St	2	5.5	16.5	1920	2001	1.50	80
PS 38	Island Bay	434a The Esplanade	4	98	750	1994	1994		
PS 39	Owhiro Bay	cnr Owhiro Bay Pde & Happy Valley Rd	2	0.25	6.21	1994	1994	0.70	
PS 40*	Waripori St	24 Waripori Street	2	2.1	12	2006	2006		30
PS 41*	Fort Dorset	Ludlum Cres	2		15.7	2002	2003		unknown
PS 42	Queenswharf Nth	Next to shed 5	2		12.2	2007	2007		
PS 44	Queens Wharf	basement next to Shed 5 ramp	2	0.65	7.49	1995	1995	1.50	
PS 45	Homebush Rd	Cnr Homebush Rd & Onslow Rd	2	0	2	1996	1996		
PS 46	Ngaio Gorge	2/112 Hutt Rd	3	3.31	70.59	1983	2002	8.00	
PS 47	Kaiwharawhara	156 Hutt Rd	2	0.09	2.15	1983	2004	1.50	

PS 48	Jarden Mile	cnr Ngauranga Gore & Hutt Rd	2	0	55	1980	1980		
PS 49	Ngauranga Gorge	Ngauranga Gorge near Hutt Rd	2	1	27.49	1984	1984	3.90	
PS 59	Oriental Bay	Part of Oriental toilets in pool carpark	2		5.6	2003	2003	0.20	

Appendix M Wastewater Overflows to the Porirua stormwater network

Porirua City has separate wastewater and stormwater networks. The wastewater network extends from Pukerua Bay at the northern end of the city, south to the boundary with Wellington City at Tawa, where it receives sewage from as far south as Johnsonville and Grenada. The part of the trunk system that transports sewage from Tawa to the treatment plant, and the plant itself are held in a joint venture with Wellington City and operated by Porirua. The rest of the local network is fully owned and operated by Porirua. There are a relatively large number of pumping stations due to the city's rolling topography, the spread-out nature of the townships served and the location of the treatment plant.

Porirua City has only one constructed network overflow but nearly 20 confirmed wastewater overflow locations, mostly from pump station weirs, which typically operate during periods of sustained wet weather when stormwater inflows or groundwater infiltration into the wastewater collection system cause flows to exceed the capacity of pipelines and pumping stations. The resulting overflows discharge either directly to streams or Porirua Harbour, or into the stormwater stormwater network which discharges into the streams or harbour (Figure M-1).

Wellington Water preliminary modelling predictions for overflow discharge volumes via constructed sewer outlets (CSO) or pump station weirs (PS) during a 6 month average return interval (ARI) rainfall event indicate that approximately 95% of the total overflow volume will discharge via a constructed overflow immediately upstream of PS20 to Porirua Stream. By comparison, the volume of wastewater overflow entering the stormwater network is relatively small. Further refinement of monitoring and modelling of wastewater overflow locations, volumes and flow rates is currently underway.

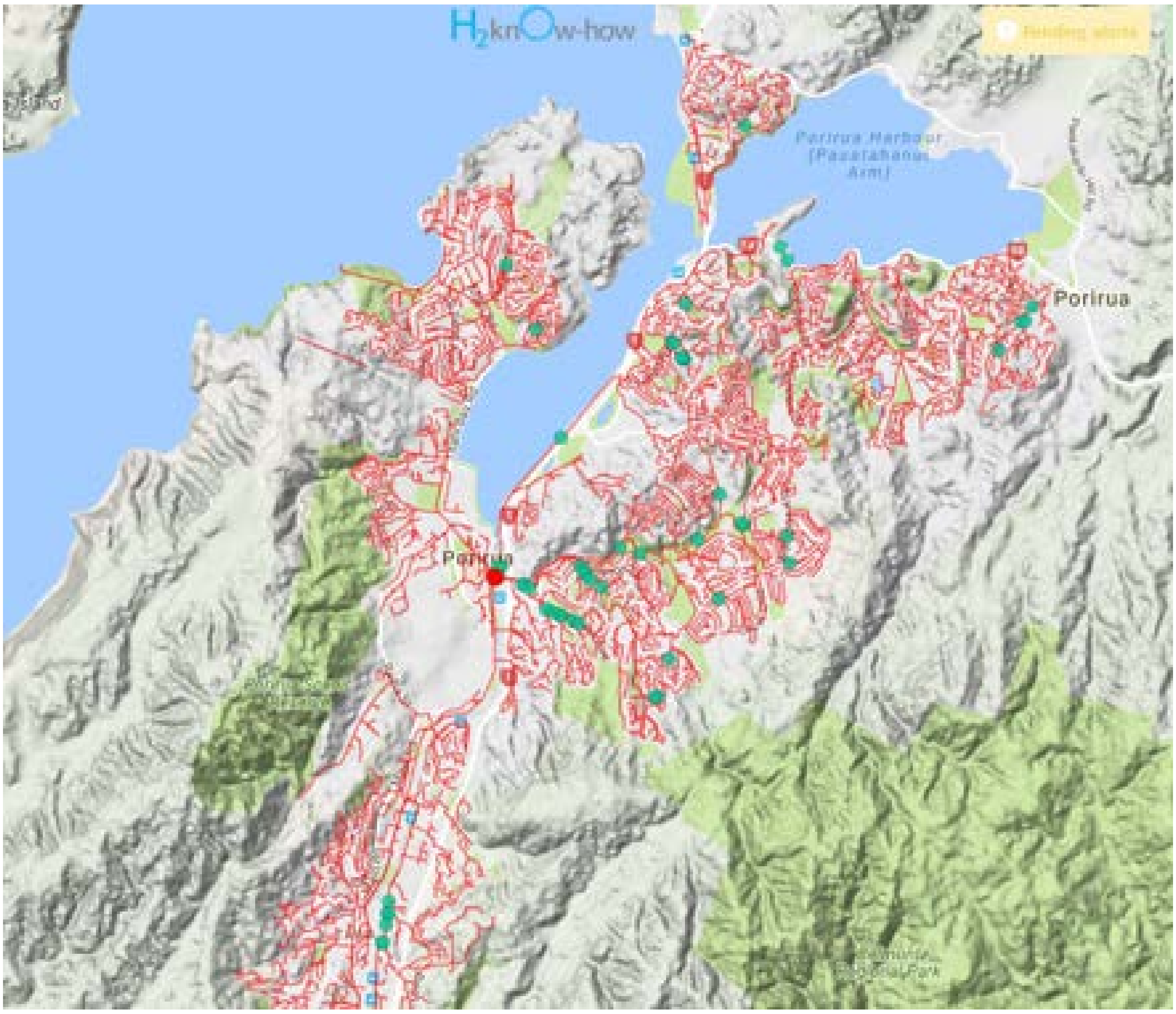
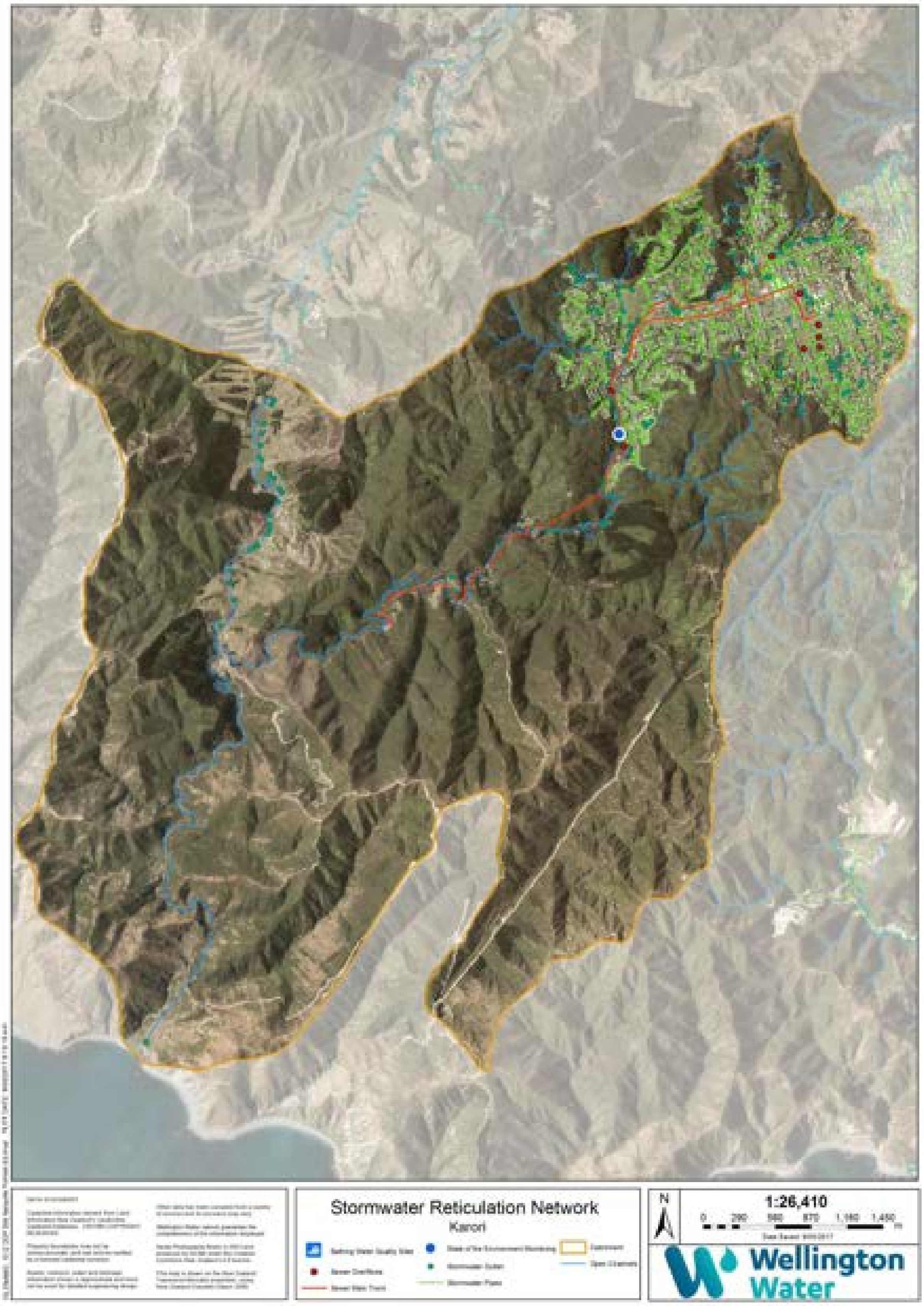


Figure M-1: Location of constructed wastewater overflows (red) and confirmed other wastewater locations in the Porirua Harbour catchment

Appendix N Wellington Harbour & Hutt Valley stormwater catchment map series




Stormwater Reticulation Network
Owhiro Bay
N
1:14,230
0 150 300 450 600 750
Wellington
Water

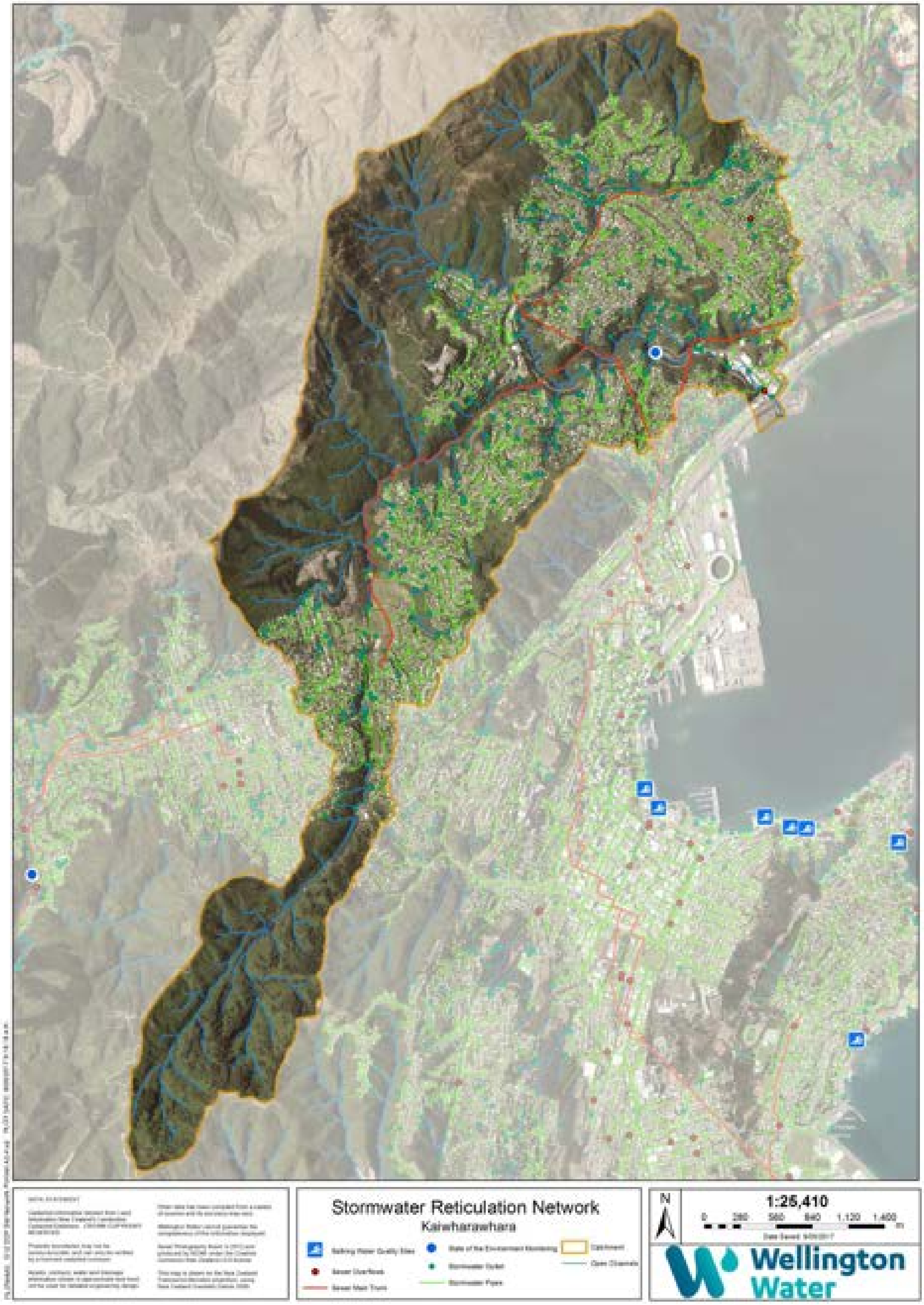

Stormwater Reticulation Network
Island Bay Houghton Bay
N
1:11,960
Wellington Water


Stormwater Reticulation Network
Lyall Bay
N
1:11,340
Wellington Water


Stormwater Reticulation Network
South East Coast
N
1:18,920
0
210
420
630
840
1,050
m
Wellington
Water


Stormwater Reticulation Network
Evans Bay
N
1:16,080
0 175 350 525 700 875
m
Wellington Water


Stormwater Reticulation Network
Lambton Harbour Oriental Bay
N
1:20,730
0 230 460 690 920 1,150
m
Wellington Water


Stormwater Reticulation Network
Kaiwharawhara
N
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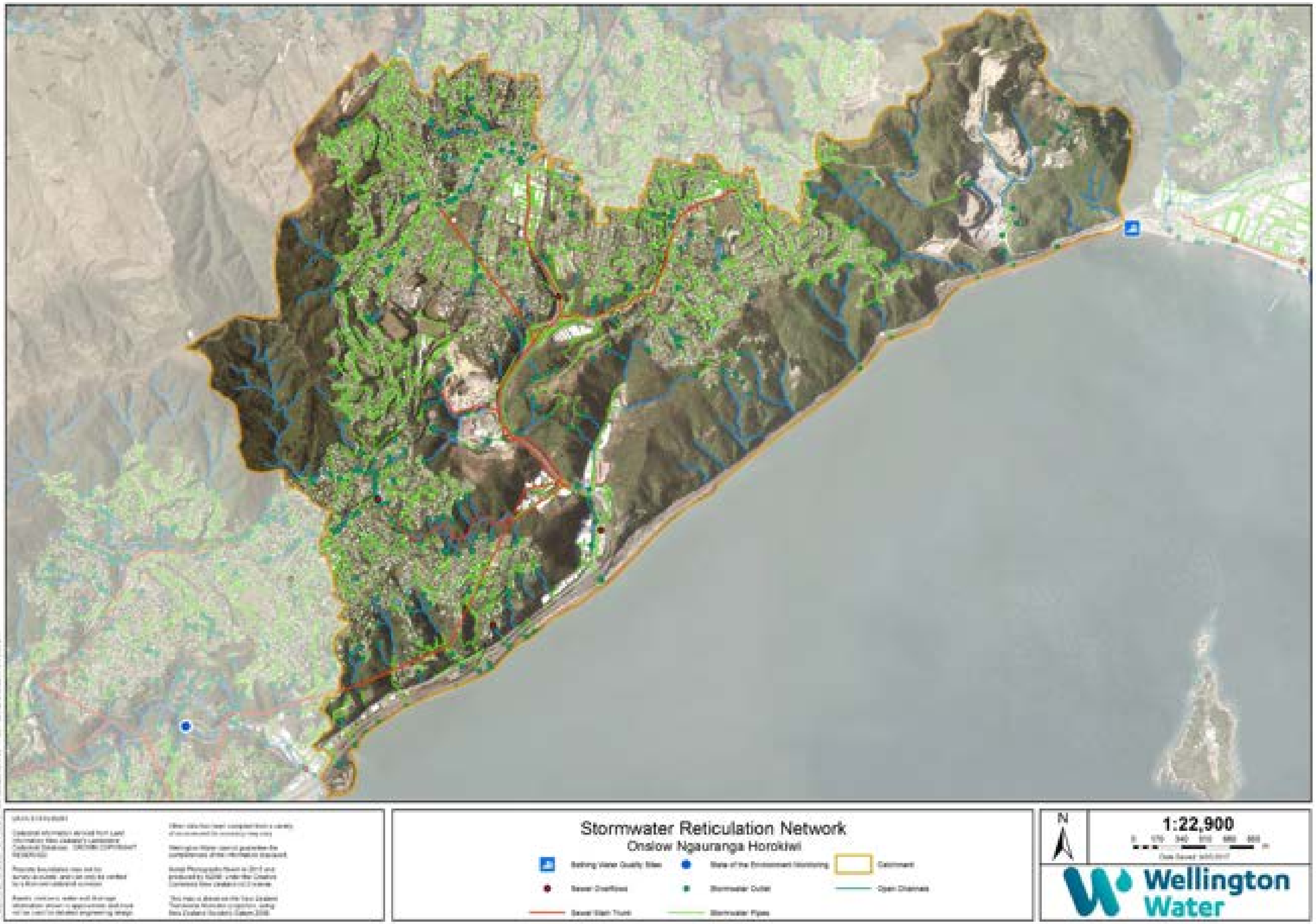
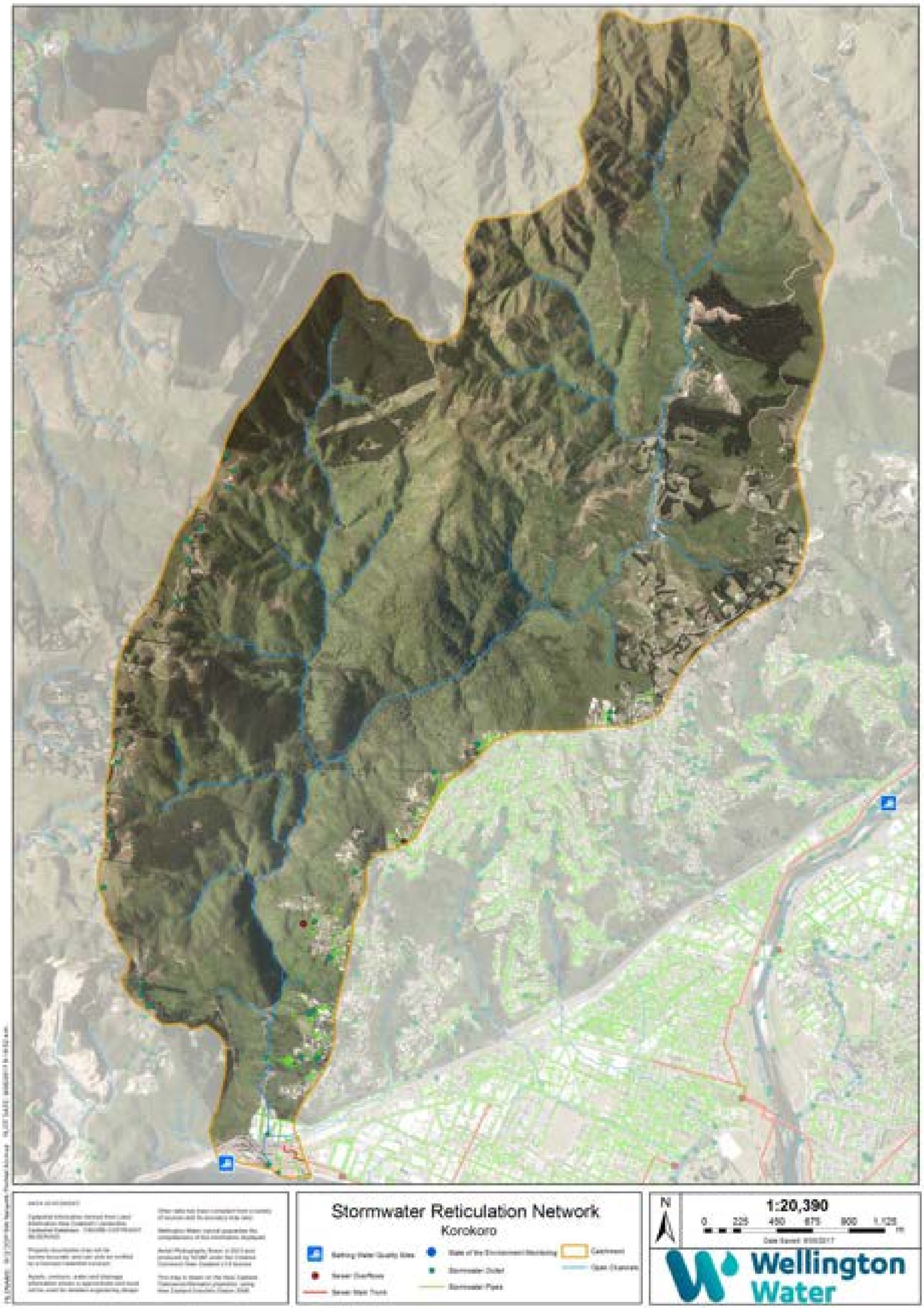
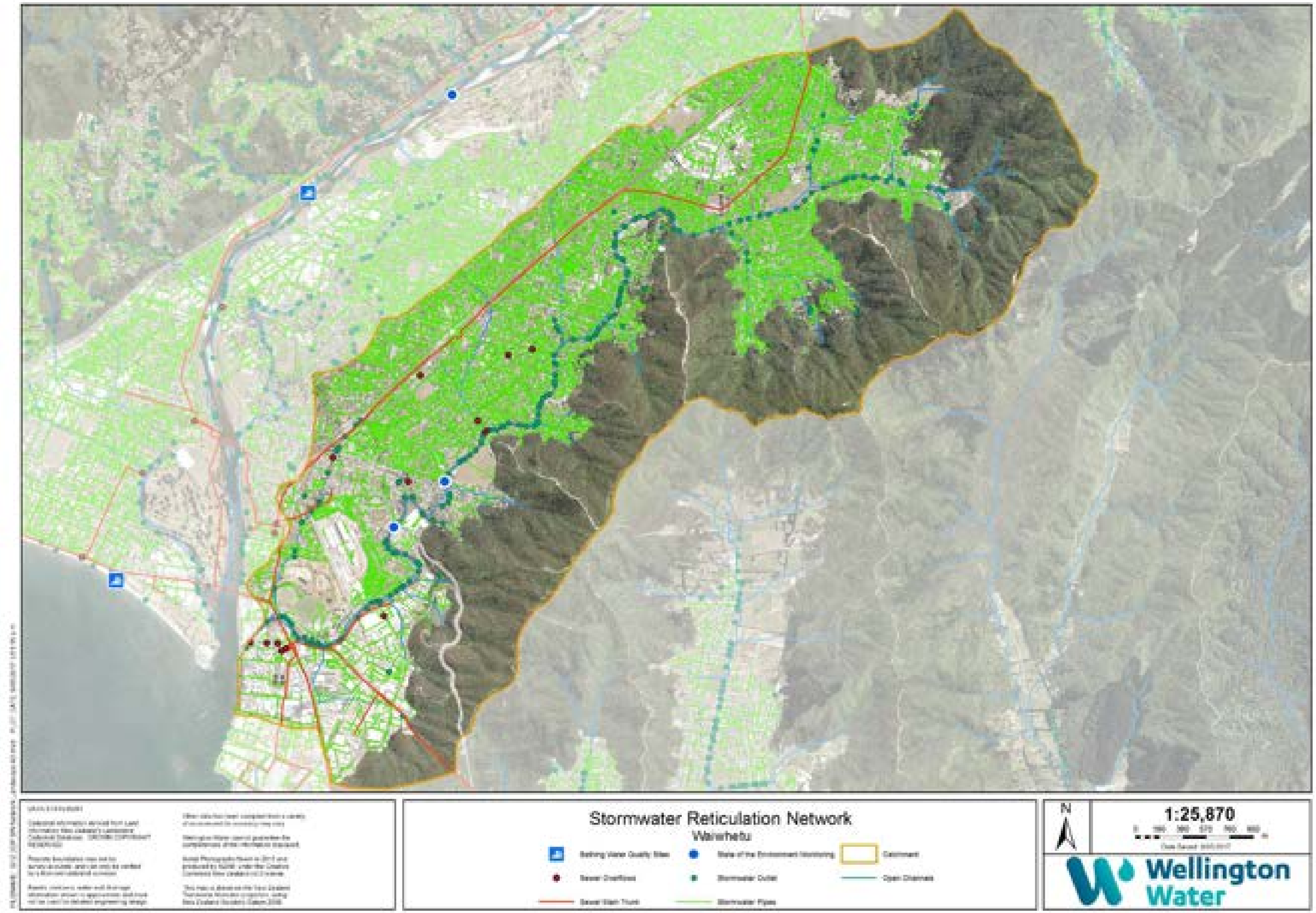
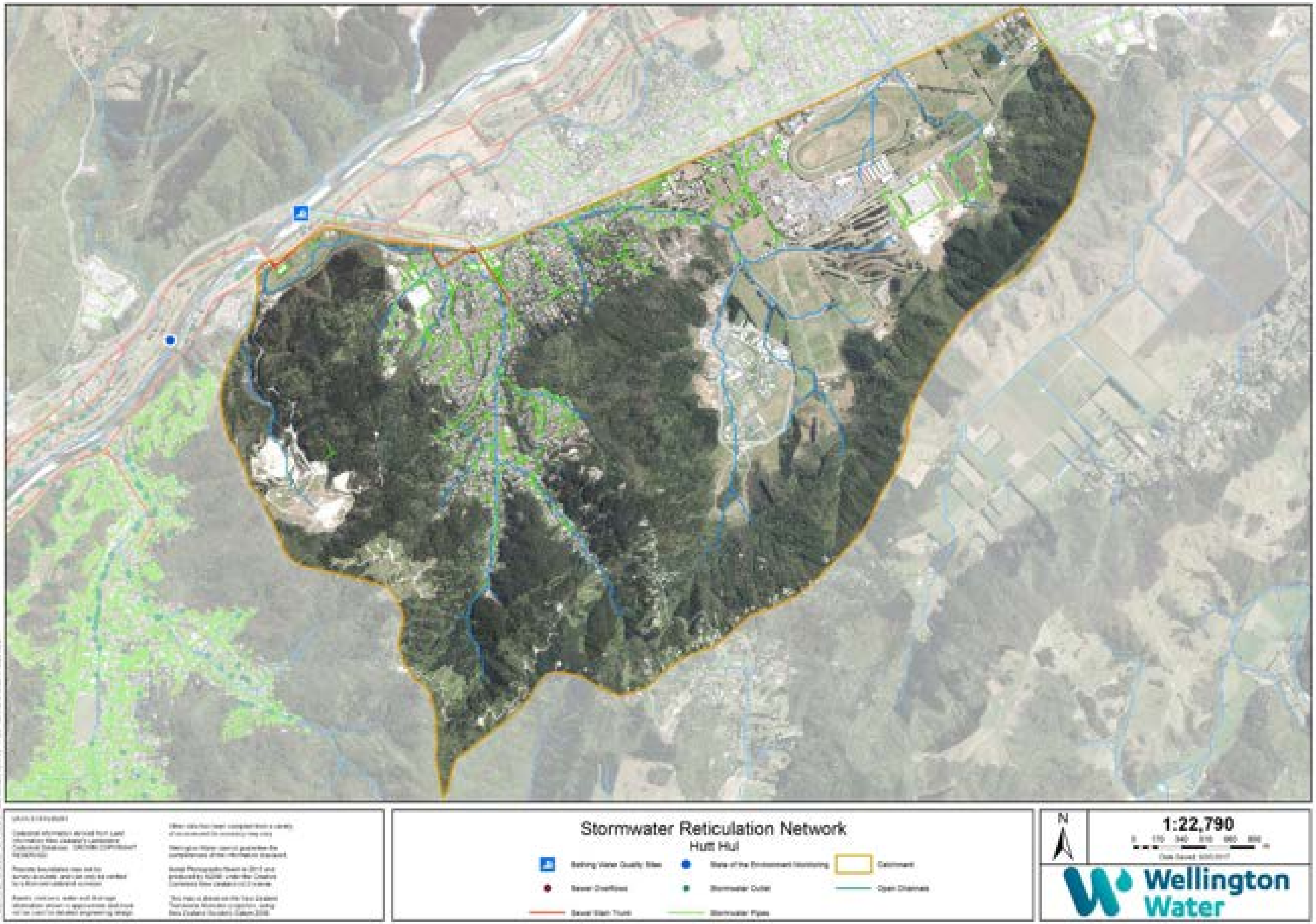
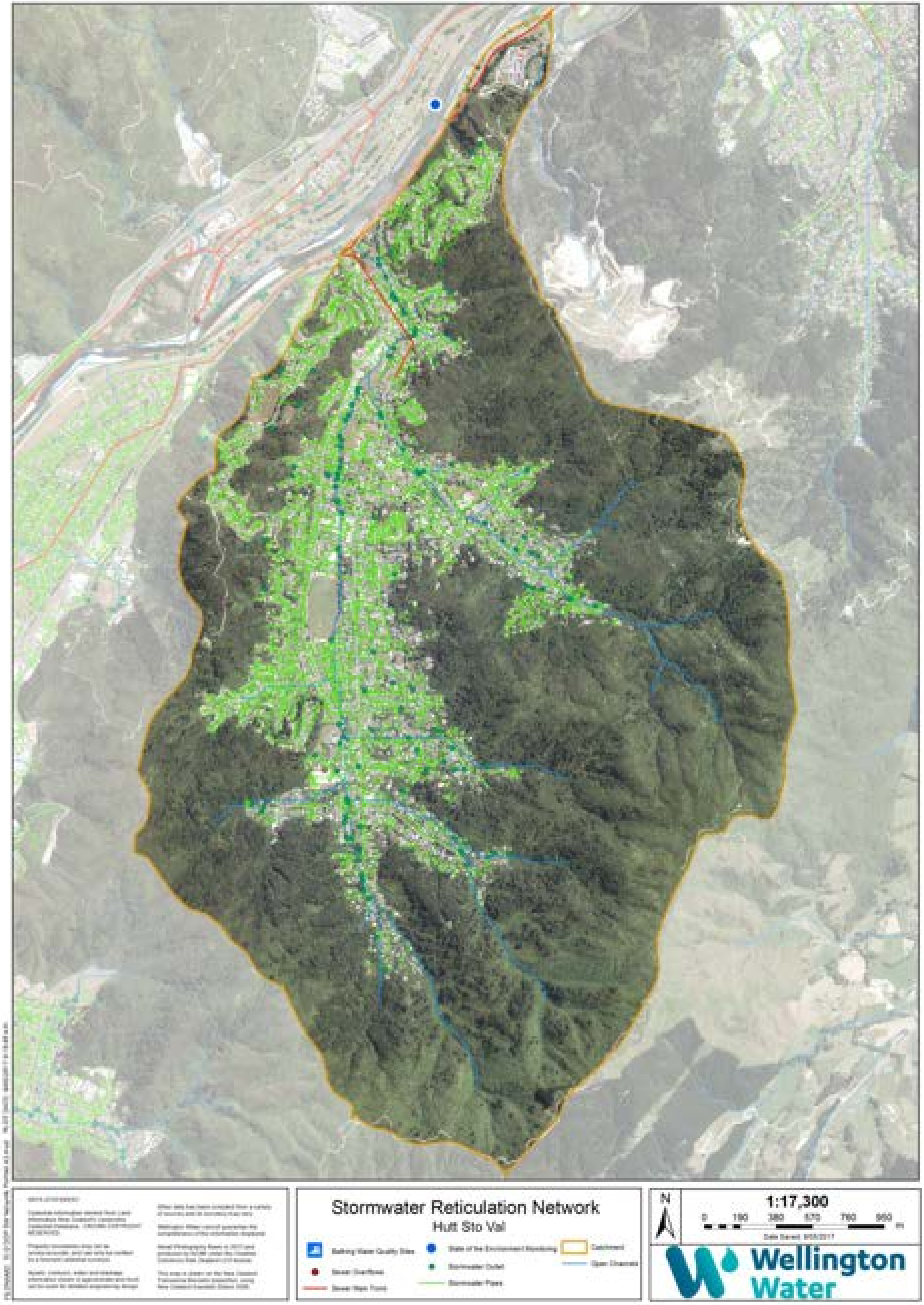
m
Wellington Water

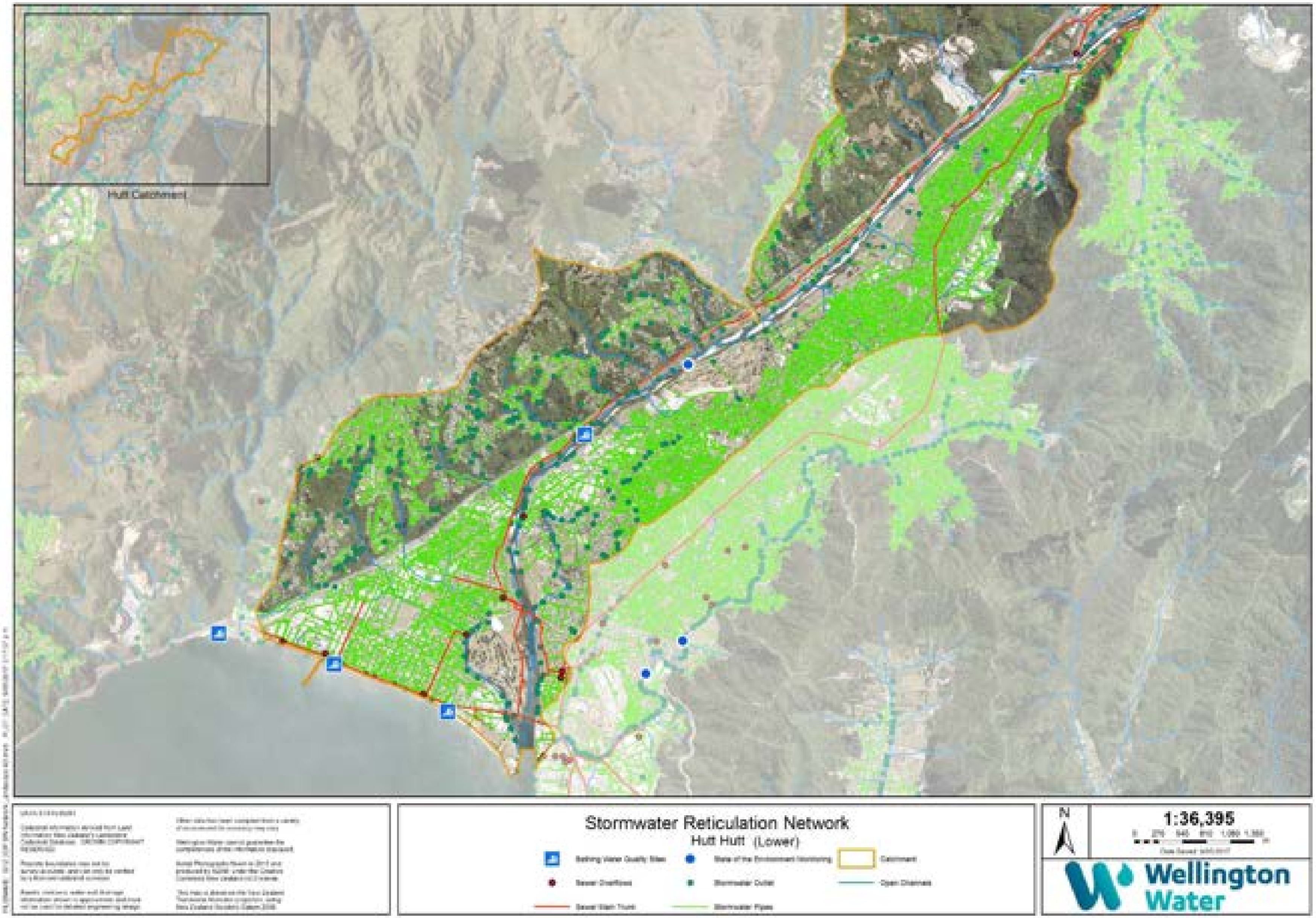

Stormwater Reticulation Network
Onslow Ngauranga Horokiwi
N
1:22,900
Wellington Water

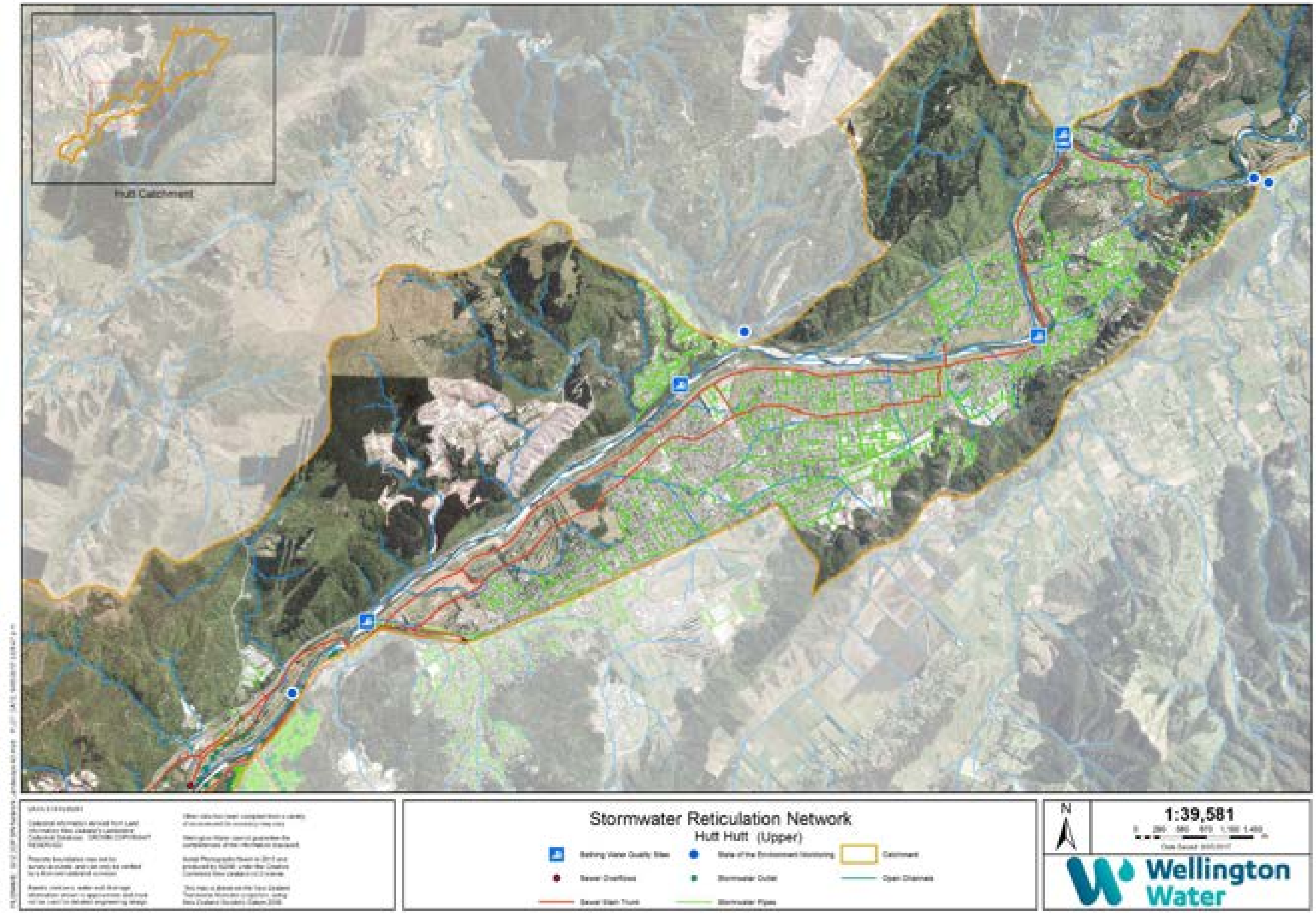

Stormwater Reticulation Network
Korokoro
N
1:20,390
Wellington Water

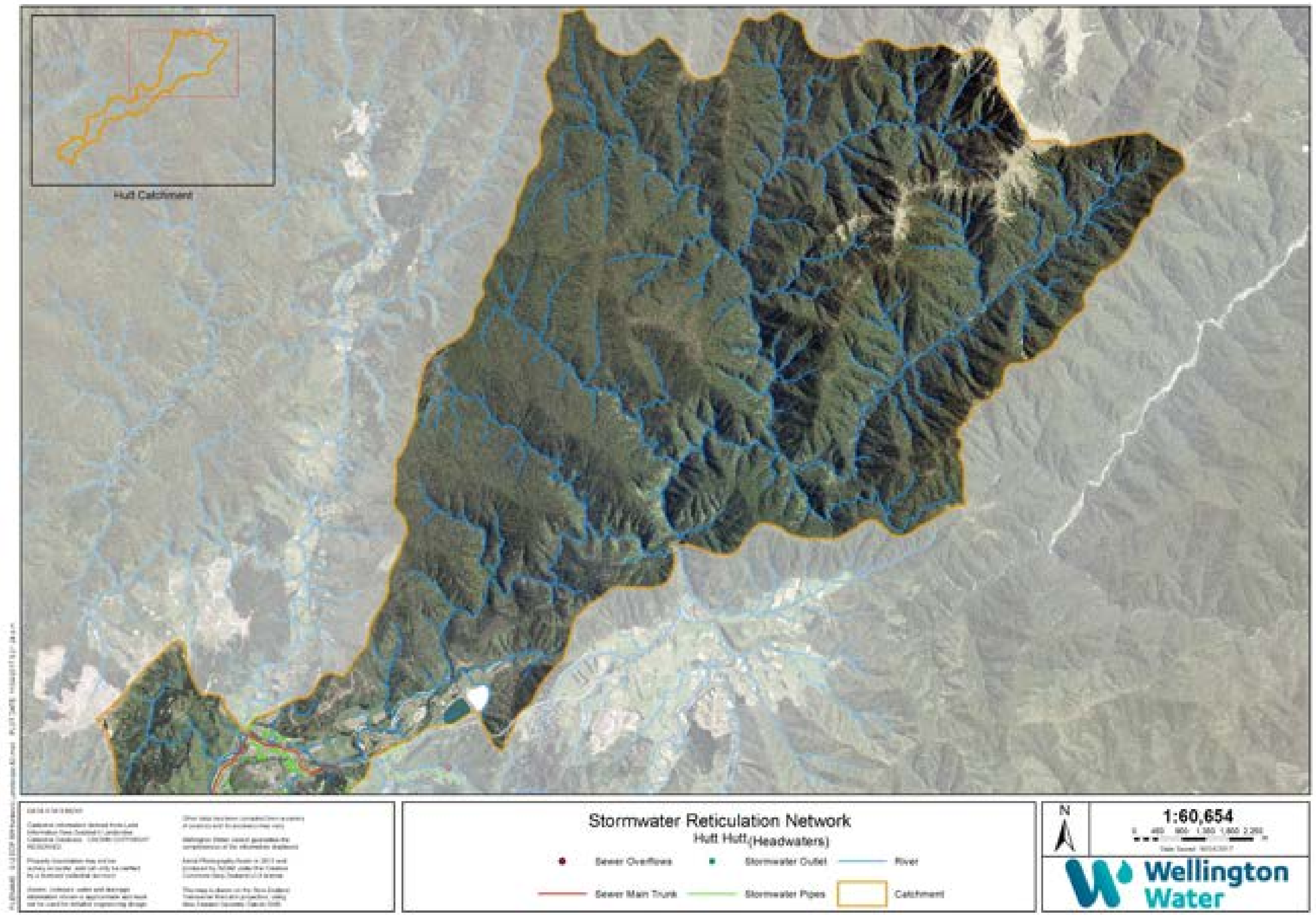

Stormwater Reticulation Network
Waiwhetu
N
1:25,870
Wellington
Water


Stormwater Reticulation Network
Hutt Hul
Bathing Water Quality Sites
State of the Environment Monitoring
Catchment
Sewer Overflows
Stormwater Outlet
Open Channels
Sewer Main Trunk
Stormwater Pipes
N
1:22,790
Wellington Water

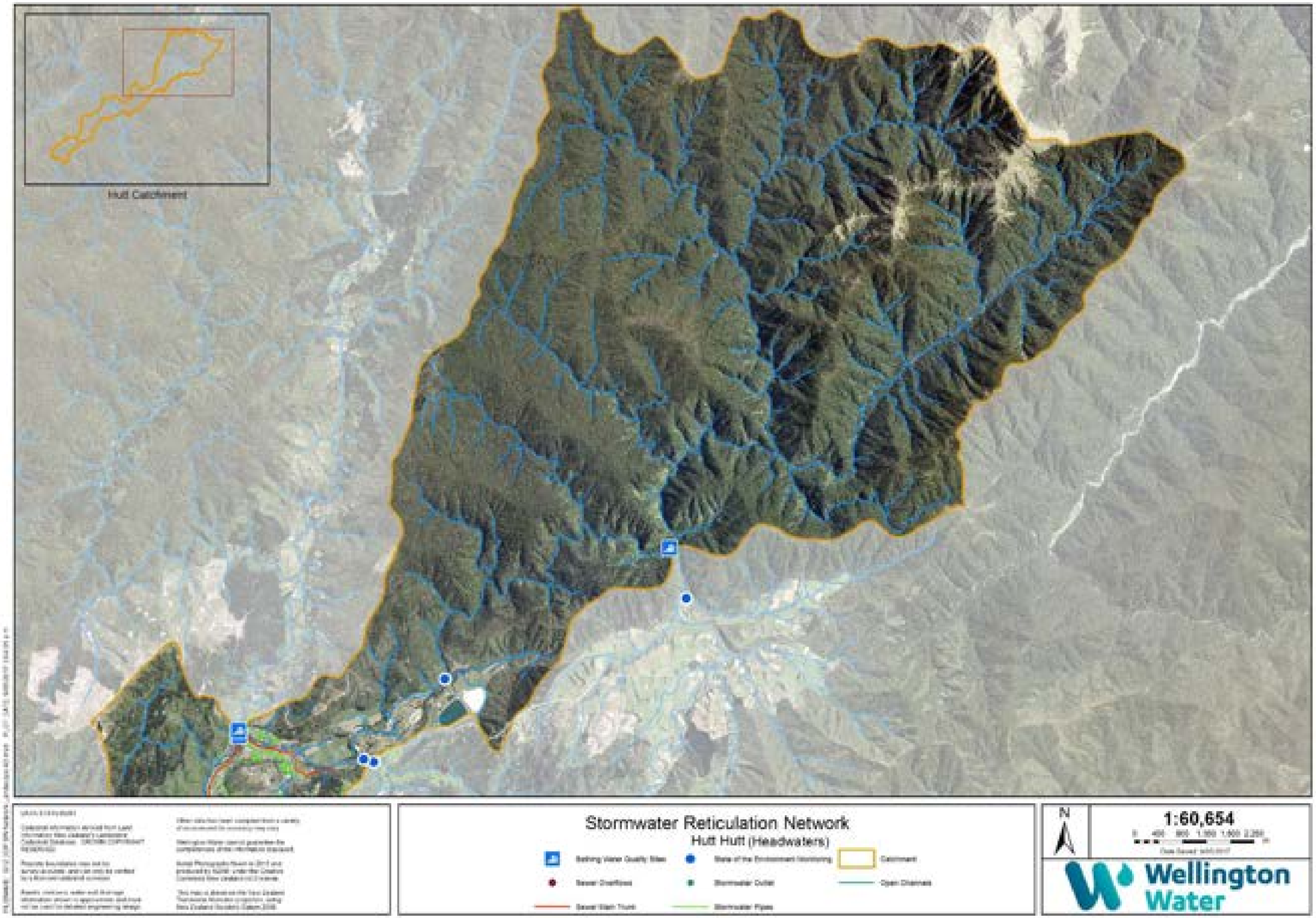

Stormwater Reticulation Network
Hutt Sto Val
N
1:17,300
0
190
380
570
760
950
m
Wellington
Water


Hutt Catchment
Stormwater Reticulation Network
Hutt Hutt (Lower)
Bathing Water Quality Sites
State of the Environment Monitoring
Catchment
Sewer Overflows
Stormwater Outlet
Open Channels
Sewer Main Trunk
Stormwater Pipes
N
1:36,395
Wellington Water


Hutt Catchment
Stormwater Reticulation Network
Hutt Hutt (Upper)
N
1:39,581
Wellington Water



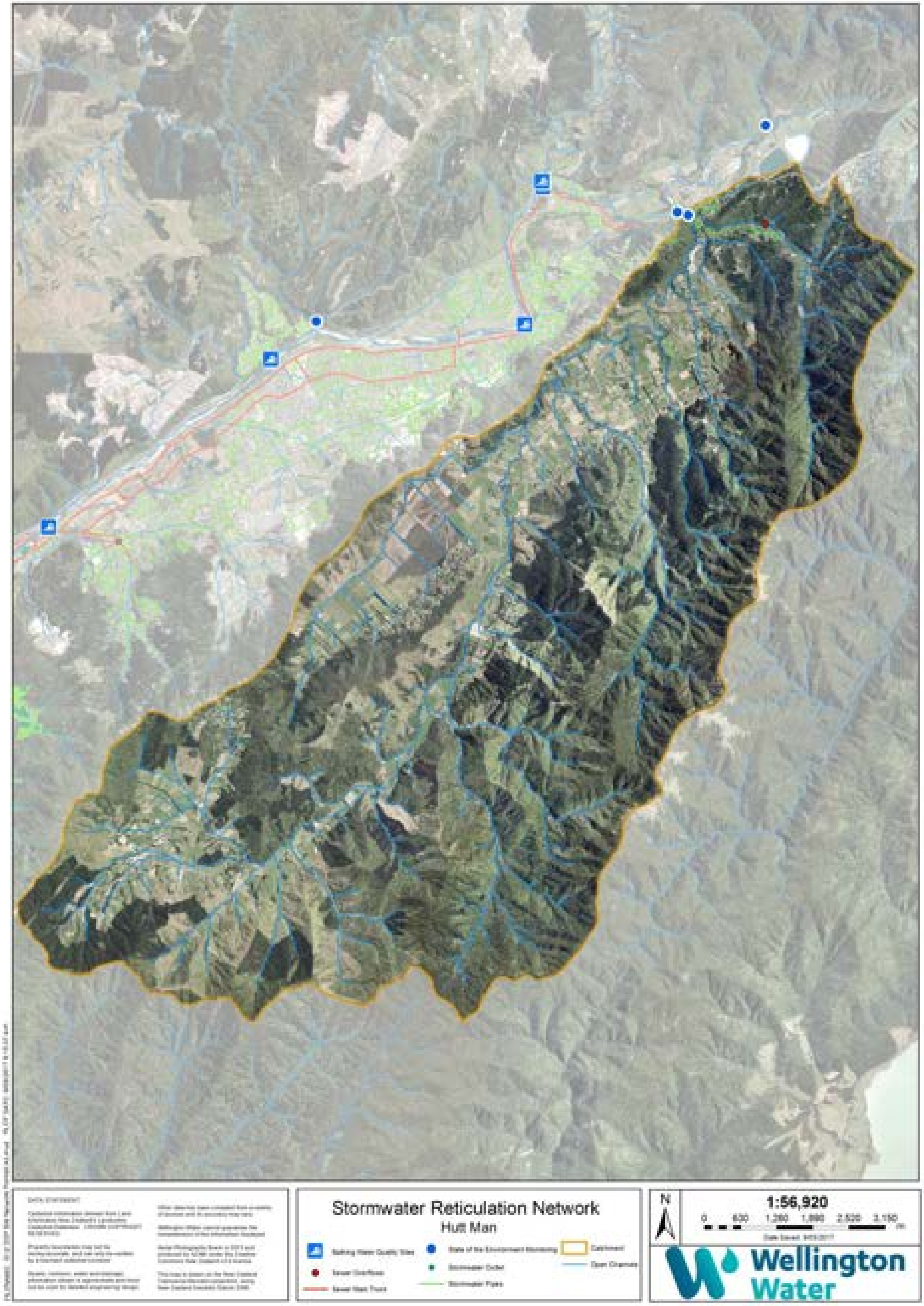
Hutt Catchment
Stormwater Reticulation Network
Hutt Hutt (Headwaters)
Sewer Overflows
Stormwater Outlet
River
Sewer Main Trunk
Stormwater Pipes
Catchment
N
1:60,654
Wellington Water



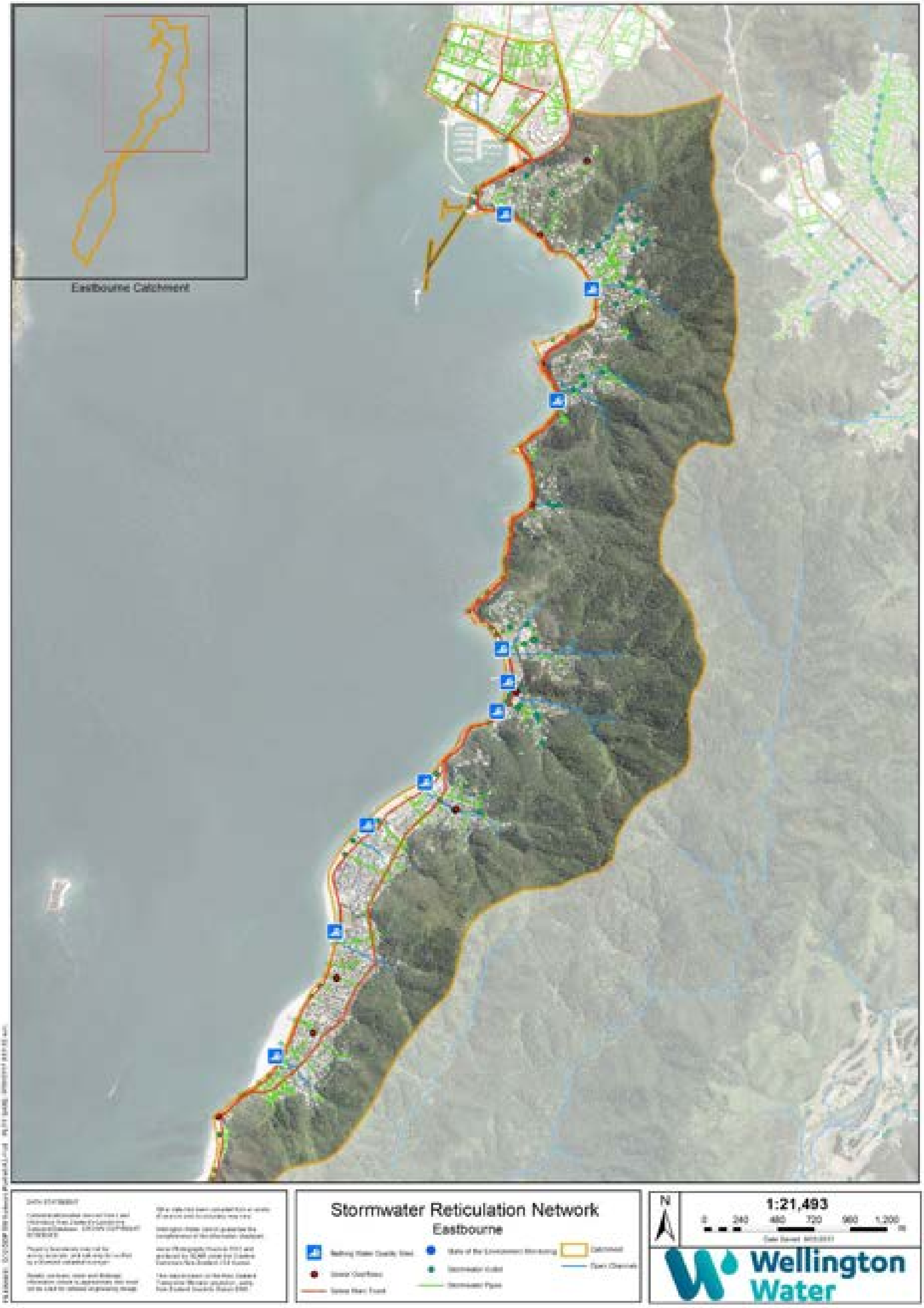
Hutt Catchment
Stormwater Reticulation Network
Hutt Hutt (Headwaters)
1:60,654
N
Wellington Water

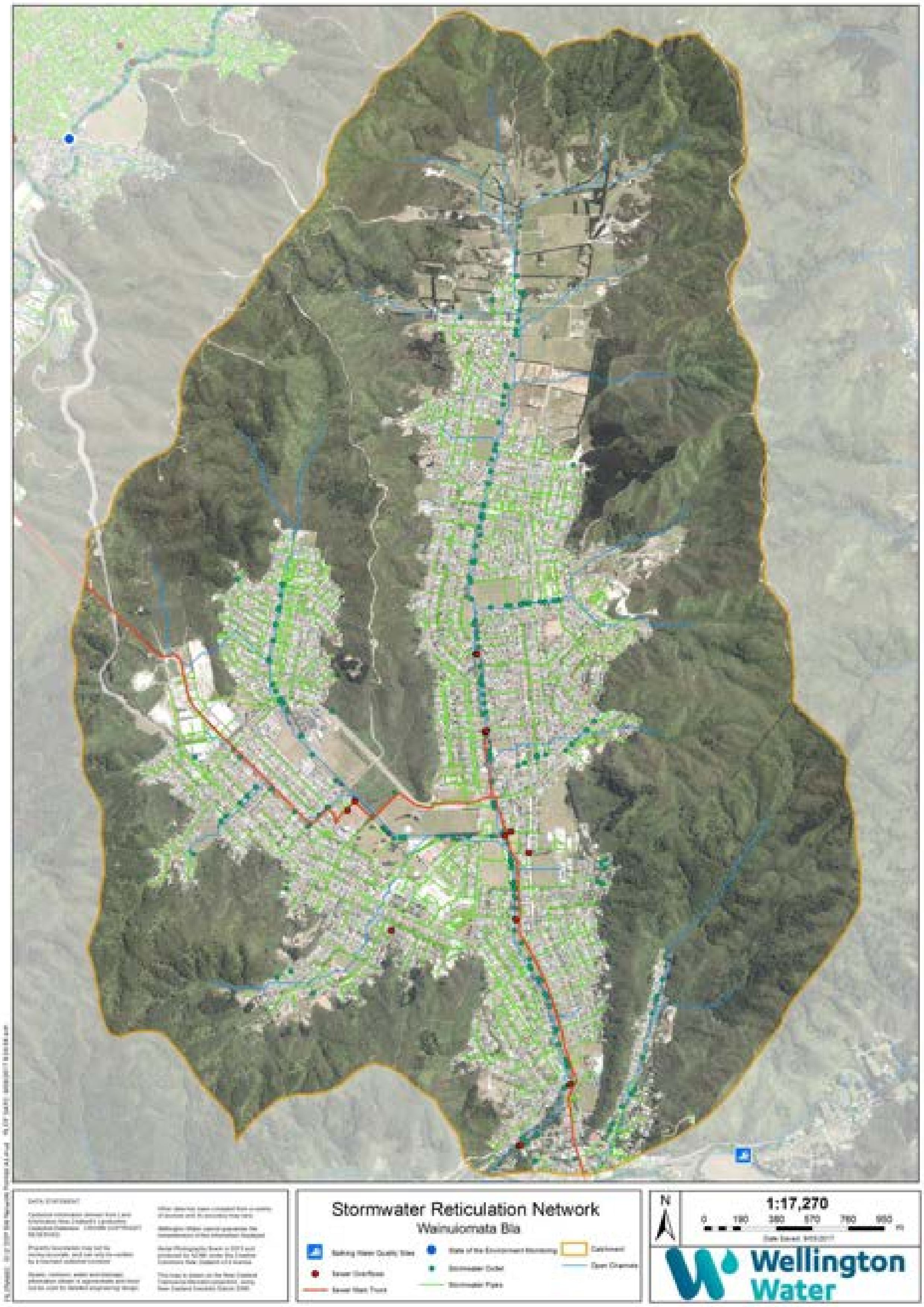

Stormwater Reticulation Network
Hutt Wha
N
1:38,470
0 430 860 1,290 1,720 2,150
m
Wellington Water


Stormwater Reticulation Network
Hutt Aka
N
1:46,390
Wellington Water


Stormwater Reticulation Network
Hutt Main
1:56,920
N
Wellington Water


Stormwater Reticulation Network
Hutt Pak
N
1:51,670
0 575 1,150 1,725 2,300 2,875
m
Wellington
Water


Eastbourne Catchment
Stormwater Reticulation Network
Eastbourne
1:21,493
N
Wellington Water


Stormwater Reticulation Network
Wainuiomata Bla
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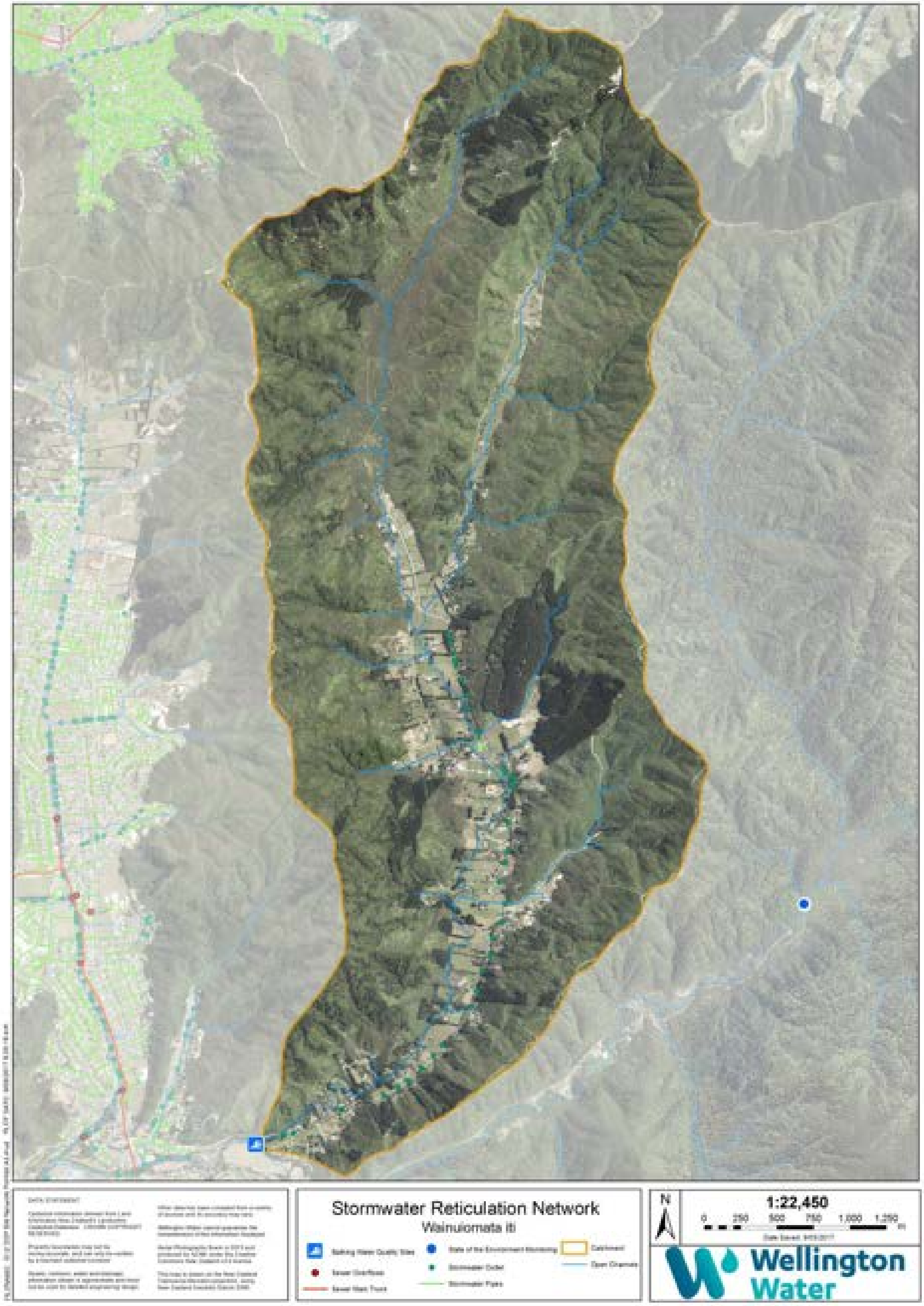
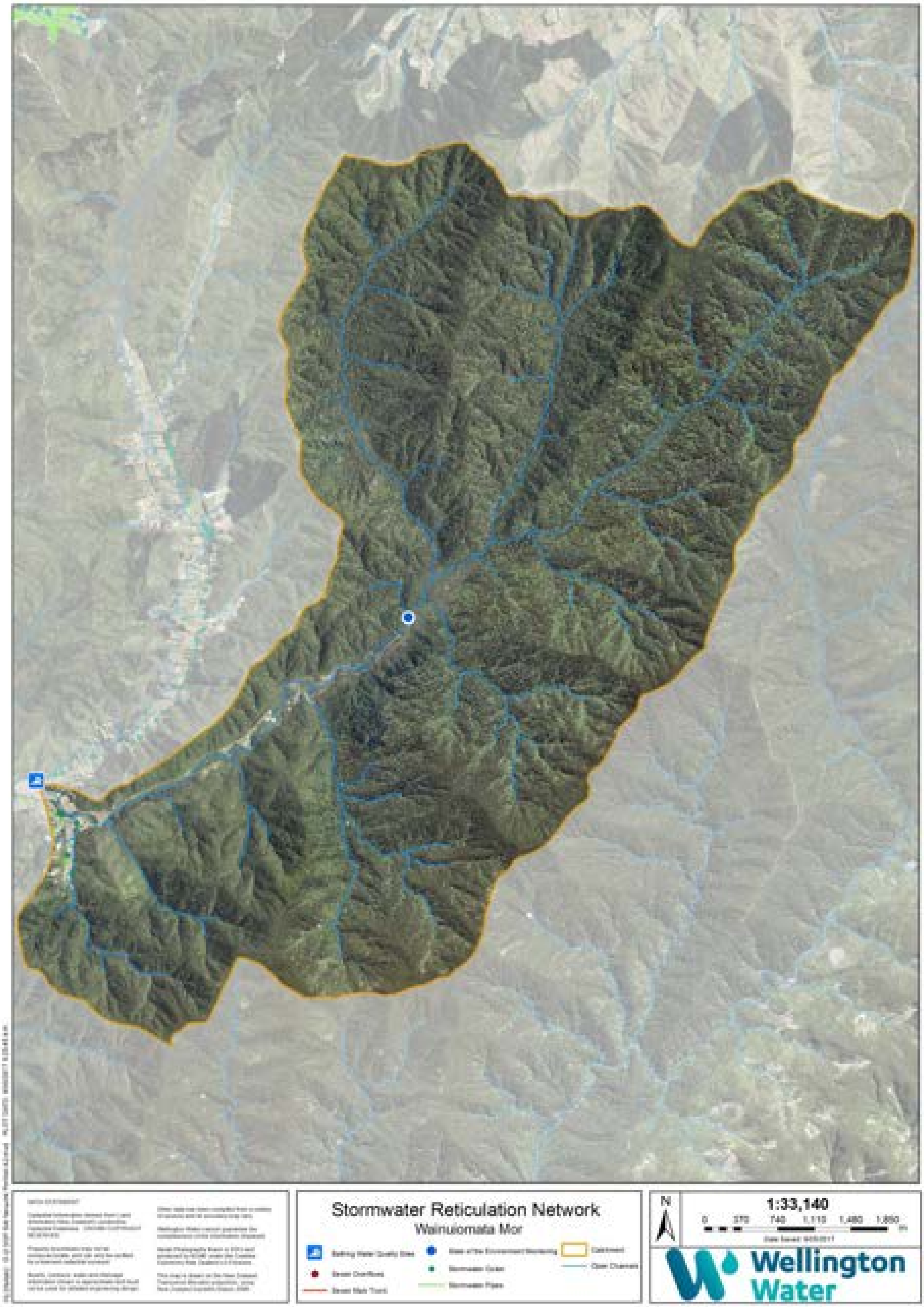
1:17,270
0
190
Wellington Water


Stormwater Reticulation Network
Wainuiomata iti
N
1:22,450
Wellington
Water

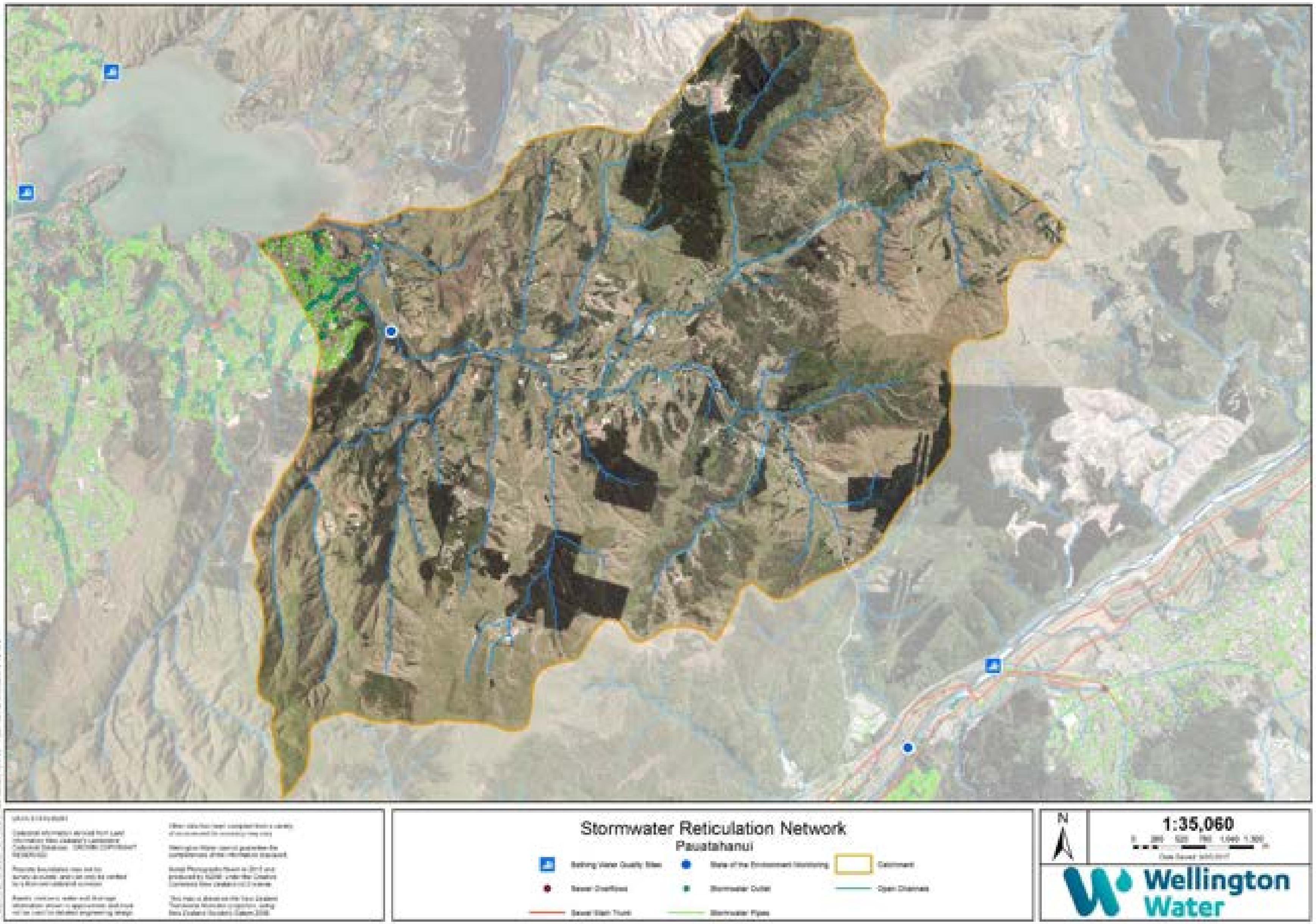

Stormwater Reticulation Network
Wainuiomata Mor
N
1:33,140
0
370
740
1,110
1,480
1,850
m
Wellington
Water


Stormwater Reticulation Network
Wainuiomata Wai
N
1:45,380
0 500 1,000 1,500 2,000 2,500
Wellington
Water

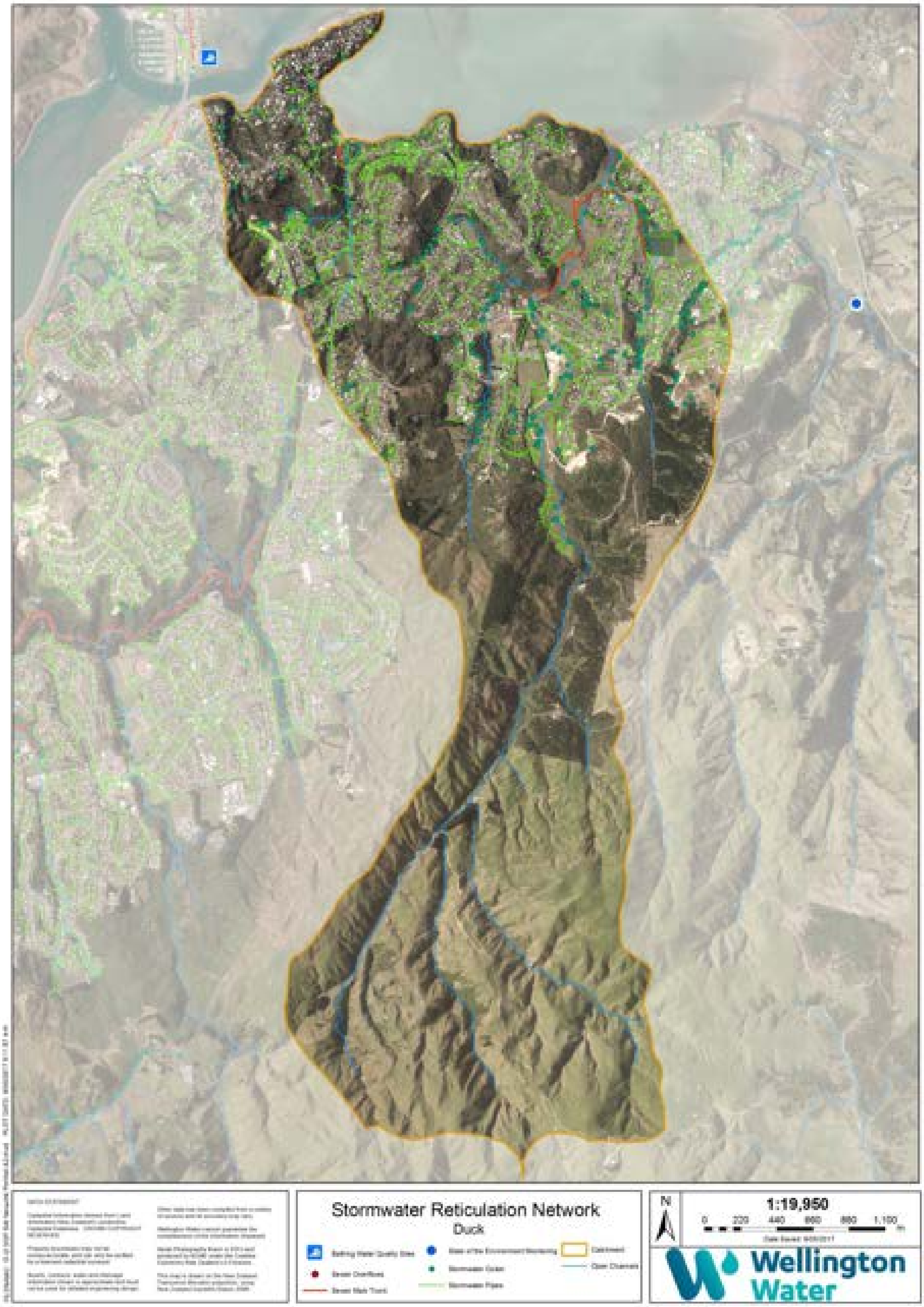
Appendix O Porirua Harbour stormwater catchment map series


Stormwater Reticulation Network
Kakaho
N
1:21,980
Wellington Water


Stormwater Reticulation Network
Horokiri
N
1:31,500
Wellington
Water



Stormwater Reticulation Network
Pauatahanui
Bathing Water Quality Sites
State of the Environment Monitoring
Catchment
Sewer Overflows
Stormwater Outlet
Open Channels
Sewer Main Trunk
Stormwater Pipes
N
1:35,060
Wellington Water


Stormwater Reticulation Network
Duck
N
1:19,950
Wellington
Water


Stormwater Reticulation Network
Porirua
N
1:42,020
0
470
940
1,410
1,880
2,350
Wellington Water


Stormwater Reticulation Network
Porirua Coast
N
1:40,190
0 450 900 1,350 1,800 2,250 m

Appendix C: Major outlets and open watercourses in each catchment

Local authority	Catchment	Outlets (>600mm diameter)	Significant Open Water Course(s)
Wellington City Council	**Karori**	One outlet to the Karori Stream	Karori Stream
	Owhiro Bay	One stream outlet	Owhiro Stream and numerous tributaries
	Island Bay and Houghton Bay	Three outfalls to Island Bay and one to Houghton Bay	There are no significant watercourses in this catchment
	Lyall Bay	Fourteen outfalls to Lyall Bay (and many minor outlets)	There are no significant open watercourses
	East Coast	Two outfalls to the CMA	There are no significant streams
	Evans Bay	Ten outfalls to the CMA	There are no significant water courses
	Lambton Bay/Oriental Bay	16 outfalls to the CMA	Open water course include Kumutoto Stream, a number of small watercourses feed the stormwater network
	Kaiwharawhara	One stream outlet.	Open water courses include Kaiwharawhara Stream, Korimako Stream, Te Mahanga Stream, Silverstream and unnamed headwater streams
	North Harbour	Ten piped outfalls and stream outlets.	Open water courses include the Ngaranga Stream, Waitohu Stream, Tyers Stream, Horokiwi Stream and numerous minor watercourses
Hutt City Council	**Korokoro**	One stream outlet	Most of Korokoro Stream is an open water course
	Hutt River	One river outlet to Wellington Harbour	Hutt River is an open water course
	Hutt – Speedy's	One stream outlet	Speedy's stream is mostly an open channel
	Hutt - Waiwhetu	One stream outlet	Much of the main stem of Waiwhetu Stream flows in an open channel, as well as the upper reaches of some headwater tributaries
	Eastbourne	Numerous minor stormwater outlets	Open water courses include Days Bay Stream and numerous stream fragments
	Wainuiomata	No major outfalls to CMA	Wainuiomata River is an open water course
	Black Creek	No major outfalls to CMA	Open water courses include Black Creek and fragments or minor tributaries

Local authority	Catchment	Outlets (>600mm diameter)	Significant Open Water Course(s)
	Wainuiomata-iti	No major outfalls to CMA	Wainuiomata-iti Stream is an open watercourse
	Morton	No major outfalls to CMA	Includes nearly 100% pristine watercourses
Upper Hutt City Council	**Hutt – Stokes Valley**	No major outfalls to CMA	Includes a heavily modified, partly open channel
	Hutt-Hulls	No major outfalls to CMA	Includes a heavily modified, partly open channel
	Hutt- Whakatikei	No major outfalls to CMA	Includes a slightly modified open river
	Hutt - Akatarawa	No major outfalls to CMA	Includes a slightly modified open river
	Hutt- Mangaroa	No major outfalls to CMA	Includes a slightly modified open river
	Hutt -Pakuratahi	No major outfalls to CMA	Includes a slightly modified open river
Porirua City Council	**Taupo Stream**	One stream outlet	Open water courses include Taupo stream and swamp
	Kakaho	One stream outlet	Open watercourses include the Kakaho Stream
	Horokiwi	One stream outlet	Open water courses include the Horokiri Stream, which is partially modified
	Pauatahanui	One stream outlet	Open water courses include Pauatahanui Stream, which is partially modified
	Duck	One stream outlet	Open water courses include Duck Creek, which is partially modified
	Porirua	Porirua Stream outlet, minor stream outlets and numerous minor stormwater outlets	Open water courses include the main stem of Porirua Stream and Kenepuru Stream, the upper reaches of some minor tributaries
	Porirua Coast	Numerous minor stormwater outfalls	Minor fragments of modified open water courses

Appendix D: Historic and existing monitoring in each catchment

Catchment	Ongoing monthly River State of Environment monitoring	Ongoing routine recreational water quality monitoring	Microbiological monitoring	Other Monitoring
1. Karori	One site in Karori Stream (Water quality and benthic ecology)		Monthly at three locations on Karori Stream (WCC)	
2. Island Bay /Houghton Bay		Island Bay and Princess Bay (adjacent to Houghton Bay)	Monthly faecal coliform monitoring by WCC at stormwater culvert outlets in Island and Houghton Bays	
3. Lyall Bay		Three locations in Lyall Bay	Monthly at two major culverts Lyall Bay (stormwater discharges)	
4. East Coast		At six popular recreational areas in the catchment		
5. Evans Bay		At three locations in the catchment	Monthly at four stormwater culverts (WCC)	Wellington Harbour sediment/biota monitoring at five year intervals Catchpit sediment monitoring in Hataitai and Miramar at five year intervals
6. Lambton Bay/Oriental Bay		Yes – ongoing		Ongoing sediment quality and benthic monitoring programmes
7. Kaiwharawhara	On the lower reaches of Kaiwharawhara Stream		Monthly at the mouth of the Kaiwharawhara Stream (WCC)	Wellington Harbour sediment/biota monitoring at five year intervals
8. North Harbour			Monthly at the Ngauranga Stream outlet to Wellington Harbour (WCC)	Wellington Harbour sediment/biota survey every five years
9. Owhiro Bay			Monthly at the stream outlet to the sea (WCC, consent monitoring) Quarterly four locations (WCC)	Routine quarterly monitoring of a range of parameters (including metals, ammonia, TSS) at five locations around the T&T Landfill (consent monitoring)
10. Korokoro		Three sites on Petone Beach	Monthly at one site on Korokoro Stream	
11. Hutt River – Mainstem	Three locations on the Hutt River	Freshwater (E. coli) at five recognised bathing areas on the Hutt River mainstem Coastal (Enterococci) at three locations on Petone Beach	Monthly at 15 locations on minor streams and culverts within the Hutt River mainstem catchment (HCC)	
12. Hutt – Speedy's			Monthly at one location on Speedys Stream (HCC)	
13. Hutt - Waiwhetu	On Waiwhetu Stream			HCC/WW consent monitoring of stormwater in the Gracefield sub-catchment, for duration of the consent
14. Eastbourne		Ten locations within the Eastbourne catchment		
15. Wainuiomata	Two sites on the Wainuiomata River	One site on the Wainuiomata River		HCC monthly monitoring at two sites on Black Creek and three sites on the Wainuiomata River
16. Hutt – Stokes Valley			Monthly by HCC	
17. Hutt - Hulls	No routine water quality monitoring data is available for this watercourse			
18. Hutt- Whakatikei	Whakatikei River at Riverstone (water quality. Periphyton, invertebrates)	Whakatkei River at Hutt Forks		
19. Hutt - Akatarawa	One site on the Akatarawa River (water quality, periphyton, invertebrates)	One site		
20. Hutt- Mangaroa	As above	One site		
21. Hutt -Pakuratahi	One site on the Pakuratahi River	One site on the Pakuratahi River		
22. Taupo Stream		Two sites on Plimmerton Beach	Ongoing at one site on Taupo Stream (PCC)	
23. Kakaho		Two sites in the Pauatahanui Inlet		No routine water quality monitoring is conducted in Kakaho Stream
24. Horokiwi	One site on Horokiri Stream	As above.		
25. Pauatahanui	One site on the Pauatahanui Stream	As above.		Porirua Harbour sediment quality and benthic biota surveys on Pauatahanui Inlet at approximately three year intervals
26. Duck		As above.	Monthly at one site in Duck Creek (PCC)	As above.
27. Porirua	Two sites on Porirua Stream	Two locations in the Onepoto inlet	Monthly at five sites in the Onepoto Inlet	Marine sediment and benthic ecology monitoring at two locations in Onepoto Inlet in 2004, 2005, 2008 and 2010
28. Porirua Coast		Six coastal sites	Monthly at Titahi Bay South Stream (PCC)	

Appendix E: Values of receiving environment waterbodies identified in Schedule F of the Proposed Natural Resources Plan

Catchment(s)	Receiving environment waterbody	Indigenous fish species recorded in rivers with significant indigenous ecosystems (F1)	Inanga spawning habitats (F1b)	Habitats for indigenous birds in the CMA (F2c)	Significant biodiversity values (sites in CMA, F4)	Significant biodiversity values (habitats in CMA, F5)
Taupo	Taupo Stream	Banded kokopu, giant kokopu, inanga, longfin eel, redfin bully and shortfin eel	✓			
	Taupo Estuary				✓	
Korokoro	Korokoro Stream	Banded kokopu, bluegill bully, common bully, common smelt, giant kokopu, inanga, koaro, longfin eel, redfin bully and shortfin eel				
	Korokoro Estuary				✓	
Pauatahanui	Pauatahanui Stream	Banded kokopu, common bully, common smelt, giant kokopu, inanga, lamprey, longfin eel, redfin bully and shortfin eel	✓			
	Pauatahanui Wildlife Reserve; Refuge				✓	
Duck	Duck Creek	Banded kokopu, common bully, common smelt, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully and shortfin eel				
	Duck Creek Estuary				✓	
Karori	Makara Estuary				✓	
	Karori Stream	Banded kokopu, inanga, koaro, lamprey, longfin eel, shortfin eel and upland bully				
Owhiro	Owhiro Stream	Banded kokopu, common bully, giant kokopu, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu	✓			
Kaiwharawhara	Kaiwharawhara Stream	Banded kokopu, bluegill bully, common bully, giant bully, giant kokopu, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu				
	Kaiwharawhara Stream Mouth/Estuary				✓	
Hutt – Main stem[47]	Hutt River	Bluegill bully, common bully, Cran's bully, dwarf galaxias, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully and shortfin eel	✓	✓ (Hutt River Mouth)	✓	
Hutt – Speedy's	Speedy's Stream	Banded kokopu, bluegill bully, common bully, giant bully, giant kokopu, lamprey, longfin eel, redfin bully and shortfin eel				
Hutt – Whakatikei	Whakatikei River	Indigenous fish species recorded in catchment are not listed				
Hutt - Akatarawa	Akatarawa Stream	Banded kokopu, bluegill bully, Cran's bully, dwarf galaxias, koaro, lamprey, longfin eel, redfin bully and shortfin eel				
Hutt - Pakuratahi	Pakuruatahi Stream	Bluegill bully, Cran's bully, dwarf galaxias, koaro, longfin eel, redfin bully, shortfin eel and upland bully				
Hutt -Stokes Valley	Stokes Valley Stream	Banded kokopu, common bully, giant kokopu, longfin eel and shortfin eel				
Eastbourne and Eastern Bays	Days Bay Stream	Banded kokopu, bluegill bully, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu				
Wainuiomata	Wainuiomata River	Banded kokopu, bluegill bully, common bully, dwarf galaxias, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully, shortfin eel and shortjaw kokopu	✓	✓		✓ (Wainuiomata River Mouth)
	Wainuiomata Estuary				✓	
Horokiwi	Horokiwi	Banded kokopu, black flounder, common bully, common smelt, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully, shortfin eel, shortjaw kokopu and torrentfish	✓			
Kakaho	Kakaho		✓			
Porirua	Kenepuru Stream			✓		
	Porirua Stream	Banded kokopu, common bully, common smelt, giant, kokopu, inanga, koaro, longfin eel, redfin bully, shortfin eel and upland bully				
	Porirua Harbour – Onepoto Arm			✓		
	Porirua Harbour – Pautahanui Arm			✓		
	Porirua Harbour					✓
Karori; Owhiro; Island and Houghton Bays; Lyall Bay	Wellington South Coast			✓		
Numerous catchments	Wellington Harbour			✓		✓
Waiwhetu	Waiwhetu Estuary				✓	
Evans Bay	Evans Bay					✓

[47] The Hutt River is also listed in Schedule F2a (Habitats for indigenous birds in rivers) as having five threatened or at risk species are resident or regular visitors to this site.

Appendix F: Draft Stormwater Monitoring Plan

Wellington Water

Wellington Water

Wellington Water Ltd Stage One Global Stormwater Discharge Consent

Draft Stormwater Monitoring Plan

Our water, our future.

Prepared by MWH, now part of Stantec
for
Wellington Water Ltd
July 2017

Prepared by ____[redacted]

[redacted] and [redacted]

Reviewed by ____ [redacted]

[redacted]

Approved by ____ [redacted]

[redacted]

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1 Introduction

1.1 Purpose and Objectives

A Stage 1 stormwater discharge consent is required by Rule R50 of the Proposed Natural Resources Plan for the Wellington Region (PNRP). A primary purpose of the consent application is to develop a Stormwater Monitoring Plan (SMP) to guide the collection of information over the next five years, to assist with the assessment of stormwater related environmental effects, and to address any acute effects on human health. The Stage 1 consent application covers all discharges from stormwater networks managed by Wellington Water Limited (WWL) on behalf of Wellington, Hutt, Upper Hutt and Porirua city councils. This includes the stormwater catchments that contribute to Porirua Harbour, Wellington Harbour and the Porirua to Wellington coastline, where there are significant settlements discharging urban stormwater.

The SMP has the following monitoring objectives:

a) To undertake focused, cost effective and efficient monitoring and modelling of stormwater quality, stormwater flows and contaminant loads;

b) To continuously improve confidence in stormwater data, and to facilitate the modelling of contaminant accumulation in depositional environments;

c) To monitor ecosystem health, using suitable indicators, in order to assess the effects of stormwater discharges on freshwater and coastal receiving environments;

d) To identify catchments, contaminant sources and stormwater discharges of priority concern;

e) To identify any acute effects of stormwater on human health detected during monitoring in order to better manage activities contributing to these acute effects;

f) To undertake targeted investigations and performance monitoring in order to better manage activities contributing to these acute effects;

g) To share stormwater discharge monitoring data with other agencies to provide a sound understanding of the adverse quality and quantity effects of discharges from the stormwater network

Cultural health monitoring is not included in the SMP but will be addressed in a separate Cultural Health Monitoring Plan.

1.2 Approach to developing the SMP

A framework for preparing the SMP was developed at a Technical Reference Group (TRG) sub-group meeting attended by [redacted] (NIWA), [redacted] (NIWA), [redacted] (Aquanet Consulting Ltd), [redacted] (GWRC), [redacted] (GHD) and [redacted] (MWH). The SMP development framework has five steps, these being data and information collation, characterisation, identification of information gaps, further investigations and implementation, as summarised below in Figure 1-1. Further detail on the development of the SMP is provided in section 8 of the Resource Consent Application report.

Stormwater and receiving environment information was collated from a variety of sources, but primarily from WWL, GWRC, Wellington City Council (WCC), Hutt City Council (HCC), Upper Hutt City Council (UHCC) and Porirua City Council (PCC). TRG members assisted in the identification of relevant information sources.

Stormwater and receiving environment information is summarised in an Existing Environment Report, which forms part of the Resource Consent Application (WWL, 2017). Information score sheets were prepared for each of 28 stormwater sub-catchments, together with catchment maps (refer Appendix A). A summary of knowledge gaps, presence of acute effects and recommended actions is provided in Table 1-1. Sections 2, 3, 4, 5, 6 and 7 provide further detail on knowledge gaps, stormwater monitoring/modelling, river/stream monitoring, coastal monitoring, identification of acute effects, and reporting, respectively.

Step 1

- Information and monitoring data collection
- Collect data, montoring informatin and otehr techncial assessments/studies reports.
- Develop catchment maps and summarise information/data collected to identify the state of the existing environment.

Step 2

- Interrogate collated information
- Develop a 'catchment data sheet' per catchment to record the adequacy of information available based on a number of criteria, using a scale of 1 to 5, with 1 being no information and 5 being very good/no information gaps.
- Assess the values/pressure/state of each catchment in an assessment matrix and assign a High, Moderate or Low priority for monitoring or further investigations in the catchment
- Discuss completed catchment data sheets with the TRG sub-group to develop a 'prioritisation list'

Step 3

- Identify major knowledge gaps
- Take into account the adequacy of information exercise

Step 4

- Identify further investigations required (modelling and monitoring) in SMP
- Take into account the values/pressure/state assessment and known major knowldge gaps

Step 5

- Identify implementation and review parameters in the SMP

Figure 1-1: Stormwater Monitoring Plan development framework

Table 1-1: Summary of knowledge gaps, presence of acute effects and recommended monitoring, modelling and mitigation actions

Catchment	Knowledge gaps	Acute effects?[1, 2, 3]	Recommended monitoring/modelling		Recommended mitigation	
			Action	Priority (rank)	Action	Priority
Porirua Stream	• Rate of contaminant increase in depositional environments; • Stormwater EMCs and contaminant loads; • Wastewater overflows to stormwater networks	**Human health:** Porirua Stream annual median *E. coli* value has exceeded both the PNRP freshwater secondary contact criteria and NPS-FM national bottom line in three of the last five years. **Human health:** Porirua Harbour @ Rowing Club five year 95th percentile *Enterococci* value exceeds the MfE/MoH (2003) Microbiological Assessment Category D criteria (500 enterococci/100ml). **Ecology:** Porirua Stream at Wall St has a degraded macroinvertebrate community. MCI scores over the last years have an average value of 83.	1. Continue RSoE monitoring at two sites on Porirua Stream;[4] 2. Continue recreational water quality monitoring at two sites in Onepoto Inlet (Porirua Rowing Club & Onehunga Bay);[4] 3. Continue monthly microbiological monitoring at nine stormwater culverts and minor streams;[7] 4. Establish an automated stormwater quality and flow monitoring station at a representative stormwater outlet. Establish event mean concentrations and contaminant loads. 5. Develop contaminant load, water quality and sediment quality models for the Porirua Harbour catchment (Note, this is work is already in progress as part of the Whaitua Process). 6. Continue Porirua Harbour sediment/biota monitoring at 5 year intervals.[5]	High (1)	1. Identify sources of stormwater contamination, including Cu and Zn, and investigate source control options; 2. Investigate causes of high indicator bacteria concentrations in Kenepuru Stream and Porirua Stream; 3. Investigate causes of high indicator bacteria concentrations in Porirua Harbour at the Rowing Club.	High
Waiwhetu	• Rate of contaminant increase in depositional environments; • Stormwater EMCs and contaminant loads;	**Ecology:** Waiwhetu Stream has a degraded macroinvertebrate community with a three year average MCI value of 68.	7. Continue RSoE monitoring at one site on Waiwhetu Stream at White line East;[5] 8. Establish an automated stormwater quality and flow monitoring station at site 1A in the Gracefield catchment. Establish event mean concentrations and contaminant loads. 9. Develop contaminant load, water quality and sediment quality models for the Wellington Harbour catchment (Note, this is work is likely to be required as part of the Whaitua Process).	High (2)	4. Identify sources of stormwater contamination, including Cu and Zn, and investigate source control options	High
Owhiro Bay	• Freshwater aquatic ecology • Wastewater overflows to stormwater network	**Human health:** The Owhiro Bay five year 95th percentile *Enterococci* value exceeds the MfE/MoH (2003) Microbiological Assessment Category D criteria (500 enterococci/100ml).	10. Establish one temporary RSoE site on Owhiro Stream downstream of urban Brooklyn; monitor all standard RSoE parameters plus Zn and Cu for a minimum period of 2 years; 11. Continue recreational water quality monitoring at one site in Owhiro Bay (as per existing consent);[4] 12. Continue monthly indicator bacteria monitoring at stream outlet (B22-017, as per existing consent);[4]	High (3=)	5. Investigate causes of high indicator bacteria concentrations in Owhiro Bay;	High
Hutt – Stokes Valley	• Freshwater aquatic ecology	**Human health:** Stokes Valley Stream annual median *E. coli* value has exceeded both the PNRP freshwater secondary contact criteria and NPS-FM national bottom line in five of the last five years. **Ecology:** Stokes Valley Stream has a degraded macroinvertebrate community with MCI scores below 80, however data are limited.	13. Establish one temporary RSoE site on the lower reaches of Stokes Valley Stream; monitor all standard RSoE parameters plus Zn and Cu for a minimum period of 2 years.	High (3=)	6. Identify sources of stormwater contamination, including Cu and Zn, and investigate source control options; 7. Investigate causes of high indicator bacteria concentrations in Stokes Valley Stream;	High
Wainuiomata	• Freshwater aquatic ecology	**Human health:** recreational water quality sites on the Wainuiomata River at Richard Prouse Park has a "Poor" show suitability for recreation grade. The five year 95th percentile *E. coli* value is 770 cfu/100ml.	13. Establish one temporary RSoE site on the lower reaches of Black Creek; monitor all standard RSoE parameters plus Zn and Cu for a minimum period of 2 years.	High (4=)	8. Identify sources of stormwater contamination, including Cu and Zn, and investigate source options;	High

		Ecology: Black Creek has a degraded macroinvertebrate community with MCI scores below 80, however data are limited			9. Investigate causes of high indicator bacteria concentrations in Wainuiomata River;	
Taupo	• Freshwater aquatic ecology	**Human health**: The Plimmerton Beach (south) five year 95th percentile *Enterococci* value exceeds the MfE/MoH (2003) Microbiological Assessment Category D criteria (500 enterococci/100ml).	14. Establish one temporary RSoE site on the lower reaches of Taupo Stream; monitor all standard RSoE parameters plus Zn and Cu for a minimum period of 2 years.	High (4=)	10. Investigate causes of high indicator bacteria concentrations at the south end of Plimmerton Beach;	High
Porirua coast	• **Wastewater overflows to stormwater network**	**Human health:** Titahi Bay South Road Access Stream annual median *E. coli* value has exceeded both the PNRP freshwater secondary contact criteria and NPS-FM national bottom line in two of the last two years; **Human health:** Titahi Bay (south) five year 95th percentile *Enterococci* value exceeds the MfE/MoH (2003) Microbiological Assessment Category D criteria (500 enterococci/100ml).	15. Continue recreational water quality monitoring at 3 sites on Titahi Bay Beach (north, middle, south);[6] 16. Continue monthly monitoring of indicator bacteria at South Road Access Stream; [7] 17. Investigate and remedy causes of wastewater overflows to the stormwater system and/or stream;	High (4=)	11. Investigate causes of high indicator bacteria concentrations in Titahi Bay South Access Road Stream;	High
Hutt River mainstem	• Rate of contaminant increase in marine sediments of Wellington Harbour; • Stormwater EMCs and contaminant loads;	**Human health** Lower Hutt River at Melling where the five year 95th percentile *E. coli* value is 835 cfu/100ml.	18. Continue RSoE monitoring at four sites on the Hutt River main-stem;[5] 19. Continue recreational water quality monitoring at five sites on the Hutt River main-stem;[6] 20. Continue recreational water quality monitoring at three sites on Petone Beach;[8] 21. Continue Wellington Harbour sediment/biota monitoring at 5 year intervals (as per existing consent); [9]	High (4=)	12. Investigate causes of causes of high indicator bacteria concentrations in the Hutt River at Melling;	High
Karori Stream	• Wastewater overflows to stormwater network	**Human health:** Karori Stream annual median *E. coli* value has exceeded both the PNRP freshwater secondary contact criteria and NPS-FM national bottom line in four of the last five years.	22. Continue RSoE monitoring at one site on Karori Stream (at Makara Peak).[5]	High (5=)	13. Investigate causes of high indicator bacteria concentrations in Karori Stream;	High
Lambton	• Rate of contaminant increase in marine sediments of Wellington Harbour; • Stormwater EMCs and contaminant loads;	**Ecology (marginal):** Elevated concentrations of Zn, Pb, Cu, Hg, DDT and PAH in marine sediments close to major outfalls, and marked effects on benthic biota at those locations, but these effects diminish rapidly within a mixing zone extending 50m from the outfall. PAH, Pb, DDT and Hg contamination is thought to be a legacy of past activities.	23. Continue recreational water quality monitoring at five sites in Oriental Bay/ Lambton Harbour (as per existing consent).[8] 24. Continue monthly indicator bacteria monitoring at nine major stormwater culverts (as per existing consent).[10] 25. Continue Wellington Harbour sediment/biota monitoring at 5 year intervals (as per existing consent).[9] 26. Establish an automated stormwater quality and flow monitoring station a representative stormwater outlet (such as Waring Taylor Culvert). Establish event mean concentrations and contaminant loads for the wider Wellington catchment. 27. Develop contaminant load, water quality and sediment quality models for the Wellington Harbour catchment (Note, this is work is likely to be required as part of the Whaitua Process).	High (5=)		Moderate
Island/Houghton Bays	• **Wastewater overflow to stormwater network**	**Human health:** The Island Bay five year 95th percentile *Enterococci* value (at three sites) exceeds the MfE/MoH (2003) Microbiological Assessment Category D criteria (500 enterococci/100ml).	28. Continue recreational water quality monitoring at three sites in Island Bay and one in Princess Bay (as per existing consent);[8] 29. Continue monthly indicator bacteria monitoring at Island Bay (G26-070) and Houghton Bay (C31-040) stormwater culverts (as per existing consent);[10]	High (6=)	14. Investigate causes of high indicator bacteria concentrations in Island Bay;	High

Evans Bay	• Rate of contaminant increase in marine sediments of Wellington Harbour; • Stormwater EMCs and contaminant loads;	**Ecology (marginal):** Elevated concentrations of Zn, Pb, Cu, PAH and TPH in marine sediments close to the Miramar S/W outfall, and marked effects on benthic biota close to the outfall, but these effects diminish rapidly within a mixing zone extending 50m from the outfall. Sediment contamination is thought to be a legacy of past activities at Miramar Wharf and Miramar Gasworks.	30. Continue recreational water quality monitoring at three sites in Evans Bay (as per existing consent).[9] 31. Continue monthly indicator bacteria monitoring at four major stormwater culverts (K35-037, J40-010, K36-001 & J37-001, as per existing consent);[10] 32. Continue Wellington Harbour sediment/biota monitoring at 5 year intervals (as per existing consent);[9] 33. Continue catch pit sediment monitoring in Hataitai and Miramar at 5 year intervals (as per existing consent);[9]	High (6=)		Moderate
Kaiwharawhara	• Rate of contaminant increase in depositional environments; • Stormwater EMCs and contaminant loads.	None	34. Continue RSoE monitoring at one site on Kaiwharawhara Stream at Ngaio Gorge;[4] 35. Continue monthly indicator bacteria monitoring at stream outlet (as per existing consent);[9]	High (6=)		Moderate
North Harbour	• Rate of contaminant increase in depositional environments; • Stormwater EMCs and contaminant loads.	**Human health (marginal):** Ngauranga Stream annual median *E. coli* value exceeded the PNRP freshwater secondary contact criteria and NPS-FM national bottom line on two of the last five years.	36. Continue monthly indicator bacteria monitoring at Ngauranga Stream outlet to coast (as per existing consent).	Moderate (7=)	15. Investigate causes of high indicator bacteria concentrations in Ngauranga Stream;	High
Lyall Bay	None	None	37. Continue recreational water quality monitoring at three sites in Lyall Bay (as per existing consent);[9] 38. Continue monthly indicator bacteria monitoring at Lyall Bay East culvert & Lyall Bay West culvert (G37-050 & F34-014, as per existing consent)[10]	Moderate (7=)		Moderate
Hutt – Hulls Creek	Freshwater aquatic ecology	**Not determined:** Insufficient data	39. Establish one temporary RSoE site on the lower reaches of Hulls Creek; monitor all standard RSoE parameters plus Zn and Cu for a minimum period of 2 years.	Moderate (8=)		Moderate
Eastbourne	• Rate of contaminant increase in marine sediments of Wellington Harbour; • Stormwater EMCs and contaminant loads; • Days Bay Stream aquatic ecology	None	40. Continue recreational water quality monitoring at seven sites along the eastern bays;[5] 41. Continue Wellington Harbour sediment/biota monitoring at 5 year intervals;[5]	Moderate (8=)		Low
Duck/Browns Creek	• Rate of contaminant increase in depositional environments; • Stormwater EMCs and contaminant loads;	**Human health.** Browns Creek annual median *E. coli* value exceeded the PNRP freshwater secondary contact criteria and NPS-FM national bottom line in two of the last two years.	42. Continue recreational water quality monitoring at 2 sites in Pauatahanui Inlet;[5] 43. Continue monthly microbiological monitoring at outlets from Duck Creek and Browns Creek;[7] 44. Continue Porirua Harbour sediment/biota monitoring at 5 year intervals.[5]	Moderate (8=)	16. Investigate causes of high indicator bacteria concentrations Browns Creek;	High
Kakaho	• Freshwater aquatic ecology	**Not determined:** Insufficient data	45. No monitoring proposed	Moderate (8=)		Moderate

	• Rate of contaminant increase in depositional environments; • Stormwater EMCs and contaminant loads;					

Notes: 1. acute effects for water contact recreational activities are defined as: (a) freshwater annual median *E. coli* value exceeds 1000 cfu/100ml, (b) coastal 5 year 95th percentile enterococci value exceeds 500 cfu/100ml.

2. Acute effects on freshwater benthic ecology are defined as a three year average MCI value less than 80.

3. It is noted that the management of **acute effects of stormwater on human health** is a matter of control under Rule R50 of the PNRP, whereas the management of **acute effects of stormwater on the benthic ecology** is not a matter of control under R50.

4. Refer to Table 2-2 for priority ranking methods.

5. Currently implemented by GWRC.

6. Currently implemented by GWRC in collaboration with PCC and WWL.

7. Currently implemented by PCC and WWL.

8. Currently implemented by GWRC in collaboration with HCC and WWL.

9. Currently implemented by GWRC in collaboration with WCC and WWL.

10. Currently implemented by WCC and WWL

2 Adequacy of information

A detailed description of the current state of the receiving environment, the stormwater networks and existing monitoring programmes is provided in the WWL Global Stormwater resource consent application (WWL, 2017). That information has been used to compile catchment score sheets which assess the level of information available and to identify information gaps (refer Appendix A). Adequacy of information was assessed and scored from 1 to 5 under a series of headings including:

- Chacterisation of the network, land-use, contaminant sources, contaminant loads, receiving environment (nature, values, state and trends);
- Identification of knowledge gaps (source/network, values, state of receiving environment); and
- Further investigations (values, monitoring/modelling, other investigations).

A summary of that assessment is provided in Table 2-1.

Table 2-1: Summary of stormwater catchment characteristics, monitoring and knowledge gaps

Catchment	Sub catchment	Catchment area (km²)	% Urban	S/W pipe length (km)	Adequacy of information: Network description	Contaminant sources	Contaminant Load (CLM)	Receiving environment	Overall score (of 75)	Existing/ongoing monitoring	Major knowledge gaps
1. Karori	Karori	30.93	14	62	✗	✓	✗	✓	47	RSoE(x1), E. coli(x3)	• Wastewater network overflows;
2. Owhiro Bay	Owhiro Stream	9.71	51	33	✓	✓	✓	✗	52	E. coli(x4), RecWQ(x1), FC(x1)	• Freshwater aquatic ecology • Wastewater overflows
3. Island/ Houghton bays	Island Bay	5.12	81	60	✓	✓	✓	✓	48	E.coli(x2), RecWQ(x4), FC(x2)	• Wastewater overflows
	Houghton Bay	0.88	54								
4. Lyall Bay	Lyall Bay	2.84	93	27	✓	✓	✓	✓	56	E.coli(x2), RecWQ(x3)	none
5. East Coast	Southeast coast	2.93	44	13	✓	✓	✓	✓	49	RecWQ(x6)	none
	Seatoun/ Karaka										
	Crawford										
6. Evans Bay	Miramar/ Strathmore	4.40	92	108	✓	✓	✓	✓	54	FC(x4), RecWQ(x3) Marine sed/biota	• Rate of contaminant increase in depositional environments; • Stormwater/EMC/contaminant loads
	Kilbirnie/ Rongotai	1.75	92								
	Hataitai	1.39	83								
	Grafton-Rata	0.84	82								
7. Lambton	Oriental Bay	0.49	97	165	✓	✓	✓	✓	55	RecWQ(x5), FC(x9), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Stormwater/EMCs/ contaminant loads
	Southern CBD	8.23	82								
	Northern CBD	4.94	86								
8. Kaiwharawhara	Kaiwharawhara	16.60	56	86	✓	✓	✓	✓	51	RSoE(x1), E. coli(x3), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Stormwater/EMCs/contaminant loads
9. North harbour	Onslow/Ngau/Horo	15.84	67	104	✓	✓	✓	✓	49	FC(x1), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Stormwater/EMCs/contaminant loads
10. Korokoro	Korokoro	15.70	2.6	4.9	✓	✓	✗	✓	49	E.coli(x1), RecWQ(x3), Marine sed/biota	• Freshwater aquatic ecology
11. Waiwhetu	Waiwhetu	18.65	59	120	✓	✓	✗	✓	58	RSoE(x1), E. coli(x5), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Stormwater/EMC/contaminant loads;
12. Hutt - Spe	Speedys	11.61	12	7.5	✓	✓	✗	✗	43	E.coli(x1),	• Freshwater aquatic ecology
13. Hutt - Hull	Hulls Creek	16.58	43	30	✓	✓	✗	✗	37	none	• Freshwater aquatic ecology
14. Hutt - Stokes	Stokes Valley	11.96	39	52	✓	✓	✗	✓	42	E.coli(x3)	• Freshwater aquatic ecology
15. Hutt River	Hutt mainstem	199.16	26	362	✓	✓	✗	✓	48	RSoE(x3), E. coli(x15), RecWQ(x5), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Contaminant loads

Catchment	Sub catchment	Catchment area (km²)	% Urban	S/W pipe length (km)	Adequacy of information					Existing/ongoing monitoring	Major knowledge gaps
					Network description	Contaminant sources	Contaminant Load (CLM)	Receiving environment	Overall score (of 75)		
16. Hutt - Wha	Whakatiki	81.84	0.5	1.9	✓	✓	✗	✓	46	RSoE(x1), RecWQ(x1)	None
17. Hutt - Aka	Akatarawa	116.42	0.06	0.8	✓	✓	✗	✓	50	RSoE(x1), RecWQ(x1)	None
28. Hutt - Man	Mangaroa	104.10	0.89	3.9	✓	✓	✗	✓	49	RSoE(x1)	None
19. Hutt - Pak	Pakuratahi	81.38	0.00	0.0	✓	✓	✗	✓	52	RSoE(x1), RecWQ(x1)	None
20. Eastbourne	Eastbourne	19.37	18	20	✓	✓	✗	✓	40	RecWQ(x10), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Contaminant loads; • Days Bay Stream aquatic ecol.
21. Wainuiomata	Black Creek	18.44	44	78	✗	✓	✗	✓	44	RSoE (x2), RecWQ(x1), E. coli (x5)	• Black Creek aquatic ecology
	Wainuiomata-iti	17.38	0.00	0.4							
	Wainuiomata	57.85	3.1	12.4							
	Morton	40.06	0.5	0.7							
22. Taupo	Taupo	10.58	7.5	5.9	✗	✓	✗	✓	38	E. coli (x1), RecWQ(x2)	• Aquatic ecology
23. Kakaho	Kakaho	17.76	9.6	14.1	✗	✓	✗	✓	40	RecWQ(x2), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Contaminant loads • Aquatic ecology
24. Horokiri	Horokiri	41.02	0.0	0.0	✓	✓	✗	✓	52	RSoE(x1), RecWQ(x2), Marine sed/biota	None
25. Pauatahanui	Pauatahanui	41.56	2.8	13.5	✗	✓	✗	✓	45	RSoE(x1), RecWQ(x2), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Contaminant loads
26. Duck	Duck/Browns	10.03	33	64	✗	✓	✗	✓	45	E. coli (x1), RecWQ(x2), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Contaminant loads
27. Porirua	Aotea/Harbour	10.71	67	367	✗	✓	✗	✓	49	RSoE(x2), RecWQ(x2), Marine sed/biota	• Rate of contaminant increase in depositional environments; • Stormwater/EMC/contaminant loads; • Wastewater Overflows to S/W
	Porirua	31.59	59								
	Paparangi	8.99	12								
	Churton	15.25	61								
28. Porirua coast	Porirua coast	14.4	16	24	✗	✓	✗	✗	33	E. coli(x1), RecWQ(x6)	• Wastewater overflows to S/W

Notes:
1. RSoE(x) = River state of the environment monitoring (at x sites)
2. RecWQ(x) = Recreation water quality monitoring in accordance with MfE/MoH (2003)
3. E. coli(x) and FC(x) = monthly indicator bacteria monitoring (at x sites)
4. % Urban land cover: green = less than 5%; orange = 5-25%; red = greater than 25%
5. Total S/W pipe length: green = less than 5km; orange = 5-25km; red = greater than 25km

3 Values, pressures and current state

The values, pressures and current state of freshwater and coastal habitats affected by discharges from stormwater networks are outlined for each sub-catchment in Appendix A and are summarised in Table 3-1. A prioritisation assessment was conducted in order to establish the following:

- *Low Priority* catchments that are not significantly affected by discharges from a stormwater network and which do not need to be monitored under the SMP.
- *Moderate Priority* catchments that have moderate to high values that are under pressure from urban development and which have been slightly too moderately disturbed by stormwater discharges. At these locations some form of stormwater and/or receiving environment is recommended under the SMP.
- *High Priority* catchments in which acute effects on human health are likely, and/or acute effects on stream ecology or coastal ecology has been identified. At these locations some form of monitoring in recommended under the SMP. In addition, investigations into the source of the contamination and identification of options to mitigate the acute effects are required.

A scoring system used to assign priority rankings for further monitoring and investigations is as follows:

a) For each sub-catchment, “Values” and “Pressure” were graded either High, Moderate or Low, while “State” was graded Good, Fair or Poor.

b) Individual grades were allocated following score:
   - High Values, High Pressure and Poor State = 3
   - Moderate Values, Moderate Pressure and Fair State = 2
   - Low Values, Low Pressure and Good State = 1

c) Monitoring priority is determined from the sum of individual grade scores for each catchment:
   - “High Priority” ≥26;
   - “Moderate Priority” 22-26;
   - “Low Priority”≤22.

d) Action Priority was determined as follows:
   - “High Priority” = One of more Poor State results
   - “Moderate Priority” = Two or more Fair State results
   - “Low Priority” = Not “High Priority” or “Moderate Priority”

Sub-catchments identified as “High Priority” or “Moderate Priority” are listed in Table 1-1 together with recommended monitoring/modelling and/or mitigation actions to be implements under this SMP. The recommended actions are further elaborated in Sections 4, 5, 6 and 7.

Table 3-1: Summary of values, pressures and current state of stormwater receiving environments

Catchment	Sub-catchment	Values				Pressure				State				Priority	
		Freshwater		Coastal		%Urban	%imperv-ious	Network	Hot spots	Freshwater		Coastal		Monitoring	Action
		Ecological	Contact recreation	Ecological	Contact Recreation					Ecological	Contact recreation	Ecological	Contact Recreation		
1. Karori	Karori	High	Moderate	High	Moderate	Moderate	Moderate	High	Moderate	Fair	Poor	Good	Fair	High	High
2. Owhiro Bay	Owhiro Stream	High	Moderate	High	High	High	Moderate	Moderate	Moderate	Poor	moderate	Good	Poor	High	High
3. Island/ Houghton	Island Bay Houghton Bay	Low	Low	High	High	High	High	Moderate	Moderate	Moderate	N/A	Good	Poor	High	High
4. Lyall Bay	Lyall Bay	Low	Low	High	High	High	High	Moderate	Moderate	Fair	N/A	Good	Moderate	Mod	Mod
5. East Coast	S'east coast Seatoun/ Karaka Crawford	Low	Low	High	High	High	moderate	low	moderate	Fair	N/A	Good	Good	Low	Mod
6. Evans Bay	Miramar/ Strathmore Kilbirnie/ Rongotai Hataitai Grafton-Rata	Low	Low	Moderate	High (Outer Evans Bay)	High	High	Moderate	High (Gasworks)	Fair	N/A	Fair	Fair	High	Mod
7. Lambton	Oriental Bay Southern CBD Northern CBD	Low	Low	Moderate	Oriental Bay & Aotea Lagoon	High	High	High	High CBD,SH1	Fair	N/A	Fair	Fair	High	Mod
8. Kaiwhara-whara	Kaiwharawhara	High	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Fair	Fair	Fair	Fair	High	Mod
9. North harbour	Onslow Ngauranga Horokiwi	Low	Low	Moderate	Moderate	High	Moderate	Moderate	High (SH1)	Fair	Poor	Fair	Fair	Mod	High
10. Korokoro	Korokoro	High	Moderate	Moderate	Moderate	Low	Low	Low	Low	Good	Good	Good	Fair	Mod	Low
11.Waiwhetu	Waiwhetu	Moderate	Moderate	High	Moderate	High	High	Moderate	Gracefield Industrial	Poor	Fair	Poor	Fair	High	High
12. Hutt -spe	Speedys	High	Moderate	N/A	N/A	Moderate	Moderate	Low	Low	Good	Good	N/A	N/A	Low	Low
13. Hutt - hul	Hulls Creek	Moderate	Moderate	N/A	N/A	High	Low	Moderate	Moderate	Fair	No data	N/A	N/A	Mod	Mod
14. Hutt - Sto	Stokes Valley	High	Moderate	N/A	N/A	High	High	Moderate	Moderate	Poor	Poor	N/A	N/A	High	High
15. Hut mainstem	Hutt - Lower Opahu Stm Hutt - Upper Hutt - Headwater	High	High	High	Moderate	High	Moderate	Moderate	High CBD,SH2	Good	Moderate	Moderate	Moderate	High	Mod

Catchment	Sub-catchment	Values				Pressure				State				Priority	
		Freshwater		Coastal		%Urban	%imperv-ious	Network	Hot spots	Freshwater		Coastal		Monitoring	Action
		Ecological	Contact recreation	Ecological	Contact Recreation					Ecological	Contact recreation	Ecological	Contact Recreation		
16. Hutt-Wha	Whakatiki	High	High	N/A	N/A	Low	Low	Low	Low	Good	Good	N/A	N/A	Low	Low
17. Hutt-Aka	Akatarawa	High	High	N/A	N/A	Low	Low	Low	Low	Good	Fair	N/A	N/A	Low	Low
18. Hutt-Man	Mangaroa	High	Moderate	N/A	N/A	Low	Low	Low	Low	Good	Fair	N/A	N/A	Low	Low
19. Hutt-Pak	Pakuratahi	High	High	N/A	N/A	Low	Low	Low	Low	Good	Good	N/A	N/A	Low	Low
20. Eastbourne	Eastbourne	Days Bay	Moderate	High	High	Moderate	Low	Moderate	Moderate	Good	No data	Good	Fair	Mod	Low
21. Wainui-omata River	Black Creek	Moderate	Moderate	N/A	N/A	High	High	High	Moderate	Poor	Fair	N/A	N/A	High	High
	Wainuiomata-iti Wainuiomata Morton	High	High	High	High	Low	Low	Moderate	Moderate	Fair	Fair	Good	No data	Mod	Low
22. Taupo	Taupo	High	Moderate	High	High	Moderate	Moderate	Moderate	SH1	Fair	Fair	Good	Poor	High	High
23. Kakaho	Kakaho	High	Moderate	High	High	Moderate	Moderate	Low	Low	No data	No data	Fair	Fair	Mod	Mod
24. Horokiri	Horokiri	High	Moderate	High	High	Low	Low	Low	Low	Good	Fair	Fair	Fair	Low	Low
25. Pauatahanui	Pauatahanui	High	Moderate	High	High	Low	Low	Low	Low	Good	Fair	Fair	Fair	Low	Low
26-Duck	Duck/Browns	High	Moderate	High	High	High	Moderate	Low	Low	Good	Poor	Fair	Fair	Mod	High
27-Porirua	Onepoto Porirua Paparangi Churton	High	Moderate	High	High	High	High	High	CBD, SH1	Fair	Poor	Poor	Poor	High	High
28-Porirua coast	Porirua coast	Moderate	Moderate	High	High	Moderate	Moderate	Moderate	Moderate	Fair	Poor	No data	Poor	High	High

Notes:

1. Values – ecology: "High" = listed in PNRP Schedule F1 or high ecological value; "Moderate" = moderate ecological value; "Low" = low ecological value
2. Values – contact recreation: "High" = recognised primary contact area; "Moderate" = partial immersion activities likely; "Low" = contact recreational use unlikely
3. Pressure - %Urban/%impervious: "High" = >25, Moderate = between 5 & 25; "Low" = <5
4. Pressure - network: "High" = significant network faults; "Moderate" = minor/moderate faults; "Low" = no known faults;
5. Pressure – Hot spots (other than wastewater overflows): "High" = major hot spots; "Moderate = minor/moderate hot spots; "Low" = no known hotspots.
6. State – freshwater ecology (three year average): "Good" = MCI>100: "Fair" = MCI 80-100; "Poor" = MCI <80
7. State – coastal ecology: "Good" = no or slight disturbance; "Fair" = slight to moderate disturbance; "Poor" = major disturbance
8. State – freshwater contact recreation (*E. coli*): "Good" = 5-year 95th%ile <540 cfu/100ml; "Fair" = 95th%ile >550; "Poor" = annual median < 1000 cfu/100ml
9. State – coastal contact recreation (*Enterococci*): "Good" = 5-year 95th%ile <200 cfu/100ml; "Fair" = 95th%ile <500cfu/100ml; "Poor" = 95th%ile >500cfu/100ml
10. Monitoring Priority is determined from the sum of individual values, pressure and state scores. High Value, High Pressure and Poor State = 3; Moderate Value, Moderate Pressure and Fair State = 2; Low Values, Low Pressure and Good State = 1. These scores are summed for each catchment: "High Priority" ≥ 26; "Moderate Priority" 22-26; "Low Priority" ≤ 22
11. Action Priority: "High Priority" = One or more "Poor" State results; "Moderate Priority" = Two or more "Fair" State results; "Low Priority" = not high or moderate

4 Stormwater monitoring and modelling

4.1 Routine microbiological monitoring

4.1.1 Overview

Although most stormwater monitoring is undertaken during storm events, the experience in Wellington City is that routine monthly monitoring of indicator bacteria by grab sampling within the stormwater network has been of considerable value in identifying wastewater network faults which could potentially degrade the recreational water quality of Wellington Harbour and south coast. WCCs stormwater discharge consent WGN090219 currently requires routine monthly monitoring at 20 major stormwater outlets discharging to Wellington Harbour and south coast. It is proposed that this approach be expanded to include stormwater culverts on the eastern side of Wellington Harbour as well as Porirua Harbour and Titahi Bay. While this monitoring does not specifically target wet weather events, field observations recorded for each sampling event enables monitoring results to be selected and analysed for either dry or wet weather conditions.

The measurement of microbiological quality of stormwater discharges under both dry and wet weather conditions is part of the general characterisation of stormwater quality, and contributes to the identification catchments and discharges that are affected by wastewater contamination. It is linked to Monitoring Objectives a) and c) in Section 1.1.

4.1.2 Sampling locations

It is proposed that routine monthly microbiological monitoring of major stormwater culverts should include 20 WCC locations specified by discharge consent WGN090219 (Table 4-1), and 9 locations that are routinely monitored by PCC (Table 4-2).

Within six months of the grant of the consent application WWL shall submit to GWRC for approval an additional list of HCC and UHCC sampling locations including major stormwater culverts discharging to the coastal marine area at Petone, Seaview, Eastern Bays and the Hutt River. Defining the HCC and UHCC sampling locations shall be made in consultation with GWRC and confirmed in the SMP to be submitted for approval to GWRC.

Table 4-1: Locations of Wellington City stormwater culvert microbiological monitoring sites

Site	NZTM	
	Easting	Northing
Owhiro Stream at Owhiro Bay (B22-017)	1747105	5421522
Island Bay (G26-070)	1748110	5421655
Houghton Bay (C31-040)	1749366	5421745
Lyall Bay East Culvert (G37-050)	1750745	5423230
Lyall Bay West Culvert (F34-014)	1750084	5423018
Hataitai Culvert (Evans Bay) (K35-037)	1750426	5425015
Miramar Culvert (Evans Bay) (J40-010)	1751613	5424761
Kilbirnie Culvert (Evans Bay) (K36-001)	1750518	5424923
Cobham Culvert (Evans Bay) (J37-001)	1750753	5424712
Overseas Passenger Terminal Culvert (Q32-035)	1749514	5427388
Tory Street Culvert (Q30-026)	1749200	5427266
Taranaki Culvert (Q30-01)	1749062	5427496
Te Aro Culvert (Q29-110)	1748948	5427497
Harris Street Culvert (R29-028)	1748928	5427748
Waring Taylor Culvert	1748961	5428330
Bowen Culvert (S29-091)	1749010	5428408
Davis Culvert (V32-022)	1749701	5429378
Thorndon Culvert (W31-010)	1749501	5429912

Site	NZTM	
	Easting	Northing
Kaiwharawhara Stream Culvert	1749965	5430732
Ngauranga Stream Culvert	1751933	5432399

Table 4-2: Locations of Porirua City stormwater culvert microbiological monitoring sites

Site No.	Site Name	NZTM	
		Easting	Northing
PCCSWM-01	Taupo Stream	1756920	5450140
PCCSWM-02	Duck Creek	1759585	5447675
PCCSWM-03	Browns Bay Stream	1758000	5447731
PCCSWM-04	Kenepuru Stream	1754817	5444490
PCCSWM-05	Semple Street culvert	1754509	5445215
PCCSWM-06	Te Hiko culvert	1754226	5445803
PCCSWM-07	Onepoto Drain	1754778	5447344
PCCSWM-08	Gloaming Hill	1755086	5446997
PCCSWM-09	Titahi Bay South Access	1753892	5447583

Table 4-3: Locations of Hutt City stormwater culvert microbiological monitoring sites

Site	NZTM	
	Easting	Northing
To be completed		

Table 4-4: Locations of Upper Hutt City stormwater culvert microbiological monitoring sites

Site	NZTM	
	Easting	Northing
To be completed		

4.1.3 Sampling frequency

Grab water samples will be collected at the sites listed in Tables 4-1 to 4-4 on a routine monthly basis, regardless of antecedent weather conditions.

4.1.4 Analytes and site observations

All samples collected at the sites listed in Tables 4-1 to 4-4 will be tested for:

a) *E. coli* (cfu/100ml); and
b) *Enterococci*.

Note, the bacterial indicator of choice depends on the receiving environment. *E. coli* should be measured in discharges to freshwater while Enterococci should be measured in discharges to estuarine and marine areas. In this instance it may be prudent to measure both.

The following field observations shall also be recorded at the time of sample collection:

a) Date and time of sample collection, in New Zealand Standard Time (NZST);
b) Weather conditions (clear, partly cloudy, overcast, rain);
c) Wind direction and an estimation of wind intensity and strength (light, moderate, strong, very strong);
d) Tidal height and state (low/mid and flood/ebb);
e) Rainfall (at each site on each sampling occasion from the nearest suitable rain gauge for the 24-hour period prior to sample collection);
f) Estimated water depth in the stormwater pipe (mm) pipe and the rate of discharge/flow;
g) Any oil or grease films, scums, or foams, or floatable or suspended materials;
h) Any change in the colour or visual clarity
i) Any emission of objectionable odour.

4.2 Storm event monitoring

4.2.1 Overview

Contaminants in stormwater are derived from traffic sources, weathering of building materials and dry deposition of pollutants emitted locally and in neighbouring areas. These contaminants accummulate over time during the dry periods between storms (antecendent periods). During storm events the contaminants are washed off impervious surfaces into the stormwater network and discharged to receiving environments. Stormwater monitoring is therefore mostly undertaken during storm events when the wash–off of contaminants occur.

Accurate stormwater quality and quantity information will give credibility to studies seeking to quantify contaminant loads discharged to receiving water bodies since load is estimated as the product of contaminant concentration and volume of flow. Furthermore, reliable event mean concentrations (EMCs) and contaminant load data will support the calibration and validation of water and sediment quality models for Wellington and Porirua harbours. It is anticipated that this type of model will become an important management tool for the region. Mean event concentrations, flow measurement and contaminant load information is also part of the general water quality characterisation of stormwater catchments. This monitoring component supports Monitoring Objectives a) and c) in Section 1.1.

4.2.2 Stormwater sampling methods

A sampling strategy involving the use of an auto sampler triggered by a water level measuring device has a number of practical advantages over manual sampling methods and is recommended for use at selected sites in the Wellington and Porirua harbour catchments. The use of an auto sampler allows consistent samples, is less labour intensive, has the ability to take multiple samples throughout a flow event and ensures that first flush and peak flow phases are sampled (refer Gadd *et al*., 2014).

4.2.3 Measures of stormwater quality

Multiple sub-samples will result in a better representation of the storm event and a more reliable estimate of the EMC, or event mean concentration (mg/L) for the contaminants of interest. The EMC is a statistical parameter used to represent the flow proportional average concentration of a given parameter during a storm event. EMCs are a useful measure of stormwater quality which enable a better comparison between storm events and between sites than the quality at a single point in time (Gadd *et al*., 2014).

Stormwater loads are the mass of contaminant discharged. These can be estimated from the EMC and volume of flow. Loads are particularly useful for assessing downstream effects in estuaries or harbours where the total mass loading of contaminants over time can result in sedimentation or contaminant accumulation. Event based loads can be used to estimate annual loads using one the methods described by Gadd *et al* (2014).

4.2.4 Sampling locations

The Lambton, Waiwhetu and Porirua Stream catchments stand out in Table 3-1 as being under intense pressure due to a high proportion of urban area, impervious surface and known contaminant hot spots. It is proposed that automated stormwater quality and flow monitoring stations will be located at a downstream location in each of these catchments, but upstream of any tidal influence (Table 4-5). To avoid vandalism all equipment should be housed in a lockable box which, if possible should be located within private premises. It is noted the GWRC have recently installed an automatic sampling station on the lower reaches Porirua Stream and that flow monitoring is also conducted at this site.

Table 4-5: Locations of stormwater culvert microbiological monitoring sites

Catchment	Sampling location
Lambton	Waring Taylor culvert (to be confirmed)
Waiwhetu	Gracefield , at or near site 1A (to be confirmed)
Porirua	Porirua Stream or major culvert (to be determined).

4.2.5 Sampling frequency and duration

Stormwater quality varies considerably between storm events, even for a single site. Consequently monitoring of a single event is unlikely to provide sufficient information on which to base environmental assessments. Most stormwater monitoring protocols recommend at least 12 storm events, while Gadd *et al* (2014) consider that between 5 and 10 storm events with a range of different rainfall depths are required to provide a reasonable characterisation of stormwater quality. It is proposed that 10 to 12 storm events will be targeted at the sites listed in Table 4-5. An indicative time-line is that the site locations would be confirmed and equipment installation completed within the first 12 months of the consent period, and data collection would be completed within the next 24 month period.

4.2.6 Analytes

A list of recommended analytes are identified in Table 4-6. Suspended solids in stormwater are most regularly referred to as TSS, or total suspended solids. In many stormwater studies, however, the measurement of SSC (suspended solids concentration) is becoming more common and is recommended by Auckland Council for stormwater and streams. It is useful to measure both total and dissolved forms of metals. Dissolved metals are generally more toxic as they are more bioavailable to aquatic biota, however, in this case, where stormwater contaminants ultimate end up in the depositional environments of Porirua and Wellington harbours, the total concentration discharged is also of interest.

Table 4-6: Recommended analytes for stormwater monitoring

Analyte	Rationale
SSC (or TSS)	Sediment is a major contaminant of stormwater, and carries other contaminants; sedimentation of estuaries is a primary concern in the Wellington Region
pH and conductivity	Spike can indicate spills, illegal discharges or seawater interaction
Total and dissolved copper, cadmium, chromium, lead, nickel and zinc	Copper and zinc are prevalent in urban stormwater in the Wellington Region; other metals can be present at high concentrations within industrial areas or other hot spots
Total nitrogen, total phosphorus, nitrate-N, ammoniacal-N and DRP	Nutrients in stormwater may be of concern at some locations in the region. Ammonia is normally present at low concentrations but may be of concern at industrial locations
E. coli	Prevalent in urban stormwater, at times at very high levels.

4.3 Contaminant load, water quality and sediment quality modelling

Storm event monitoring as outlined in Section 4.2 will provide a detailed characterisation of stormwater run-off quality and quantity, including EMC's event based loads from selected catchments. This information will be used to calibrate or validate catchment scale contaminant load, water quality and sediment quality models. These models are already under development as part of the GWRC Porirua Whaitua process and will very likely also be developed for the Wellington/Hutt Valley Whaitua. It is anticipated that WWL and GWRC will adopt a collaborative approach to ensure that a single modelling exercise covers both processes.

Details and timeframes of the recommended modelling will be confirmed in the final SMP.

5 River and stream monitoring

5.1 Overview

The water quality and ecological condition of rivers and streams into which stormwater is discharged is currently monitored by GWRC and the territorial authorities (TAs). WWL propose to utilise these existing monitoring programmes supplemented with additional sites at some locations, but to large extent they already allow a comprehensive assessment of the current state of inland waters affected by stormwater discharges. It is recognised that continuance of existing monitoring programmes is not guaranteed and that WWL will need to collaborate with GWRC to ensure that the environmental monitoring network maintains a sufficient focus on stormwater issues. It is likely also that catchment models will play an increasing role and may in the future replace some of the monitoring that is currently undertaken.

River state of the environment (RSoE) monitoring and recreational water quality monitoring contribute to the assessment of ecosystem health and to identify acute effects on human health, in line with Monitoring Objectives b) and d) in Section 1.1.

5.2 Mixing zones

Policy P72 of the PNRP states that the zone of reasonable mixing for discharges to receiving waters shall be minimised and will be determined in a case by case basis. In determining the mixing zone particular regard shall be given to:

(a) acute and chronic toxicity effects, and

(b) adverse effects on aquatic species migration, and

(c) efficient mixing of the discharge with the receiving waters, and

(d) avoiding a site with significant **mana whenua** values identified in Schedule C (mana whenua), and

(e) the identified values of that area of water, and

(f) avoiding significant adverse effects within the **zone of reasonable mixing**.

The determination of a zone of reasonable mixing for the discharge of stormwater to urban streams presents some practical difficulties, not least of which is the fact that urban streams receive stormwater discharges from multiple locations often in close proximity, so that mixings zones, if defined as an area extending x metres downstream of each outfall, would either overlap or have to be very small in some cases. In any event, as indicated on Policy P72, this determination should be made in a case-by-case basis and cannot reasonably be specified globally. WWL look for guidance from GWRC for a recommended mixing zone to be confirmed in the final SMP

5.3 Water quality

5.3.1 Location of existing receiving water quality monitoring sites

The water quality of rivers and many streams across the Wellington Region is currently well characterised by the GWRC State of the Environment monitoring programme (RSoE). In addition, the Hutt and Wainuiomata rivers, which are identified in the PNRP as regionally significant primary contact recreation fresh water bodies, are monitored on a weekly basis during the bathing season for suitability for recreation.

Existing RSoE sites that WWL propose to utilise for assessing the effects of stormwater discharges are listed in Table 5-1. Existing recreational water quality monitoring sites WWL propose to also utilise for assessing the effects of stormwater are listed in Table 5-2.

Table 5-1: Existing GWRC RSoE monitoring sites potentially influenced by stormwater

Site no	Site name	NZTM site coordinates	
		Easting	Northing
RS13	Horokiri S at Snodgrass	1761804	5450653
RS14	Pauatahanui S at Elmwood	1761097	5446783
RS15	Porirua S at Glenside	1753289	5438364
RS16	Porirua S at Wall Park	1754366	5443031
RS18	Karori S at Makara Peak M.B.P	1744213	5426874
RS19	Kaiwharawhara S at Ngaio G.	1749069	5431077
RS20	Hutt R at Te Marua Intake Site	1780071	5450158
RS21	Hutt R opp. Manor Park G.C.	1766679	5442285
RS22	Hutt R at Boulcott*	1760858	5437486
RS23	Pakuratahi R 50m d/s Farm Ck	1784607	5451677
RS24	Mangaroa R at Te Marua	1778543	5448643
RS25	Akatarawa R at Hutt confl.	1776183	5449184
RS26	Whakatikei R at Riverstone	1772256	5446748
RS57	Waiwhetu S at Whites Line East	1760977	5434510
RS28	Wainuiomata R at Manuka Track	1768242	5430634
RS29	Wainuiomata R d/s of White Br	1757316	5415724

Table 5-2: Existing GWRC freshwater recreational area sites potentially influenced by stormwater

Site name	NZTM site coordinates	
	Easting	Northing
Pakuratahi River at Forks	1784288	5452620
Akatarawa River at Hutt Confluence[1]	1776183	5449184
Hutt River at Birchville	1776196	5449091
Hutt River at Maoribank Corner	1775882	5446696
Hutt River at Poets Park	1771461	5446092
Hutt River at Silverstream Bridge	1767598	5443172
Hutt River at Melling Bridge	1759906	5436831
Wainuiomata River at Richard Prouse Park	1764536	5429141

5.3.2 Location of proposed temporary RSoE sites

While the current level of monitoring coverage is comprehensive, a number of significant urban streams have been identified that receive discharges from stormwater networks but where the water quality is not sufficiently characterised to assess the effects of the stormwater discharges:

1) Owhiro Stream,
2) Stokes Valley Stream,
3) Hulls Creek (Silverstream),
4) Black Creek (Wainuiomata), and
5) Taupo Stream (Plimmerton).

It is proposed that temporary RSoE sites should be established and monitored downstream of the urban area on each of these watercourses. The standard suite of RSoE water quality monitoring, plus copper and zinc, would be conducted at each site on a monthly basis. The exact location of these five temporary RSoE sites will be discussed in consultation with GWRC, and confirmed in a final SMP submitted within six months of grant of consent.

5.3.3 Sampling methods and analytes

GWRC's RSoE monitoring programme includes monthly monitoring of 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 RSoE sites located in urban catchments with likely exposure to heavy metal inputs, or which discharge into sensitive downstream receiving environments (e.g., harbours and estuaries), are also analysed for dissolved concentrations of copper and zinc. It is proposed that this same sampling regime and suite of analyses will apply to the temporary RSoE sites listed in Sections 5.3.2, for a period of no less than 24 months.

GWRC's microbiological monitoring programme in freshwater recreational area includes weekly monitoring of indicator bacteria (*E. coli*) in accordance with the microbiological water quality guidelines for recreational areas (MfE/MoH, 2003). The guidelines provide trigger values which underpin a three-tier management framework analogous to traffic lights (Green/Surveillance, Amber/Alert and Red/Action). The guidelines also outline a process to grade the suitability for recreational use (SFRG) of these waters from a public health perspective. This includes a sanitary Inspection Category (SIC) and Microbiological Assessment Category (MAC). The SIC allows the principal source of faecal contamination in a catchment (e.g. sewage overflow, stormwater discharges, agricultural runoff, wildlife, etc.) to be identified and assigns a category (value) according to risk. This value is 'very high', 'high', 'moderate', 'low' or 'very low', and is found for a specific water body by use of a SIC flow chart. It is anticipated that this monitoring programme will continue in its current form at the sites listed in Table 5.2 for the 5 years.

5.4 Sediment quality

While sediment quality monitoring can provide useful results in soft bottomed streams, the majority of the urban streams within the study have a gravel or cobble bottom, indicating that fine sediments are flushed rapidly through the system. The fine sediment would typically accumulate in a depositional receiving environment such as an estuary or harbour. For that reason this SMP recommends that sediment quality monitoring should be focused in depositional environments of Wellington and Porirua harbours (refer Section 6.4).

5.5 Aquatic ecology

The temporary RSoE sites proposed under Section 5.1 will be assessed for ecological condition. This involves semi-quantitative assessments of macroinvertebrate communities and periphyton biomass during stable/low flows in summer or autumn. Habitat assessments will be made annually during summer or autumn (at the time biological samples are collected). This assessment provides an indication of the condition of the physical habitat and its ability to support stream biota. It incorporates fine sediment cover, invertebrate habitat abundance and diversity, fish habitat abundance and diversity, hydraulic heterogeneity, bank stability, channel modification, and riparian buffer width, integrity and shade.

6 Coastal monitoring

6.1 Overview

The microbiological water quality of coastal recreational areas is focused on the management of risk to human health, in line with Monitoring Objective d) in Section 1.1. Surveys of marine sediment quality and benthic ecology are focused on ecosystem health, in line with Monitoring Objective b) in Section 1.1.

6.2 Mixing zones

Policy P72 of the PNRP states that the zone of reasonable mixing for discharges to receiving waters shall be minimised and will be determined in a case by case basis (refer Section 5.2). In respect of stormwater discharges to coastal environments it is proposed that the zone of reasonable mixing should extend 50m in any direction from the stormwater outfall, culvert or pipe.

6.3 Water quality

6.3.1 Location of recreational water quality monitoring sites

The microbiological water quality of bathing beaches in Wellington Harbour, Porirua Harbour and the southern and western coastline is monitored during the bathing season by GWRC and the TA's. All of the coastal recreational water quality monitoring sites listed in Table 5-1 below are potentially affected by urban stormwater discharges. WWL proposed to utilise the monitoring currently undertaken at these sites.

Table 6-1: Coastal recreational area monitoring sites

	Site name	NZTM site coordinates	
		Easting	Northing
Porirua	Pukerua Bay	1759058	5456278
	Karehana Bay at Cluny Road	1756093	5451360
	Onehunga Bay	1755796	5449181
	Plimmerton Beach at Bath Street	1756706	5450316
	South Beach at Plimmerton	1756810	5449874
	Pauatahanui Inlet at Water Ski Club	1758074	5449593
	Pauatahanui Inlet at Paremata Bridge	1757153	5448284
	Porirua Harbour at Rowing Club[2]	1754891	5446947
	Titahi Bay at Bay Drive	1754132	5448169
	Titahi Bay at Toms Road	1754110	5447857
	Titahi Bay at South Beach Access Road	1753906	5447682
Wellington	Aotea Lagoon	1748985	5427683
	Wellington Harbour at Taranaki St Dive Platform	1749092	5427538
	Oriental Bay at Freyberg Beach	1749920	5427464
	Oriental Bay at Wishing Well	1750118	5427386
	Oriental Bay at Band Rotunda	1750243	5427375
	Balaena Bay	1750958	5427267
	Hataitai Beach	1750632	5425730
	Shark Bay[2]	1752211	5426197
	Mahanga Bay[2]	1753468	5427115
	Scorching Bay	1753517	5426647
	Worser Bay	1753074	5424823
	Seatoun Beach at Wharf	1753129	5424234
	Seatoun Beach at Inglis Street	1753405	5423994

	Breaker Bay	1753312	5422970
	Lyall Bay at Tirangi Road	1750747	5423230
	Lyall Bay at Onepu Road	1750286	5423116
	Lyall Bay at Queens Drive	1749990	5422868
	Princess Bay	1749586	5421504
	Island Bay at Reef Street Recreation Grd	1748229	5421542
	Island Bay at Surf Club	1748377	5421590
	Island Bay at Derwent Street	1748155	5421415
	Owhiro Bay	1747122	5421463
Hutt Valley & east Harbour	Petone Beach at Water Ski Club	1755744	5434591
	Petone Beach at Sydney Street	1757045	5434248
	Petone Beach at Kiosk	1758326	5433711
	Sorrento Bay[2]	1759632	5431384
	Lowry Bay at Cheviot Road	1760206	5430891
	York Bay	1759977	5430160
	Days Bay at Wellesley College	1759616	5428529
	Days Bay at Wharf	1759654	5428313
	Days Bay at Moana Road	1759582	5428120
	Rona Bay at Northern end of Cliff Bishop Park	1759109	5427654
	Rona Bay at Wharf	1758730	5427371
	Robinson Bay at HW Shortt Recreation Ground	1758519	5426674
	Robinson Bay at Nikau Street	1758131	5425856

6.3.2 Sampling methods and analytes

The microbiological monitoring programme in coastal recreational areas includes monitoring of indicator bacteria in accordance with the microbiological water quality guidelines for recreational areas (MfE/MoH, 2003). The guidelines provide trigger values which underpin a three-tier management framework analogous to traffic lights (Green/Surveillance, Amber/Alert and Red/Action). The guidelines also outline a process to grade the suitability for recreational use (SFRG) of coastal waters from a public health perspective. The two components providing a SFRG for the water at an individual site are:

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

Sites are sampled weekly for 20 weeks between mid- November and 31 March. On each sampling occasion a single water sample is collected 0.2 m below the surface in 0.5 m water depth and analysed for enterococci indicator bacteria. Observations of weather, the state of the tide and visual estimates of seaweed cover are also made at each site to assist with interpretation of the monitoring results.

WWL will utilise the monitoring results from the microbiological monitoring programme.

6.4 Sediment quality and benthic ecology

GWRC have conducted surveys of marine sediment quality and benthic ecology in both Wellington Harbour and Porirua Harbour at roughly five year intervals. These studies have established the degree to which marine sediments are been contaminated by stormwater and other discharges, and have allowed rates of contaminant accumulation to be estimated. They have also described the benthic community health in sub tidal habitats and provide an assessment of stormwater related effects on these communities.

It is anticipated that in the future the development of catchment models for both harbours will reduce the need for comprehensive marine sediment surveys, however, within the 5 year period covered by this SMP it is recommended that one further round of surveys should be conducted. The location of sampling sites and methodologies for sampling should be consistent with the most recent survey round, taking account of recommendations made by Milne (2010) and Oliver & Conwell (2014).

7 Acute effects on human health

Under Rule R50 of the PNRP the discharge of stormwater into water from a local authority stormwater network is a *controlled activity* for which the management of acute effects of stormwater on human health is one of a number *matters of control*. For the purpose of this SMP, acute effects on human health are considered to be likely to occur:

- At any popular freshwater bathing site where the annual median *E. coli* values exceeds 1000 cfu/100ml; or
- At any popular coastal bathing site where the five year 95 percentile *Enterococci* value exceeds 500 cfu/100ml.

In the event that either of these triggers are exceeded, WWL will conduct an investigation into the cause of elevated indicator bacteria levels in the contributing catchment. That investigation should include a targeted survey of faecal contamination sources including water quality sampling of contributing stormwater culverts, identification and monitoring of any constructed wastewater overflow structures, identification of any wastewater network faults by way of visual inspection, dye testing or CCTV surveys, and identification of any non-human sources of faecal contamination by faecal source tracking. The findings of the investigation shall be set out in the Annual Report together with an assessment of mitigation options.

A flow diagram showing recommended triggers and responses to manage acute effects on human health is included in Figure 7-1.

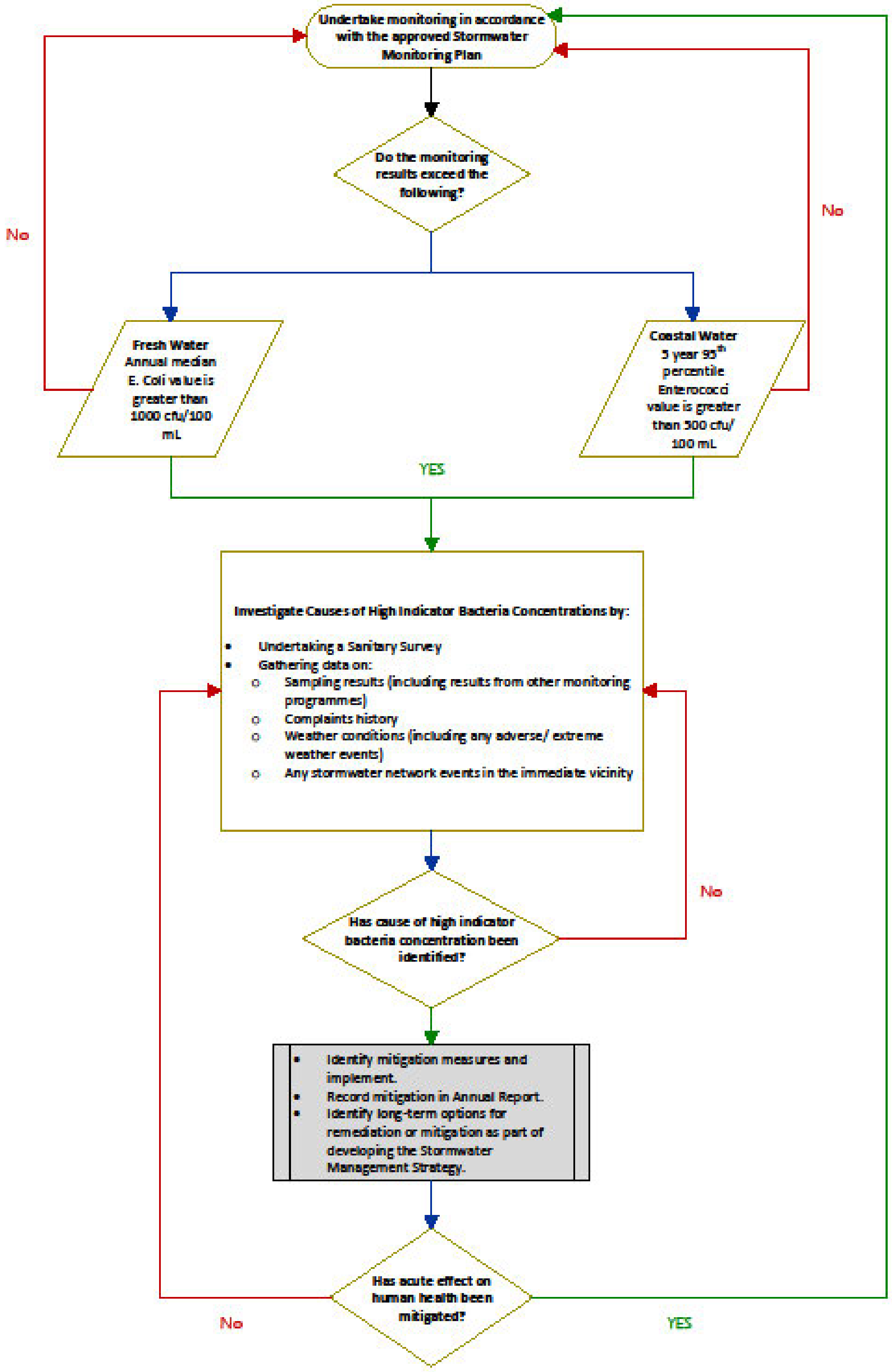

Figure 7-1: Flow diagram showing acute effects triggers and management responses

8 Reporting

WWL will engage a suitably qualified and experienced environmental scientist to prepare and submit an annual report to GWRC by 1 September each year following the commencement of monitoring. The report shall include the following

a) Stormwater outfall discharge water quality monitoring results, including an evaluation of the results, an analysis of the dry and wet weather sampling results and differences, and an analysis of any differences or trends from previous results;

b) Observations and photographs from the visual inspections undertaken during stormwater outfall discharge water quality monitoring;

c) A summary of sanitary survey results, remedial works or management actions in relation to acute adverse effects on human health detected during monitoring;

d) Sediment quality and benthic fauna monitoring results where applicable, including an assessment of these by an appropriately qualified and experienced scientist, and an analysis of any trends;

e) Results where applicable from Wellington Regional Council’s Wellington Harbour and Porirua Harbour sub tidal sediment and biota monitoring programmes, Wellington Regional Council’s Hilltop Database on water quality and sediment quality, and marine and freshwater recreational water quality monitoring programme;

f) A discussion of the key findings of the monitoring undertaken in relation to environmental impacts and network performance;

g) Recommendations for amendments to monitoring procedures or locations;

h) Any other matters the consent holder considers relevant, including any follow-up actions resulting from the preceding year's operation.

References

Gadd, J., Semadeni-Davies, A., & Moores, J. (2014). *Design of stormwater monitoring programmes.* Prepared by NIWA for Environment Southland.

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Milne, J. (2010). *Wellington Harbour marine sediment quality investigation - supplementary report.* GWRC Report.

Oliver, M., & Conwell, C. (2014). *Te Awarua-o-Porirua Harbour subtidal sediment survey: Results from the 2010 survey.* Wellington: Greater Wellington Regional Council, Publication No. GW/ESCI-T-14/110.

Wellington Water Ltd. (2017). *WWL Global Stormwater Consent Stage 1: Resource consent application.* Wellington Water Ltd.

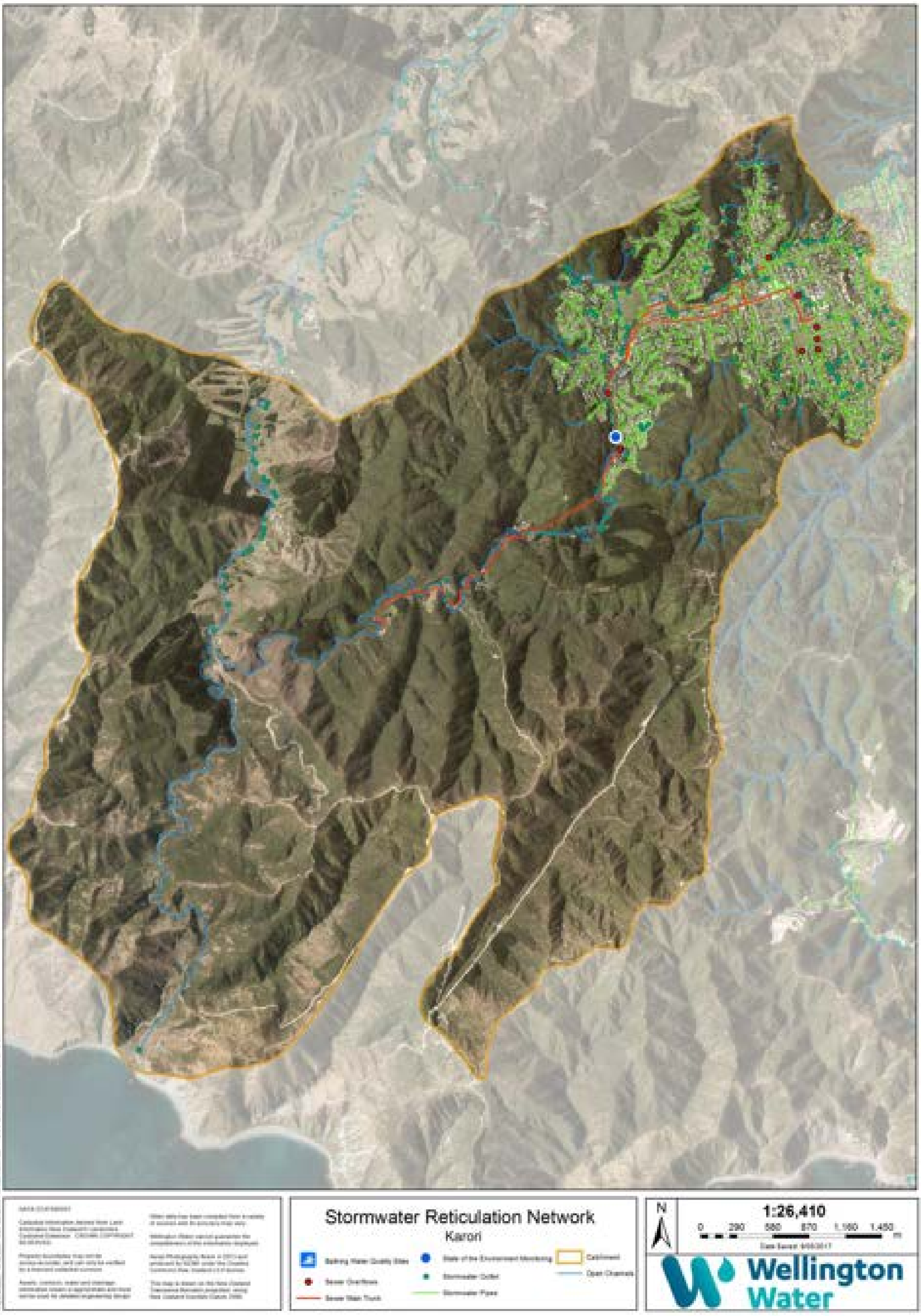
Appendices

Appendix A Catchment score sheets 1 to 28

1. Karori

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	100%	
2	**Characterise**		
a)	Network	3	The Karori Stream catchment extends from Messines Road in north-eastern Karori to the stream mouth between Karori Rock and Sinclair Head on Wellington's south coast. The stormwater network developed gradually over time: circa 1860s onwards. Around 50% was constructed during major housing development in Karori between 1950 and 1970, and the remaining 30% was constructed from the 1980s onwards. Relatively high number of faults due to age. Total public stormwater length is 62 km. The remaining open channel stream length is 33 km
b)	Land use characterisation	3	The total catchment area is 30.9 km² of which 14% is served by a stormwater network and 6% is impervious surface (residential and light commercial). The remainder of the catchment is open space, being in pasture, scrub and plantation forest. The principal headwater tributary of Karori Stream arises within urban Karori and is fed by run-off from a residential catchment. A second major headwater tributary (Silver Stream) drains "Long Gully" which is in pasture and scrub.
c)	Contaminant sources	3	Catchment-wide sources are dominated by run-off from pasture, scrub and plantation forests. Within the urban area contaminant sources include roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from major city streets and parking lots.
d)	Volume/loads	1	Contaminant load modelling (CLM) information is not available
e)	Receiving environment		
	i. Nature	3	Karori Stream is modified by urban development in its upper reaches and by agricultural development in its middle and lower reaches. The rural reach has been repeatedly burnt and extensively grazed but maintains a moderately diverse aquatic biota. The stormwater network discharges via multiple outlets to Karori Stream which transports it more than 6km to the coast. Due to its open, exposed aspect, Wellington's south coast it is not considered to be a depositional environment.
	ii. Values	4	While much of the stream is piped through urban Karori, numerous short reaches of open channel remain, running beside residential properties as well as Karori Park and Makara Peak Mountain Bike Park. The middle and lower stream runs through private property and runs adjacent to several holiday batches. Due to its small size the stream is not suitable for bathing or other primary contact recreation activities but is accessible to the public at a number of locations and is likely to be used for secondary contact activities. Schedule F1 of the PNRP identifies Karori Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in Karori Stream include banded kokopu, inanga, koaro, lamprey, longfin eel, shortfin eel and upland bully.
	iii. State and trends		
	• Hydrology	2	Limited urban stream hydrology information.
	• Freshwater ecology	4.5	At the RSoE site immediately downstream of urban Karori, invertebrate communities are in a fairly degraded state. The invertebrate community includes a relatively low number of EPT taxa (mayflies, stoneflies, caddisflies), and is dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). The average MCI score at Boulcott for the years 2013/14, 2014/15 and 2015/16 is 87.
	• Coastal ecology	2	Intertidal habitats in the embayment to which the stream discharges are generally mobile gravel, and coarse sand with sparse fauna or flora. Local areas of intertidal rocky reef are exposed in western side of the embayment. The reef habitats support a high biomass of algae, and a high diversity of associated invertebrate organisms. The dominant mobile organisms include rock lobster, crabs, paua, chitons, starfish and kina. A variety of fish species are associated with the rocky reef habitat (Larcombe 1994).
	• Sediment quality	3.5	Streambed sediments sampled at Karori Stream (Makara Peak) in 2005 and 2006 exceeded the ANZECC (2000) ISQC-Low trigger value for Zn, Total PAH, Total DDT and Dieldrin.
	• General coastal water quality	1	Coastal water quality information is not available.

	• General freshwater quality	4.5	The GWRC RSoE site at the Makara Peak Mountain Bike Park immediately downstream of urban Karori received a 'fair' WQI grade for the 2015/2016 year. Water quality at this location typically fails to meet guidelines for *E. coli*, nitrate/nitrite nitrogen and dissolved reactive phosphorus. Dissolved Cu and Zn consistently exceed ANZECC (2000) trigger values in the water column.
	• Contact recreation (micro.)	4.5	Median and maximum *E. coli* values from monthly monitoring for the 2015/16 monitoring year were 1,359 and 4,300 cfu/100ml, respectively. The median value exceeded the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100ml). Faecal source tracking indicates a predominantly human source but dog, ruminant and wildfowl also contributes to faecal contamination.
	• Monitoring (historic and current)	4	• Ongoing monthly RSoE monitoring (water quality and benthic ecology) at one site in Karori Stream; • WCC monthly microbiological monitoring at 3 locations on Karori Stream
	• Known key problems	3.5	Old network/faults/overflows leading to high microbiological content of stormwater discharges and stream water, exceeding the NPS-FM national bottom line for secondary contact recreation High stream water and sediment concentrations of Cu, Zn and PAH
3	**Identify knowledge gaps**		
a)	Source/network		A detailed characterisation of wastewater overflows to the stormwater system is not available (location, frequency and duration).
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of RSoE monthly monitoring (water quality, invertebrates and periphyton) at the Makara Peak site on Karori Stream;
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		2. **Investigate and remedy** causes of wastewater overflows to the stormwater system.
	• Effectiveness of existing solutions		Not required
	Total Score	**46.5**	


Stormwater Reticulation Network
Karori
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
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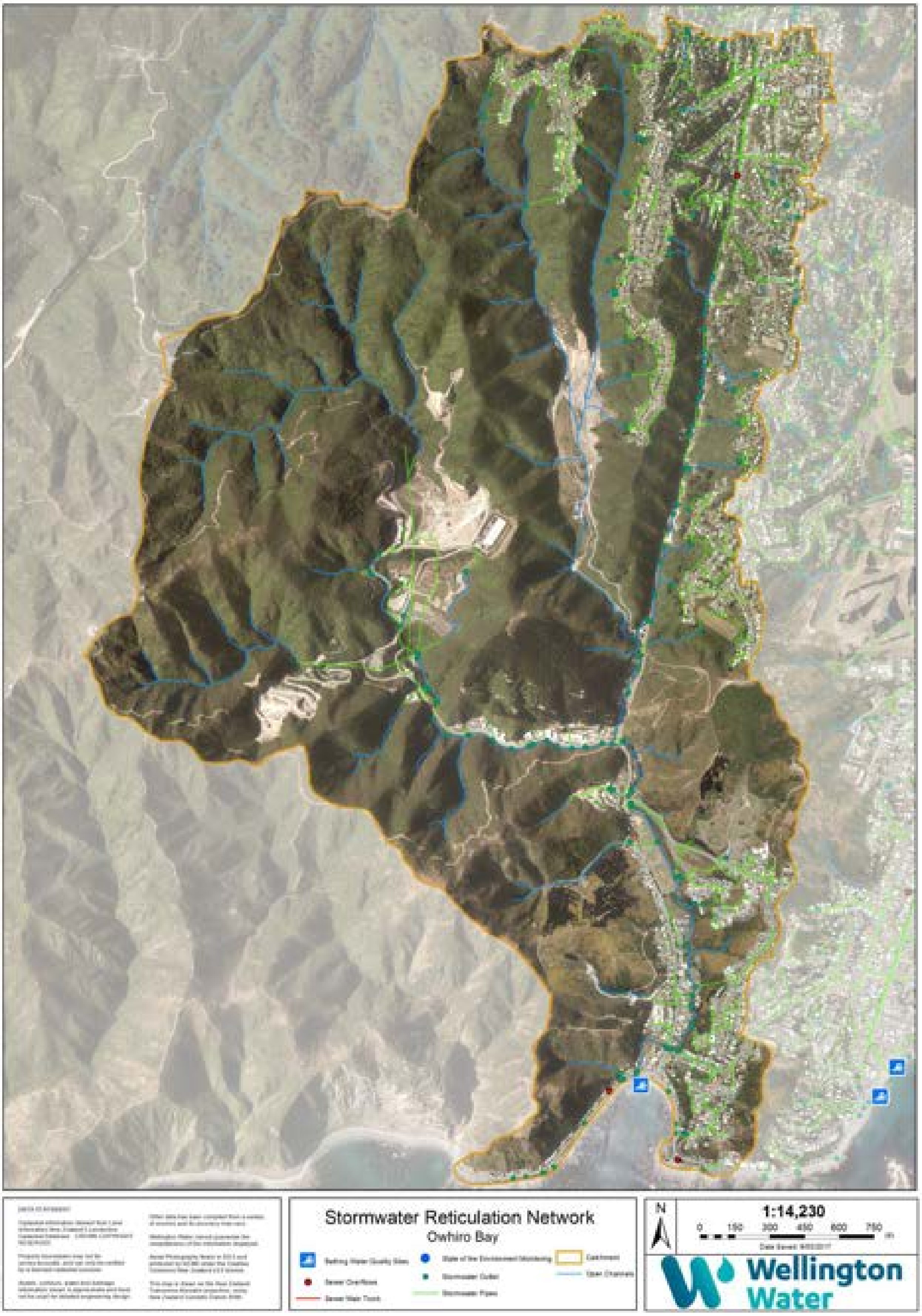
0 290 580 870 1,160 1,450 m
Wellington Water

2. Owhiro

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	100%	
2	**Characterise**		
a)	Network	4	Owhiro Stream catchment lies to the south of Wellington City centre, extending from Brooklyn in the north to the stream mouth at Owhiro Bay. The catchment is bounded by Hawkins Hill, Polhill, Todman Street, The Ridgeway, Frobisher Street and Severn Street. The stormwater network developed gradually over time: circa 1890 onwards. Less than 10% constructed prior to 1940's and 15% between the 1940s and 1960s. The remaining 75% was constructed from 1970 onwards. The total public stormwater length 33 km. The remaining open channel stream length is estimated at 26 km
b)	Land use characterisation	4	The total catchment area is 9.71 km² of which 51% is served by a stormwater network and 15% is impervious surface. The remainder is predominantly open space with scrubland and gorse land south of Polhill and east of Hawkins Hill, surrounding Southern Landfill. The eastern part of the catchment is largely residential. Industrial activity is clustered around Landfill Road while business properties are concentrated on Owhiro Road and Cleveland Road at Brooklyn. Owhiro Stream has 3 main tributaries draining Carey's Gully (occupied by Southern Landfill and C&D Landfill), Kowhai Park Gully (occupied by T&T Landfill) and urban Brooklyn (which is largely culverted).
c)	Contaminant sources	4.5	Catchment wide sources are dominated by runoff from gorse scrubland. While urban stormwater is not a major input, contaminants sourced from the urban area include metal roofs and building materials, road surfaces and other permeable pavements, soil disturbance, vegetation, wild and domestic animals, and vehicles (tyres, brake linings, oil leakage, and exhaust). Potential known point sources include three operating landfills, at least one of which is known to have a measurable effect on the water quality of Owhiro Stream.
d)	Volume/loads	5	Predicted stormwater loads of Zn, Cu, Pb and PAH from the catchment, (excluding inputs from the landfill sites), are low. The catchment area is about 13% of Wellington City and loads are about 6% of the total stormwater load from Wellington (Diffuse Sources, 2014).
e)	Receiving environment		
	i. Nature	3.5	Owhiro Stream has been modified by urban development, including the development and three operating landfills. The reticulated stormwater system discharges to Owhiro Stream and its tributaries at multiple locations throughout its length. The stream discharges to Owhiro Bay. Owhiro Bay lies on the exposed south coast of Wellington, bounded by rocky headlands on either side. It is part of the Taputeranga Marine Reserve. It has a predominantly gravel upper beach with a firm sand and gravel lower shore, with little vegetation adjacent to the beach. Due to its open, exposed aspect, Wellington's south coast it is not considered to be a depositional environment.
	ii. Values	3.5	The stream is mostly open in its middle and lower reaches, running beside residential properties as well as Happy Valley Park and Owhiro Bay Primary School. The stream is not suitable for bathing or other primary contact recreation activities but is accessible to the public at a number of locations and is likely to be used by children and others for a variety of secondary contact activities. Wellington's south coastal waters are identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. The rocky shore and coastal area from Red Rock to Hue Te Taka Peninsular is identified in Schedule C of the PNRP as an area of significance by mana whenua iwi. Schedule F1 of the PNRP identifies Owhiro Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Schedule F1B identifies the tidal reach as potential inanga spawning habitat. Schedule F4 identifies Owhiro Bay as having significant biodiversity values (being located in the Taputeranga Marine Reserve). Tapu te Ranga – Owhiro – Haewai is identified in Schedules 3 & 4.
	iii. State and trends		
	• Hydrology	2	Limited information on urban stream hydrology
	• Freshwater ecology	4.5	Macroinvertebrate surveys show that the invertebrate community in Owhiro Stream immediately downstream urban Brooklyn is in a consistently poor condition with metric scores in the following ranges: MCI (78 to 84), QMCI (2.57 to 3.12) and %EPT taxa (5 to 25). These communities are characterised by a low number of pollution sensitive EPT taxa (mayflies, stoneflies, caddisflies), and are dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae).

			Fish species recorded in Owhiro Stream include banded kokopu, common bully, giant kokopu, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.
	• Coastal ecology	1	Stevens & Robertson (2004) conducted a broad scale habitat of Wellington beaches, including Owhiro Bay, but coastal ecology information is otherwise quite limited.
	• Sediment quality	3.5	Streambed sediments sampled at Owhiro Stream in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Zn in both years, and exceeded the Pb trigger value in 2005 but not in 2006 (Milne & Watts, 2008). The ISQC-Low trigger values for Total DDT and Dieldrin were exceeded in both years. The ISQC-High trigger value for Dieldrin was exceeded on one occasion. The water quality and sediment results indicate that the stream environment at this location may be toxic to some aquatic organisms. Sediment quality information is not available for Owhiro Bay.
	• General coastal water quality	1	There is no information on chemical contamination of the coastal waters or sediment of Owhiro Bay.
	• General freshwater quality	3	No RSoE site on Owhiro Stream. However, a number of studies have established that dissolved Cu and Zn exceed ANZECC trigger values in storm flows and during base flows.
	• Contact recreation (micro.)	4.5	Routine monthly microbiological monitoring is conducted by WCC at the stream outlet to the sea in accordance with the city's stormwater consent. The annual median faecal coliform value has seldom exceeded 1000 cfu/100ml but maximum values above 10,000 cfu/100ml have occurred in most years. Owhiro Bay is open to the south coast and is exposed to a high energy wave environment. Despite this exposed aspect, the nearshore waters of Owhiro Bay have exhibited variable levels of microbiological contamination resulting in a "poor" Suitability for Recreation Grade (SFRG) grade. Faecal source tracking conducted by GWRC in Owhiro Bay during February and March 2014 identified a number of faecal sources including wildfowl, human and dog.
	• Monitoring (historic and current)	3.5	Current monitoring includes: • Routine monthly microbiological monitoring is conducted by WCC at the stream outlet to the sea (consent monitoring). • Routine quarterly monitoring microbiological monitoring conducted by WCC at four locations. • Routine quarterly monitoring of a range of parameters (including metals, ammonia, TSS) at 5 locations around the T&T Landfill (consent monitoring)
	• Known key problems	4	Occasionally elevated indicator bacteria levels is stream water, however annual median values mostly less than 1000 E. coli cfu/100ml. Wastewater overflow locations and frequencies are reasonably well characterised. Occasional discharges from Landfills.
3	**Identify knowledge gaps**		
a)	Source/network		Cause of elevated indicator bacteria concentrations in Owhiro Bay
b)	Values		Well characterised
c)	Receiving environment state		Freshwater ecology only partially characterised.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of monthly microbiological monitoring at stream outlet to Owhiro Bay (existing consent). 2. **Continuation** of recreational water quality monitoring at one location in Owhiro Bay (existing consent). 3. **Establish** a temporary RSoE site on Owhiro Stream downstream of urban Brooklyn, monitor for 2 years
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		4. **Investigate** and remedy causes of high indicator concentrations in Owhiro Bay
	• Effectiveness of existing solutions		No required.
	Total Score	**51.5**	


Stormwater Reticulation Network
Owhiro Bay
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
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1:14,230
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Wellington Water

3. Island & Houghton bays

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	100%	
2	**Characterise**		
a)	Network	4	The catchment includes the suburbs of Island Bay, Southgate, Berhampore, Vogeltown, Mornington, Kingston and Houghton Bay. The Island Bay catchment was historically drained by an unnamed stream which followed the approximate alignment of the trunk stormwater system. The main spine of the stormwater network was constructed in the 1910's gradually extending though Berhampore in the 1930's. The network extended into the upper hills in the 1960, 70s & 80s. Stormwater is now discharged to the Bay via three major outfalls opposite Shortland Park and 218 the Esplanade. The Houghton Bay catchment lies to the east of Island Bay and was historically drained by a minor unnamed stream. The stormwater network was developed from 1930's onwards. Total public stormwater length 60 km. The remaining open channel stream length is 6km.
b)	Land use characterisation	4	Total catchment area is 6 km² of which 77% is served by a stormwater network and 31% is impervious surface. Island Bay is a mature urban area mostly in residential and light commercial land use. A large proportion of the Houghton Bay catchment is occupied by the closed Houghton Bay Landfill, which extends up the original valley floor from Cave Rd to Sinclair Park (opened in 1951 and completed in 1971). Scrub and gorse occupy the steep slopes to the west of the landfill while the area to the east is predominantly residential. Historic landfills include: • Macalister Park • Martin Luckie Park • Tapu Te Ranga Marae • Southgate Reserve • Former Melrose Road/ Albert Street Landfill • Former clean-fill on Wye Street • Former Houghton Bay Landfill
c)	Contaminant sources	4	Catchment wide sources common to all older urban areas include metal roofs and building materials, road surfaces and other permeable pavements, soil disturbance, vegetation, wild and domestic animals, and vehicles (tyres, brake linings, oil leakage, exhaust). Land use is predominantly residential and traffic densities are moderate to low. Sewage contamination of stormwater has been a major issue in the past. There are four locations in the catchments where sewage is designed to overflow into the stormwater system during extreme situations. These include two constructed network overflows and two pumping stations. Potential hot spots include a large closed landfill Houghton Bay Landfill which appears to be a major source of contamination of stormwater is Houghton Bay.
d)	Volume/loads	4	Stormwater loads of Zn, Cu, Pb and PAH from the catchment (excluding inputs from the landfill sites) are moderate. The catchment is about 6.5% of the Wellington City area and loads are about 9% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington.
e)	Receiving environment		
	i. Nature	3.5	Island and Houghton bays lie on Wellington's exposed south coast, bounded by rocky headlands adjacent to Owhiro Bay and at Te Raekaihu. They are part of the Taputeranga Marine Reserve and have popular beaches. Island Bay is dominated by firm sand, with a small area of rock and gravel near the centre of the beach. Houghton Bay is predominantly a firm sand beach characterised by a steep back dune area extending up to the road. It has a more exposed aspect and is subject to a high energy wave environment. Due to its open and exposed aspect, Wellington's south coast it is not considered to be a depositional environment.
	ii. Values	3.5	Island Bay is a popular safe bathing beach and, being near the centre of Taputeranga Marine Reserve, is popular for recreational diving. Shorland Park is just over the road and has plenty of play equipment, BBQs, picnic tables and toilets. A swim raft is moored in this bay during summer months. Houghton Bay is popular for surfing. Wellington's south coastal waters are identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. The rocky shore and coastal area from Red Rocks to Hue Te Taka Peninsula is identified in Schedule C of the PNRP as an area of significance by mana whenua iwi. Te Raekaihau Point reef is identified in C4 for mahinga kai values. Schedule F4 identifies Island and Houghton bays as having significant biodiversity values (being located in the Taputeranga Marine Reserve).
	iii. State and trends		
	• Hydrology	3	No significant open channel streams.

	• Freshwater ecology	3	There are no significant freshwater streams in the catchment. However, monthly microbiological monitoring conducted by WCC at the Island Bay culvert at Reef Street indicates elevated faecal coliform levels at this location, with a median value 2200 FC cfu/100ml. Water discharged from the Houghton Bay culvert had a median value of 600 faecal coliforms cfu/100ml.
	• Coastal ecology	1	Stevens & Robertson (2004) conducted a broad scale habitat of Wellington beaches, including Island and Houghton bays, but coastal ecology information is otherwise quite limited.
	• Sediment quality	2	There are no sediment contaminant data for Island Bay, however Cd, Pb and Hg were below national food standards in paua flesh collected in Island Bay, and concentrations of PAH, DDT and PCB were very low. At Houghton Bay, sediment samples collected in 2000 and 2012 where the stream crosses the beach did not show any serious contamination for heavy metals (except iron) or PAH.
	• General coastal water quality	1	There are no general water quality data.
	• General freshwater quality	3	No significant freshwater open channel streams
	• Contact recreation (micro.)	4	The microbiological water quality is monitored at three locations in Island Bay and one location in Princess Bay. During the 2015/16 bathing season the suitability for recreation grading (SFRG) was "Poor" at all three Island Bay sites, but was "Very Good" at Princess Bay immediately to the east of Houghton Bay.
	• Monitoring (historic and current)	3.5	• Ongoing routine recreational water quality monitoring for Island Bay and Princess Bay (adjacent to Houghton). • Monthly faecal coliform monitoring by WCC at stormwater culvert outlets in Island and Houghton Bays.
	• Known key problems	4	Wastewater contamination of stormwater in Island Bay Landfill leachate contamination of stormwater in Houghton Bay.
3	**Identify knowledge gaps**		
a)	Source/network		Wastewater overflows to Island Bay
b)	Values		Well characterised
c)	Receiving environment state		No general water quality or ecological information.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling/monitoring		Not required
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring at 3 locations in Island Bay and 1 location at Princess Bay (existing consent). 2. **Continuation** of monthly microbiological monitoring at the Reef St. S/W culvert in Island Bay and the Houghton Bay culvert (existing consent)
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		3. **Investigate** and remedy causes of high indicator concentrations in Island Bay
	• Effectiveness of existing solutions		Not required
	Total Score	**47.5 (of 75)**	


Stormwater Reticulation Network
Island Bay Houghton Bay
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Wellington Water

4. Lyall Bay

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	100%	
2	**Characterise**		
a)	Network	4	The Lyall Bay catchment is bounded by the ridgeline between Lyall bay and Houghton Bay to the west, the Kilbirnie/Rongotai catchment to the north and the Miramar/Strathmore catchment to the east. Sub catchments include Lyall Bay West, Lyall Bay East, Airport South Strathmore Park South and Moa Point. The stormwater network developed gradually over time, circa 1909 onwards. Western Lyall Bay is the oldest part of the suburb, mostly constructed prior to 1940. The majority of the eastern catchment was constructed between 1939 and 1963. The total public stormwater pipe length is 27 km. The remaining open channel stream length is 1km.
b)	Land use characterisation	4	Total catchment area is 2.84 km², of which 93% is served by a stormwater network and 48% is impervious surface. Land use in the Lyall catchment is predominantly residential, light commercial, industrial and airport. Traffic densities are likely to be relatively high. The high proportion of impervious area and high density of sources means that diffuse sourced pollution is probably at the medium-upper end the urban contamination range.
c)	Contaminant sources	4	Catchment-wide sources in Lyall Bay includes roofs and other building materials found in older urban areas, traffic, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, and exhaust) are a significant generic source. Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Because of the old ceramic piping system (some parts are circa 1910) maintenance repairs continue as needed to the present day. There are five pumping stations and one constructed network overflow in the catchment. Contamination hop spots include 2 historic landfill (Endeavour Park and ex WCC works depot).
d)	Volume/loads	4	Predicted stormwater loads of Zn, Cu, Pb and PAH from the catchment are moderate. The catchment area is about 4%, and loads are about 5%, of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington.
e)	Receiving environment		
	i. Nature	4	Lyall Bay is a semi-circular, large open bay on Wellington's south coast, situated between the rocky headlands of Te Raekaihu to the west and Hue te Taka (Moa Point) to the east. It is a long gently sloping firm sand beach with two small gravel beds present within the sand. The Bay shoals progressively from about 28 m in outer Lyall Bay to the shoreline. It is very exposed and can be subject to strong southerly swells and large high energy waves. Lyall Bay receives stormwater from Lyall Bay catchment, the southern parts of Miramar Golf Course and Wellington Airport and part of Moa Point Wastewater Treatment Plant. Due to its open and exposed aspect, Wellington's south coast it is not considered to be a depositional environment. There are no significant freshwater streams remaining in the catchment.
	ii. Values	3.5	Lyall Bay is Wellington's most popular surf beach. It is home to two surf lifesaving clubs, and many of the activities here are surf-related. Lyall Bay also has a playground. Recreation includes walking, picnics, dog walking, swimming, surfing, windsurfing, kitesurfing and kayaking. Wellington's south coastal waters are identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. Te Raekaihau Point reef is identified in C4 for mahinga kai values. Schedule F4 identifies Lyall Bay as having significant biodiversity values (being located in the Taputeranga Marine Reserve).
	iii. State and trends		
	• Hydrology	3	No significant freshwater streams in the catchment
	• Freshwater ecology	3	No significant freshwater streams in the catchment
	• Coastal ecology	4.5	Studies of benthic and reef communities were conducted by MacDiarmid, et al, (2015) and James et al (2016), as part of the runway extension project. As would be expected with a dynamic, exposed, highly mobile fine-sand dominated habitat, both epifaunal communities (animals living on the soft sediment surface) and were very low in overall abundance and diversity. The macrofauna that live in the sediment were also not very abundant with densities half those typically encountered in similar environments in more sheltered harbours, due to the wave-exposed dynamic habitat. Rocky reef habitats are found all along the exposed southern coast supporting a rich and diverse community of brown, red and green macroalgae which in turn support a rich reef community including gastropods, paua, kina

			and rock lobster (MacDiarmid, et al, 2015). The communities found on the reefs off the southern end of the runway are typical of those found along the Wellington coastline. While the sensitivity of reef communities at either end of Lyall Bay is likely to be high, the risk of significant ecological impacts from stormwater discharges is probably low, mainly because of flushing with clean oceanic water from the exposed south coast, which provides rapid dilution and dispersion.
	• Sediment quality	4.5	A study of marine sediments and contaminants conducted in Lyall Bay as part of the runway extension project (Depree, et al, 2016), confirm that Lyall Bay is not a depositional environment, and is characterised by uniformly moderately well sorted fine sandy sediments with low mud and clay content. The authors found that: • Total extractable heavy metals (and arsenic) concentrations were consistent with background soil/rock for the Wellington region, with no measurable anthropogenic foot print observed in the Lyall Bay surficial sediments. • Total extractable heavy metal concentrations of arsenic As Cd, Cr, Cu, Ni, Pb, Zn and Hg in Lyall Bay sediments (<2 mm fraction) were all well below ANZECC ISQG-Low trigger values. • DDT and associated analogues were the main organochlorine pesticides present in the surficial sediments of Lyall Bay, but all were well below ANZECC ISQG-Low trigger values. • PAH concentrations were an average 40 times lower than ANZECC ISQG-Low trigger value. The authors concluded that contaminant concentrations in Lyall Bay surficial sediments are very low and uniformly distributed across the study area.
	• General coastal water quality	2	General coastal water quality data, except for microbiological data, is not available for Lyall Bay
	• General freshwater quality	4	There are no significant freshwater open channel streams in Lyall Bay. WCC monthly microbiological monitoring of discharges from two major stormwater culverts indicates moderate levels of faecal coliform bacteria (annual median faecal coliform values mostly less that 1000 cfu/100ml)
	• Contact recreation (micro.)	4	Microbiological quality is monitored at three locations in Lyall Bay. During the 2015/16 bathing season the suitability for recreation grade was "Good" near the middle of the beach and "Fair" towards either end.
	• Monitoring (historic and current)	3.5	• Ongoing routine recreational water quality at three locations in Lyall Bay. • Ongoing monthly microbiological monitoring of stormwater discharges to Lyall Bay at two major culverts.
	• Known key problems	3.5	Occasional wastewater contamination of stormwater discharges.
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring at 3 sites in Lyall Bay. 2. **Continuation** of microbiological monitoring of stormwater discharges from the Lyall Bay East Culvert and Lyall Bay West Culvert.
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	**55.5 (of 75)**	

Stormwater Reticulation Network
Lyall Bay
Bathing Water Quality Sites
State of the Environment Monitoring
Catchment
Sewer Overflows
Stormwater Outlet
Open Channels
Sewer Main Trunk
Stormwater Pipes
N
1:11,340
0 80 160 240 320 400 m
Wellington Water

5. East Coast

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	100%	
2	**Characterise**		
a)	Network	4	The East Coast lies on the eastern side of the Miramar Peninsula, to the east of the city. It receives stormwater from four stormwater catchments: Crawford, Karaka Bays, Seatoun, and South-east Coast. The catchment does not form a single drainage area but rather a series of minor catchments. The stormwater network developed gradually over time from the 1920s onwards. The total public stormwater length is 13 km. The remaining open channel streams have a total length of 3 km.
b)	Land use characterisation	4	The total catchment area is 2.94 km² of which 44% is served by a stormwater network and 22% is impervious. Seatoun and Karaka Bays are residential suburbs with scattered small commercial areas. The south-west coast and Crawford are mostly open space in scrub and regenerating forest. Traffic densities are light
c)	Contaminant sources	4	Catchment-wide sources are minor and include roofs and other building materials found in residential land, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source, and contaminants from roads probably dominate urban runoff quality. Diffuse urban-sourced pollution is expected to be at the low end of the urban contamination range. No contamination hot spots are anticipated.
d)	Volume/loads	4	Predicted stormwater loads of Zn, Cu, Pb and PAH from the catchment are low. The catchment is about 3.4% of the Wellington City area and loads are about 2.5% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are very low for Wellington, a reflection of the large area of open space.
e)	Receiving environment		
	i. Nature	3.5	The eastern side of the Miramar Peninsula forms the western side of the channel leading into Wellington Harbour and is very exposed in the south but more sheltered in the north. It has a rocky coastline interspersed with popular beaches such as Breaker, Worser and Karaka bays. Due to its open and exposed aspect, this stretch of coast it is not considered to be a depositional environment.
	ii. Values	3.5	Beaches such as Breaker, Worser, Karaka and Scorching bays, are popular for a wide variety of activities including walking, picnics, dog walking, swimming, surfing, windsurfing, kite surfing, sailing and kayaking. Wellington's south coastal waters are identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. The rocky shore and coastal area at Hue Te Taka Peninsular is identified in Schedule C of the PNRP as an area of significance by mana whenua iwi.
	iii. State and trends		
	• Hydrology	3	No significant freshwater open channel streams
	• Freshwater ecology	3	No significant freshwater open channel streams
	• Coastal ecology	3	The eastern and northern shores of the Miramar Peninsula support Macrocystis, and two other brown seaweeds, Carpophyllum and Cystophora, as well as numerous red and green seaweeds, which thrive in the shelter of the larger brown seaweeds. At Mahanga Bay the intertidal zone supports a biologically rich community of invertebrates including many species of molluscs, crustaceans and polychaete worms. In the deeper sandy sub tidal zone (below 7m) the cushion star, whelks, hermit crabs and a rich burrowing fauna occur as well. At a depth of 7m the sandy bottom is dominated by sea cucumbers, gastropods and large green-lipped mussels. At a depth of more than 10m the bottom becomes muddy with a rich burrowing fauna, as well as horse mussels and sea cucumbers. (Lewis 1990 in MWH 2003).
	• Sediment quality	2	The chemical contamination of the marine sediments has not been assessed, but as none of these areas are depositional zones, and all have an exposed or very exposed shoreline, contamination levels are likely to be low or very low, as reported for Lyall Bay (see above). A GWRC survey of blue mussel quality in 2006 found low faecal coliform concentrations in these shellfish at Mahanga and Scorching Bays, and at Pt. Dorset. Concentrations of heavy metals (Cd, Cr, Cu, Pb, Hg, Ni, and Zn) were all relatively low in mussels collected from these east coast locations compared to inner harbour sites, and none of the metal concentrations exceeded the national food standards for edible tissue, where standards exist (Milne, 2006).

	• General coastal water quality	1	General coastal water quality information is not available, except for the recreational water quality data described below.
	• General freshwater quality	3	General freshwater quality information is not available for this catchment, however very little open channel stream remains.
	• Contact recreation (micro.)	4	Microbiological water quality is monitored at six popular recreational areas in the catchment. During the 2015/16 bathing season, suitability for recreation was "Good" at Breaker Bay, "Fair" at Seatoun – Inglis St, "Fair" at Seatoun Wharf, "Good" at Worser Bay, "Fair" at Scorching Bay and "Good" at Mahanga Bay. Microbiological water quality has been found to be fully compliant for shellfish gathering and consumption at Mahanga Bay (Morar & Greenfield, 2016). A GWRC survey of blue mussel quality in 2006 found low faecal coliform concentrations in these shellfish at Mahanga and Scorching Bays, and at Pt. Dorset.
	• Monitoring (historic and current)	3	Ongoing routine recreational water monitoring at 6 popular recreational areas in the catchment.
	• Known key problems	3	None
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring at 6 sites on the east coast.
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		Not required
	• Effectiveness / performance of existing solutions		Not required
	Total Score	**49 (of 75)**	


Stormwater Reticulation Network
South East Coast
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:18,920
0 210 420 630 840 1,050
m
Wellington Water

6. Evans Bay

Component	Level of adequacy (scores 1-5)	Comments
Collate information	100%	
Characterise		
Network	4	The Evans Bay stormwater catchment includes the suburbs of Rata, Grafton, Hataitai, Kilbirnie, Rongotai, Miramar and Mt Crawford. The stormwater network was constructed from Circa 1900 onwards, developing gradually over time. The total public stormwater length is 108 km. The remaining open channel stream length in the catchment is estimated at 4.5 km
Land use characterisation	4	The total catchment area is 9.45 km^2 of which 84% is served by a stormwater network and 43% is impervious surface. Land use in the Evans Bay catchment is predominantly residential, with some significant commercial and light industrial areas including part of the airport runway. Traffic densities are moderate to heavy. The Crawford area is mostly open land, with through roads and small pockets of residential land use. The high proportion of impervious area and high density of sources means that diffuse sourced pollution is probably at the medium-upper end the urban contamination range.
Contaminant sources	4	Catchment-wide sources include roofs and other building materials found in older largely residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source. A former Wellington Gas Company gasworks site at Miramar, which operated from 1915 to 1972, caused significant levels of shallow groundwater contamination in that vicinity (Diffuse Sources 2014). Contaminated groundwater was moving off-site to the east and southeast in 1996, with a potential pathway to Evans Bay. Contaminants included a variety of volatile organic compounds and PAHs. Relatively high concentrations of PAH have been found in the bay near the Miramar outfall (Ahrens & Olsen, 2007), and gasworks-derived contaminants from runoff probably have affected sediment contamination in the bay (Depree, 2010). Oils have also been observed in sediments near Miramar Wharf in the southern bay, and are likely to be sourced from seepage or spillage (Ahrens et al. 2007). Contamination hot spots include closed landfills at Kilbirnie Park, Miramar Park, Strathmore Park, the former gasworks, and oils in marine sediments near Miramar Wharf
Volume/loads	4	Predicted stormwater loads of Zn, Cu, Pb and PAH from the catchment are moderate. The catchment area is about 12% and predicted loads are about 14% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of well-developed, predominantly residential area.
Receiving environment		
i. Nature	3.5	Evans Bay is a large, semi-exposed bay on Wellington Harbour. It stretches from Point Jerningham east of Oriental Bay, to Point Halswell below Mount Crawford. Due to its partially enclosed aspect Evan Bay is a depositional environment.
ii. Values	4	Amenity at the head of the bay is mostly related to boating and shipping, such as port activities, marina, boat launching and kayaking. Secondary contact recreation may occur through these activities and via wading in the shallow waters near the marina. Some passive recreation (walking, viewing) also occurs. In contrast, the outer half of the bay is used for recreational activities involving primary contact – swimming, kite and wind surfing, and scuba/snorkelling, as well as boating and fishing. Wellington's south coastal waters are identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. The rocky shore and coastal area at Hue Te Taka Peninsular is identified in Schedule C of the PNRP as an area of significance to mana whenua iwi. Schedule F5 of the PNRP identifies *Adamsiella* algal beds in Evans Bay as habitat with significant biodiversity values in the CMA.
iii. State and trends		
• Hydrology	3	Stream hydrology data is not available for the Evans Bay catchment, but there are few remaining open watercourses
• Freshwater ecology	3	Freshwater ecology information is not available for the Evans Bay catchment, but there are few remaining open watercourses.
• Coastal ecology	3.5	High levels of heavy metal contamination close to stormwater outfalls appeared to be having a strong effect on the ecology near the outlets, with large decreases in the types and numbers of animals (Bolton-Ritchie 2003). However, this biological effect could also be partly due to other perturbations at the outfalls, such as frequent high flows, coarse sediments due to the outfall flows and shallow shoreline, enrichment with organic matter, salinity changes and other contaminants (Bolton-Ritchie 2003). Whatever the causes, the effects on benthic communities are quite marked close to the outfalls but diminish rapidly within distances of 30–50m from the outfall (e.g., Bolton-Ritchie 2003, Stevenson 2007). Further offshore, where samples are more indicative of the overall ecological health of the bay, and in the southern part of the bay, ecological monitoring has distinguished "moderate" biological effects (Kelly 2010). In the northern part of the bay, these effects are slight. Small or no effects are only found out towards the middle of Wellington Harbour at considerable distances (4-6 km) from the bay (Kelly 2010).
• Sediment quality	4.5	Very high levels of heavy metals (Zn, Pb and Cu) have been found within 50m Miramar and Kilbirnie outfalls (Pilloto, 1996, Tonkin & Taylor 1996, Bolton-Ritchie 2003). The relatively sheltered water of Evans Bay allow discharged contaminants to settle, and dispersal processes (such as waves on the shore) are sufficiently weak to allow high levels to remain near the

		outfalls. High concentrations of PAH and total petroleum hydrocarbons (TPH) found close to the Miramar outfall may have been partly due to runoff or groundwater contamination from the former gasworks. High levels of PAH have also been attributed to the historical use of coal tar (a by-product of gasworks) for roading adhesive (Ahrens et al. 2007, Depree 2010). As this material became abraded by road use, it could have been carried by stormwater to the bay. Spillage of petroleum products, perhaps associated with port activities, is also a potential issue (Ahrens et al. 2007). Over the wider area PAH, Pb, Hg, DDT, Cu and Zn exceeded sediment quality guidelines (Stephenson et al 2008, Oliver 2014). These guidelines are used to signal the possibility of effects on benthic animals that live in and on the sediments of the bay. PAH, Pb, DDT and Hg are currently not being discharged in sufficient quantities in urban stormwater to have led to such high levels of contamination, but stormwater may have carried high loads of these substances in the past resulting in "legacy contamination" (Diffuse Sources 2014). There may also have been other sources such as industrial discharges (before connection to the sanitary system), spillage during port loading/off-loading, and leaching/cleaning of antifouling paints from ships and boats. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly (Diffuse Sources 2014). Oliver (2014) reported that sediments in roadside stormwater catch pits in Hataitai and Miramar contained Cu, Pb and Zn at concentrations five to ten times higher than in harbour sediments near major stormwater outfalls. In contrast Hg concentrations were approximately eight times lower in catch pit sediments. Concentrations of TPH were higher in catch pit sediments compared to harbour sediments, while PAH concentrations were similar in catch pit and harbour sediments.
• General coastal water quality	2	General coastal water quality data, except for microbiological data, is not available for Evans Bay.
• General freshwater quality	3	Freshwater quality data is not available for open channel streams in Evan Bay catchment. WCC monthly microbiological monitoring of discharges from four major stormwater culverts (Hataitai, Miramar, Kilbirnie & Cobham) indicates moderate levels of faecal coliform bacteria with annual median faecal coliform values consistently less that 1000 cfu/100ml.
• Contact recreation (micro.)	4	Microbiological water quality is monitored at three recreational area in the catchment. During the 2015/16 bathing season the suitability for recreation grade was "Good" at Balaena Bay, "Fair" at Hataitai Beach, and "Fair" at Shark Bay. Microbiological water quality has been found to be fully compliant for shellfish gathering and consumption at Shark Bay (Morar & Greenfield, 2016).
• Monitoring (historic and current)	4	• Ongoing routine recreational monitoring at 3 locations in the catchment; • Ongoing WCC monthly microbiological monitoring at 4 stormwater culverts. • Wellington Harbour sediment/biota monitoring at 5 year intervals • Catch pit sediment monitoring in Hataitai and Miramar at 5 year intervals.
• Known key problems	3.5	High concentrations of PAH and TPH in marine sediments close to the Miramar outfall may have been partly due to runoff or groundwater contamination from the former gasworks. High levels of PAH have also been attributed to the historical use of coal tar (a by-product of gasworks) for roading adhesive.
Identify knowledge gaps		
Source/network		Contaminant load information
Values		Well characterised
Receiving environment state		Rate of contaminant accumulation in marine sediments
Further Investigations		
Values		Not required
Modelling and Monitoring		
• State of receiving environment		1. **Continuation** of recreational water quality monitoring at 3 sites in Evans Bay. 2. **Continuation** of monthly microbiological monitoring of stormwater discharges from the Hataitai, Miramar, Kilbirnie & Cobham culverts. 3. **Continuation** of Wellington Harbour sediment/biota monitoring at 5 year intervals
• Future trends		4. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
• Source / investigation		5. **Continuation** of catch pit sediment monitoring in Hataitai and Miramar at 5 year intervals (in conjunction with the Harbour sediment study)
• Effectiveness of existing solutions		Not required
Total Score	**54 (of 75)**	


Stormwater Reticulation Network
Evans Bay
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:16,080
0 175 350 525 700 875 m
Wellington Water

7. Lambton Harbour

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	100%	
2	**Characterise**		
a)	Network	4	Includes Aotea North, Tinakori, Glenmore St, Aitken, Bowen, Waring Taylor, Hunter, Harris, Te Aro, Taranaki, Tory, Newtown, and Oriental Bay. The stormwater network developed gradually over time: circa 1860s onwards. High number of faults due to age. Gradual replacement of aged infrastructure. Total public stormwater length 165 km. The remaining open channel stream length is 13.7 km, mostly headwater streams.
b)	Land use characterisation	4	Total catchment area of 13.3 km² of which 83% is served by a stormwater network and 48% is impervious surface. The Southern CBD catchments are predominantly inner city commercial and high density residential, with significant port and railway areas, motorways, and light industrial and green spaces. Traffic densities are very heavy and include many truck and rail movements. The northern CBD catchments have large areas of Open space (Botanic Gardens and Tinakori Hill) and low-medium density residential in the upper parts, and significant port and railway areas, motorways, commercial and light industrial in the lower regions. Traffic densities in the lower areas are very heavy and include many truck and rail movements. Land use in the Oriental Bay catchment is predominantly residential, which also includes a number of cafés, restaurants, the Freyberg Swimming pool, and the Port Nicholson Marina. Traffic densities are moderate.
c)	Contaminant sources	4	Catchment-wide sources include roofs and other building materials found in older urban areas, road surfaces, and other impermeable pavements. These are major stormwater sources as much of the land is built on and impervious, and many buildings are tall, with large surface areas of building materials. Vehicles (tyres, brake linings, oil leakage, exhaust) are another major generic source, as the catchment has a dense network of motorways, streets, parking lots and buildings, and transport hubs, including Wellington's main train and bus stations and distribution yards. Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. The most significant constructed overflow in the wastewater network is located at Murphy Street and is discharged via the Davis Street culvert. The recorded average annual overflow volume is about 6000 m³ with an average frequency of 1 in 4 months. Contaminant hot spots: - Railway shunting yards and workshops, - Port marshalling yards, - Urban motorway, - Closed landfills (x7), - Constructed wastewater overflow at Murphy Street
d)	Volume/loads	3.5	Stormwater loads of Zn, Cu, Pb and PAH from the catchment are predicted to be high. The catchment area is about 18% of Wellington City and loads are about 37% of the total stormwater load from Wellington. The specific loads (mass of contaminant per area) are moderate for Wellington, a reflection of a well-developed high-density urban area. The combined discharge from the Lambton Harbour catchments has an estimated dry weather flow of about 0.4 m³/s and a combined two year ARI storm flow of about 47 m³/s. Flooding has been a frequent problem in the Lambton Harbour catchment. The capacity of the stormwater network is restricted in the lower reaches due to flat gradients across reclaimed land.
e)	Receiving environment		
	iv. Nature	3	Some discharges to inner city stream fragments (see below) but mostly via large culverts (x19) to the marine environment of Oriental Bay and Lambton Harbour. Due to its partially enclosed, sheltered aspect Lambton Harbour is a depositional environment.
	v. Values	4.5	The major amenity in the vicinity of these outfalls is the port as well as the Chaffers marina. Most of the Lambton basin shore is accessible to the public and is a major recreational asset for Wellington. Walking and sight-seeing are popular activities, and fish also occurs in those areas. Wellington's most popular beaches (Freyberg and Oriental) are used extensively for swimming and picnicking, along with small boat activities on the water. Wellington Harbour is identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. It is also identified in Schedule F2 as providing significant biodiversity values for indigenous birds in the coastal marine area. The former Te Aro Pa in Lambton Harbour is identified in Schedule C of the PNRP as an area of significance by mana whenua iwi.
	vi. State and trends		

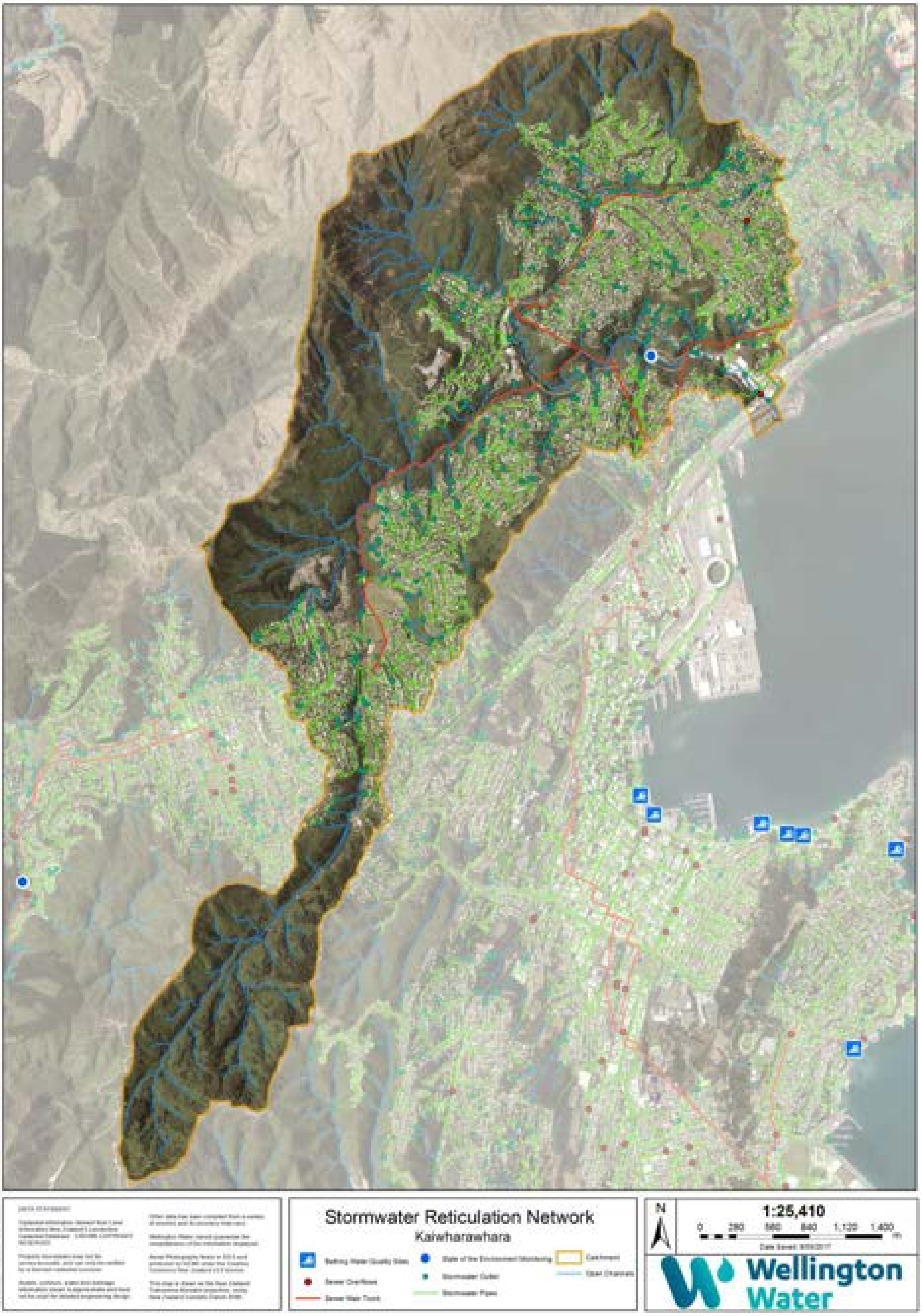
	• Hydrology	3	No information on urban stream hydrology, but stream only fragments remain
	• Freshwater ecology	3	EOS (2015) describes the ecology of the urban stream fragments, limited data.
	• Coastal ecology	5	Harbour marine sediment & benthic ecology investigations (GWRC 2008, 2010, 2014), Bolton Ritchie (2003). Wear (2001) described the rocky reef communities at Oriental Bay. Haddon & Wear (1993) and Anderlini & Wear (1995) described the soft sediment benthic communities within Lambton Harbour. Ecology near wharves and the large outfall can be strongly disturbed, but rapidly becomes more varied and numerous with increasing distance (10 – 50m) from the outfall. Further offshore, where samples are more indicative of the overall health of the harbour, ecological effects are characterised as "intermediate", decreasing to "slight" or "no effect" at mid harbour sites.
	• Sediment quality	5	Harbour marine sediment quality investigations (GWRC 2008, 2010, 2013) found DDT, HMW PAH, Pb, Hg, Cu and Zn to exceed sediment quality guidelines in Lambton Harbour. PAH, Pb DDT and Hg are legacy contaminants which are no longer discharged in large quantities. Cu and Zn are the contaminants of ongoing concern, but neither are predicted to increase rapidly. Monitoring of stormwater catch pit sediments in Thordon, Waring Taylor Street and Newtown reported by Oliver (2014) shows that concentrations of Cu, Pb and Zn were generally five to ten times higher in catch pit sediments compared to harbour sediments near major stormwater outfalls. In contrast Hg concentrations were approximately eight times lower in catch pit sediments, with the exception of Waring Tylor catch pit samples which were roughly half of the concentration in nearby harbour sediments
	• General coastal water quality	2	General coastal water quality information, except for microbiological water quality, is not available.
	• General fresh WQ	2	WCC regular quarterly monitoring at 27 urban stream sites, indicator bacteria only. WCC monthly monitoring at 20 stormwater pipe outlets to CMA, indicator bacteria only.
	• Contact recreation (micro.)	4	Weekly recreational water quality monitoring (microbiological) at Aotea Lagoon and Oriental Bay bathing areas. Additional new monitoring sites have been established as part of Recreational Water Quality programme e.g. Fergs Kayaks;
	• Monitoring (historic and current)	4	Ongoing harbour recreational water quality, sediment quality and benthic monitoring programmes.
	• Known problems	3.5	Old network/faults/overflows leading to high microbiological content of stormwater discharges; high runoff loads of Cu, Zn and PAH; legacy sediment contamination; suitability for recreation is occasionally compromised at Oriental Bay and Aotea Lagoon, but mostly during wet weather. These events are short lived.
3	**Identify gaps**		
a)	Source/network		Better characterisation of stormwater quality for comparison with other catchments Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Rate of Cu, Zn & PAH accumulation in marine sediments
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring at five sites in Oriental Bay/Lambton Harbour; 2. **Continuation** of 5-yearly monitoring of contaminant levels in marine sediments, and benthic biota community composition; 3. **Continuation** of monthly microbiological monitoring at 9 stormwater culverts (OPT, Tory, Taranaki, Te Aro, Harris, Waring Taylor, Bowen, Davis, and Thorndon).
	• Future trends		4. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Source / investigation (e.g. hot spots)		5. **Continuation** of 5-yearly monitoring of catchment sediment quality in Thorndon, Waring Taylor Street and Newtown (in association with the Wellington Harbour sediment study) 6. **New investigation**: Establish an automated stormwater quality and flow monitoring station at a representative stormwater outlet (Waring Taylor Culvert). Establish event mean concentrations and contaminant loads. This information would be used to better characterise the quality of stormwater runoff from an intensively urbanised Wellington CBD catchment, and for use in calibrating and validating catchment models.
	• Effectiveness of existing solutions		Not required
	Total Score	**54.5 (of 75)**	

Stormwater Reticulation Network
Lambton Harbour Oriental Bay
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:20,730
0
230
460
690
920
1,150
m
Wellington
Water

8. Kaiwharawhara

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	100%	
2	**Characterise**		
a)	Network	4	The Kaiwharawhara Stream and stormwater catchment lies to the north and west of the CBD and includes parts of Karori, Northland, Wilton, Crofton Downs, Wadestown, Ngaio and Khandallah. The stormwater network has been developed gradually over time from the 1880s onwards and generally reflects the age of the main housing subdivisions. Less than 20% of the current network was constructed prior to the 1940's. Around 50% was constructed during major housing development in Wilton and Ngaio between 1950 and 1970, and the remaining 30% was constructed from the 1980s onwards. The total public stormwater length is 86 km. The remaining length of channel streams is 58 km.
b)	Land use characterisation	4	Total catchment area is 16.7 km² of which 56% is served by a stormwater network and 18% is impervious surface. Land use in the Kaiwharawhara catchment is predominantly residential and light commercial, but with large areas of open space within the Karori Wildlife Sanctuary, to the west of Crofton Downs and west of Ngaio. Traffic densities are likely to be moderate to heavy.
c)	Contaminant sources	4	Catchment-wide sources include roofs and other building materials found in older largely residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source. Historic landfills are located at Ian Galloway Park (1946 – 1973), Appleton Park (filled in the 1930s), Creswick Terrace play area, Otari Native Pant Museum (former clean-fill, completed around 1980), and Calcutta / Bengal St. One wastewater pump station and one wastewater network overflow located within the catchment have the potential to overflow into the stormwater system. Contaminant hot spots include the historic landfills and commercial/ light industrial area at the bottom of Ngaio Gorge.
d)	Volume/loads	4	Stormwater loads of Zn, Cu, Pb and PAH from the catchment are predicted to be moderate. The catchment area is about 19% of Wellington City and loads are about 10% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of the mixed open space and high density urban areas in this catchment.
e)	Receiving environment		
	i. Nature	3.5	The catchment is bounded to the east and south by the ridgeline extending from Te Ahumairangi Hill (Tinakori Hill) and around the Zelandia Wildlife Sanctuary, to the west by Karori, Johnsons Hill and to the north by Mt Kaukau and a low ridge through Khandallah. The Kaiwharawhara Stream (and tributaries Korimako Stream, Te Mahanga Stream, Silverstream and numerous unnamed headwater streams) receives multiple stormwater discharges throughout its length. The stream discharges to Wellington Harbour via Ngaio Gorge, to the north of the CBD. The Kaiwharawhara coastline is made up of approximately 5 ha of reclaimed land. The shoreline has been modified with the deposition of man-made rubble (EHEA 1998). East of Kaiwharawhara the straight coast is rocky and exposed and has limited access due to the proximity of SH1, SH6 and the main trunk railway.
	ii. Values	4	Schedule F1 of the PNRP identifies Kaiwharawhara Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Wellington Harbour is identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. It is also identified in Schedule F2 as providing significant biodiversity values for indigenous birds in the coastal marine area. Schedule F4 identifies the Kaiwharawhara estuary as a site with significant biodiversity value (providing passage for migratory fish)
	iii. State and trends		
	• Hydrology	2	Little information on urban stream hydrology
	• Freshwater ecology	4	Recent RSoE results indicate that the invertebrate community in the Kaiwharawhara Stream at Ngaio Gorge is in poor condition (QMCI = 2.52, %EPT taxa = 5, Taxa richness = 21), characterised by a relatively low number of pollution sensitive EPT taxa (mayflies, stoneflies, caddisflies), and dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). The average MCI score for the years 2013/14, 2014/15 and 2015/16 is 83.

			KML (2005) reported invertebrate similarly poor metric scores at in Kaiwharawhara Stream at Ngaio Gorge, and in the middle reaches downstream of Ian Galloway Park (a closed landfill) but higher-up in the catchment metric scores indicate good invertebrate quality. Fish species recorded in Kaiwharahwara Stream include banded kokopu, bluegill bully, common bully, giant bully, giant kokopu, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.
	• Coastal ecology	2	Little coastal ecology information is not available for the area adjacent to Kaiwharawhara Stream mouth.
	• Sediment quality	3	During 2005 and 2006 streambed sediments in Kaiwharawhara Stream were found to exceed the ANZECC (2000) ISQC-Low trigger values for nickel (Ni), Pb, antimony (Sb), Zn, Dieldrin and Total DDT on at least one occasion (Milne & Watts, 2008). The ISQC-High trigger values for Zn, Pb and Total HMW PAH were also exceeded on at least one occasion. Marine sediment quality information is not available for the area adjacent to Kaiwharawhara Stream mouth.
	• General coastal water quality	1	Coastal water quality monitoring information is not available for this area.
	• General freshwater quality	4	A GWRC RSoE site located at Ngaio Gorge on the Kaiwharawhara Stream received a 'fair' WQI grade for the 2015/2016 year, and was ranked 44th out of 53 sites in the Wellington Region. At that location the contributing catchment is 39% urban. Water quality meets recommended guidelines of dissolved oxygen, visual clarity and ammoniacal nitrogen but typically fails to meet guidelines for E. coli, nitrate/nitrite nitrogen and dissolved reactive phosphorus. Dissolved Cu and Zn concentrations were elevated and commonly exceeded ANZECC (2000) trigger values at base flows.
	• Contact recreation (micro.)	3.5	Kaiwharawhara Stream median and maximum *E. coli* values for the 2015/16 monitoring year were 600 and 4,700 cfu/100ml, respectively. The median value did not exceed the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100ml). Faecal source tracking conducted on samples collected at this site during 2013 and 2014 indicate a predominantly human source, but dog and ruminant sources were also detected.
	• Monitoring (historic and current)	3.5	• Ongoing monthly RSoE monitoring is conducted on the lower reaches of Kaiwharawhara Stream. • Ongoing monthly microbiological monitoring is conducted by WCC at the mouth of the Kaiwharawhara. • Wellington Harbour sediment/biota monitoring at 5 year intervals.
	• Known key problems	3.5	Elevated water metal concentrations in stream water and sediment, probably associated with closed landfills in the catchment
3	**Identify knowledge gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Rate of Cu, Zn & PAH accumulation in marine sediments
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of RSoE monitoring on Kaiwharawhara Stream. 2. **Continuation** of monthly microbiological monitoring at the Kaiwharawhara Stream outlet to Wellington Harbour (existing consent). 3. **Continuation** of 5-yearly monitoring of contaminant levels in marine sediments, and benthic biota community composition, at existing sites;
	• Future trends		4. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Source / investigation (e.g. hot spots)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	**51 (of 75)**	



Stormwater Reticulation Network
Kaiwharawhara
Bathing Water Quality Sites
State of the Environment Monitoring
Catchment
Sewer Overflows
Stormwater Outlet
Open Channels
Sewer Main Trunk
Stormwater Pipes
N
1:25,410
0
280
560
840
1,120
1,400
m
Wellington
Water

9. North Harbour (Onslow/Ngauranga/Horokiwi)

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	100%	
2	**Characterise**		
a)	Network	4	The north coast of Wellington Harbour stretches from Aotea Quay to the western end of Petone Beach. It receives stormwater from Onslow, Ngauranga and Horokiwi. Onslow is a small coastal catchment that lies between the Kaiwharawhara and Ngauranga stream mouths. The Ngauranga stormwater catchment includes parts of Khandallah, Johnsonville and Newlands. Horokiwi/Belleview lies to the west of Petone and is mostly rural and conservation land. The stormwaters developed gradually over time, from 1926 onwards. Less than 5% was constructed prior to the 1940s, about 30% was constructed between 1940 and 1960, and 65% was constructed from the 1960 onwards. The total public stormwater length is 104 km. Approximately 32 km of open channel streams remains, consisting of numerous small fragments.
b)	Land use characterisation	4	The total catchment area is 15.8 km² of which 67% is served by stormwater networks and 24% is impervious surfaces. Ngauranga Stream drains a predominantly residential catchment, but includes significant commercial and light industry areas in Johnsonville, Newlands and Ngauranga. Onslow is predominantly open space with significant areas of motorway and light industrial/commercial premises. Horokiwi/Bellevue stream carries mostly "rural" runoff.
c)	Contaminant sources	4	Catchment-wide sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tires, brake linings, oil leakage, exhaust) are probably the major generic source; from motorways, SH1, major city streets, and parking lots. Landfills are located at Homebush Park, Coastal filling, Raroa Park, Cashmere Avenue (completed in 1930s), and the former Ramsbottom's Yard. Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Four constructed wastewater overflows are located in the catchment. Potential hotspots include the Wellington to Hutt and Porirua motorways. State Highway 1 has an average daily traffic count in excess of 50,000 vehicles. Former landfills, including a large landfill at Raroa Park that operated until 10971. The Kiwi Point Quarry and Taylor Preston Abattoir are currently located in this area.
d)	Volume/loads	4	Stormwater loads of Zn, Cu, Pb and PAH from these catchments are predicted to be moderate. The combined catchment area is about 21% of Wellington City while predicted loads are about 18% of the total stormwater load from Wellington. The specific loads (the mass of contaminant per area) are moderate for Wellington, a reflection of higher loads for Ngauranga and low loads from large areas of Open Space.
e)	Receiving environment		
	i. Nature	3.5	Stormwater discharges to a series of minor streams, the largest of which, Ngauranga Stream, drains a heavily urbanised catchment (31% impervious), predominantly in residential land use, but including commercial and light industry premises in Johnsonville, Newlands and Ngauranga, including the Kiwi Point Quarry and Taylor Preston Abattoir, a closed landfill at Raroa Park, and State Highway 1. Ngauranga Stream discharges to Wellington Harbour via a large culvert. The north coast of Wellington Harbour stretches from Kaiwharawhara to the western end of Petone Beach. The Kaiwharawhara coastline is made up of approximately 5 ha of reclaimed land. The shoreline has been modified with the deposition of man-made rubble (EHEA 1998). East of Kaiwharawhara the straight coast is rocky and exposed and has limited access due to the proximity of SH1, SH6 and the main trunk railway. It receives stormwater from Onslow, Ngauranga and Horokiwi.
	ii. Values	3.5	The values associated with streams in this catchment are limited by extensive culverting and concrete channelling, which constrain access and availability of habitat. The main exception to this is Tyres Stream, a tributary of Ngauranga Stream which has retained relatively high aquatic ecology values. Schedule F1 of the PNRP does not identify any watercourse in this catchment as have significant indigenous ecosystem values Access to the harbour is constrained along the northern shoreline by the motorway and main trunk railway. The main amenity values of the receiving waters are boating and fishing. Some water skiing and rowing occurs from the west end Petone Beach. Wellington Harbour is identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. It is also identified in Schedule F2 as providing significant biodiversity values for indigenous birds in the coastal marine area.
	iii. State and trends		

	• Hydrology	2	Little information on urban stream hydrology
	• Freshwater ecology	3.5	Young *et al* (2016) reported that the invertebrate community in the Ngauranaga Stream at two locations beside Ngauranga Gorge is in poor condition (QMCI = 2.0 to 2.1 %EPT taxa = 0, Taxa richness = 3 to 12). The invertebrate community was characterised by a complete absence of pollution sensitive EPT taxa (mayflies, stoneflies, caddisflies), and is dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). KMA (2005) reported similarly poor metric scores, again with almost a complete absence of EPT taxa. Fish species recorded in Ngauranga Stream include short fin eel, common bully, koaro and banded kokopu.
	• Coastal ecology	3.5	Ecological monitoring has distinguished moderate biological effects (Kelly 2010) at distances 0.5 to 1 km off the northern harbour shore. Low or no effects are only found towards the middle of Wellington Harbour at considerable distances (4-6 km) from the shore. Sediments along the northern coast of Wellington are probably also affected by other major stormwater discharges from Wellington's CBD, from the Hutt River discharge and by stormwater from Hutt City.
	• Sediment quality	4	Streambed sediments sampled at three sites in the Ngauranga Stream in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger values for Zn on both occasions and Dieldrin on at least occasion (Milne & Watts, 2008). No exceedance of ISQC-High trigger values were recorded for any constituent. Within Wellington Harbour, marine sediment concentrations of Cu and Zn were below guideline levels near Ngauranga Stream mouth while DDT, Pb, and Hg exceeded sediment quality guidelines at that location (Stephenson et al 2008, Milne 2010, and Oliver 2014). However DDT, Pb and Hg are considered to be legacy contamination. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly (Diffuse Sources 2014).
	• General coastal water quality	1	Coastal water quality monitoring information is not available for this area.
	• General freshwater quality	3	A stormwater study conducted by Milne & Watts (2008) included a monitoring site on the lower reach of Ngauranga Stream. The results indicate that both Cu and Zn exceeded ANZECC trigger values in storm flows and that Zn exceeds the guideline in base flows.
	• Contact recreation (micro.)	3	Routine monthly microbiological monitoring by WCC at the stream outlet to the sea show that annual median faecal coliform value at the Ngauranga Stream outlet has regularly exceeded 1000 cfu/100ml over the last five years, and maximum values occasionally exceeded 30,000 cfu/100ml. These results suggest that intermittent overflows from the wastewater system have occurred. Four wastewater overflow structures are located within the catchment. The coastal receiving waters are not monitored for microbiological quality.
	• Monitoring (historic and current)	3	• Ongoing monthly monitoring microbiological monitoring is conducted by WCC at the Ngauranga Stream outlet to Wellington Harbour. • Wellington Harbour sediment/biota survey every five years
	• Known key problems	3	NPS-FM national bottom line for secondary contact recreation seldom achieved.
3	**Identify knowledge gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of WCC monthly microbiological monitoring at Ngauranga Stream outlet to the harbour (existing consent) 2. **Continuation** of 5-yearly monitoring of contaminant levels in marine sediments, and benthic biota community composition, at existing sites.
	• Future trends		3. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (this is also required as part of Whaitua process);
	• Source/ investigation		4. **Investigate and remedy** causes of wastewater overflows to the stormwater system.
	• Effectiveness of existing solutions		Not required
	Total Score	**49 (of 75)**	

Stormwater Reticulation Network

Onslow Ngauranga Horokiwi

Bathing Water Quality Sites	State of the Environment Monitoring
Catchment	Sewer Overflows
Stormwater Outlet	Open Channels
Sewer Main Trunk	Stormwater Pipes

N

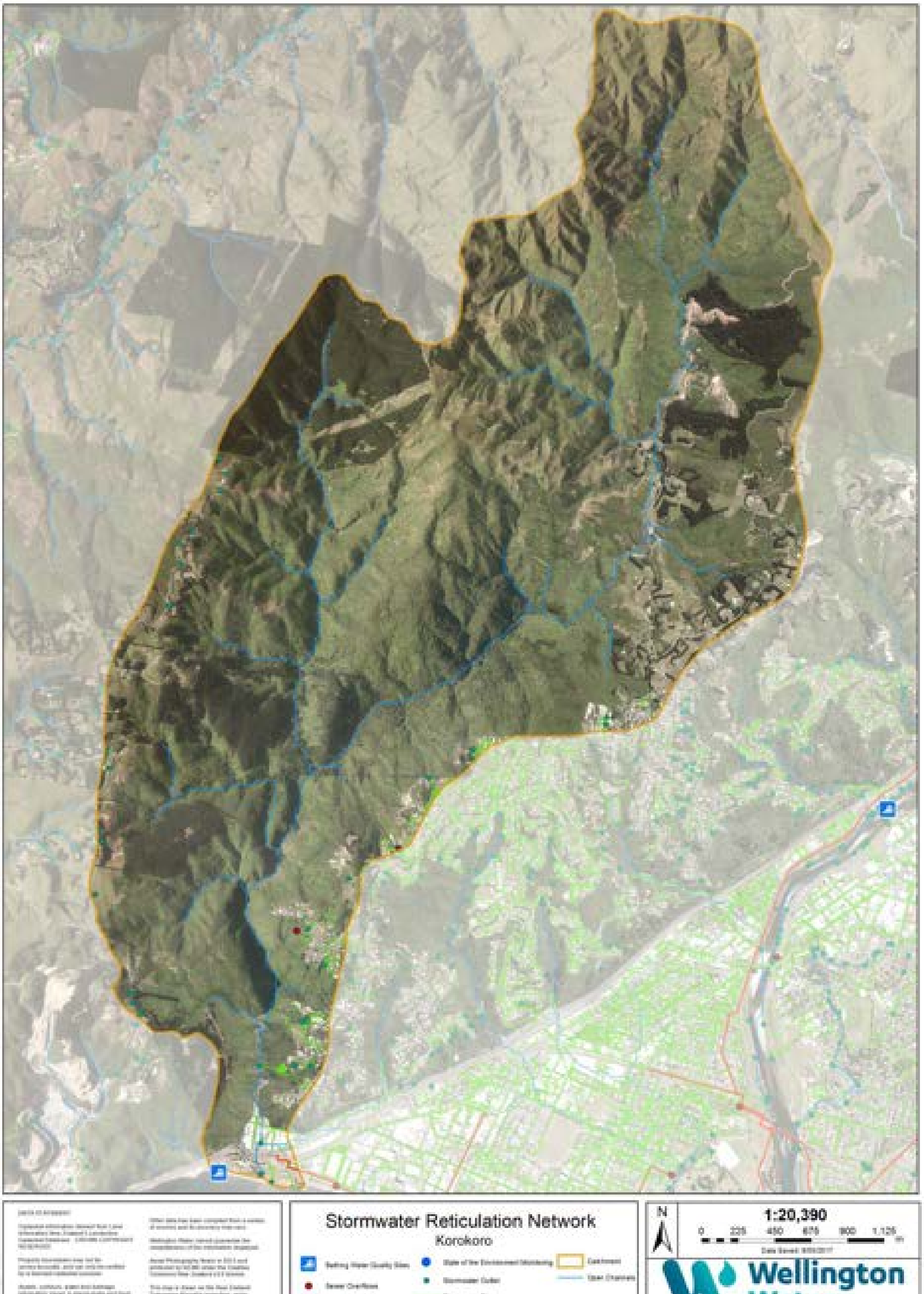
1:22,900

Wellington Water

10. Korokoro

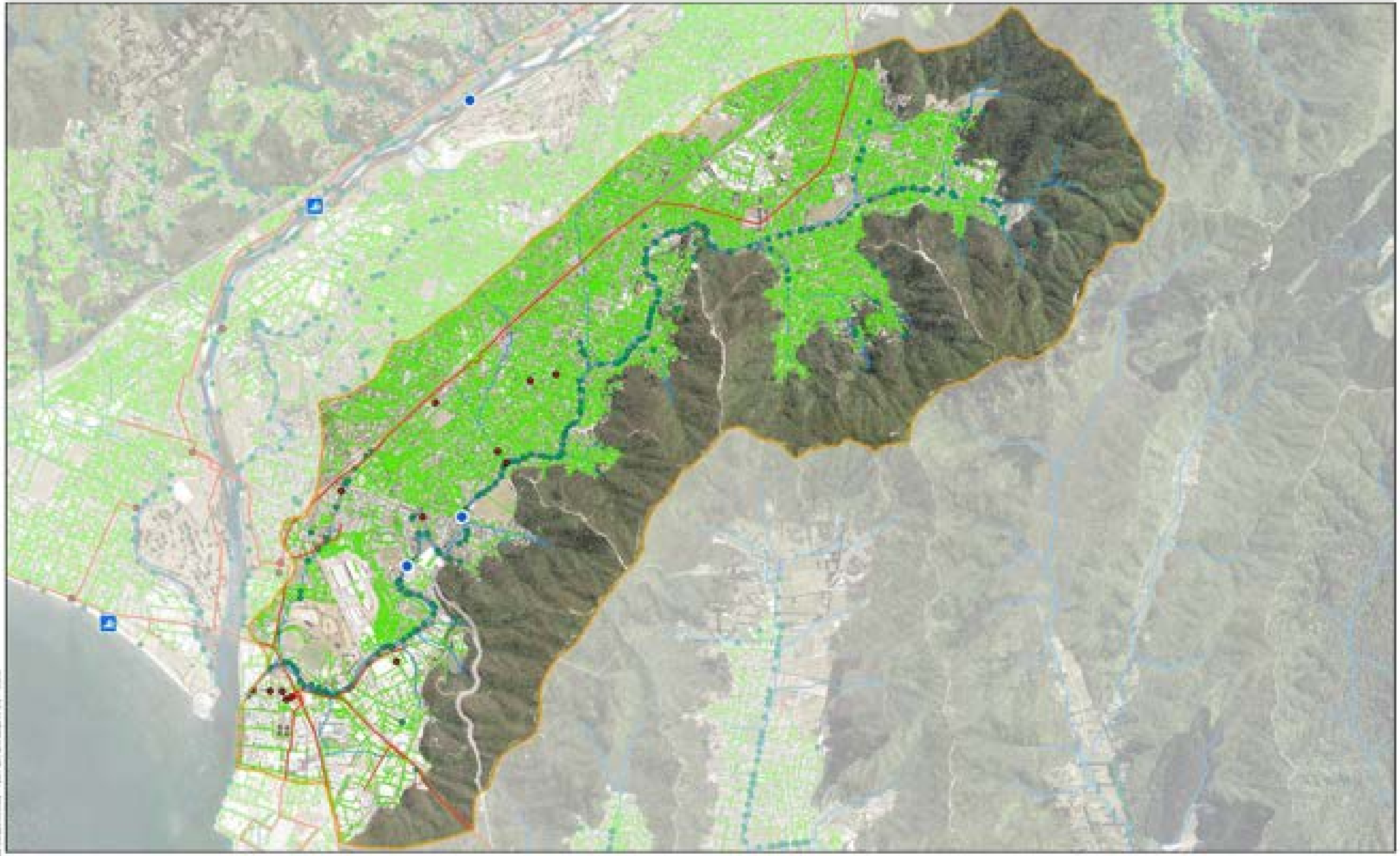
Step	Component	Level of adequacy (scores 1-5)	Comments
1	Collate information/data	100%	
2	Characterise		
a)	Network	3.5	The Korokoro Stream drains a small catchment that is mostly in scrub, regenerating forest and mature indigenous forest. The stormwater network was constructed from 1950s onwards. Less than 20% of the current network was constructed prior to the 1960's. The total public stormwater length is 4.9 km. The great majority of the stream network remains as an open stream (the open channel stream length has not been calculated).
b)	Land use characterisation	3.5	The total catchment area is 15.7 km² of which 3% is served by a stormwater network and an estimated 3% is impervious surface. Korokoro Stream drains a moderately small catchment which is mostly in mature indigenous forest and scrub, including the last significant stand of rimu-rata-tawa-kohekohe in the southwest of the Wellington Region. It is situated within Belmont Regional Park on the western hills of the Hutt Valley.
c)	Contaminant sources	4	Catchment-wide sources are dominated by runoff from regenerating forest and scrub. In the Cornish Street commercial/light industrial area at the bottom of the catchment, sources includes roofs and other building materials found in urban areas, road surfaces, other permeable pavements and vehicles (tyres, brake linings, oil leakage, exhaust). Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Two constructed wastewater overflows are located in the catchment. Significant contaminant sources are not anticipated.
d)	Volume/loads	1	Contaminant load predictions are not available
e)	Receiving environment		
	i. Nature	4	The Korokoro Stream drains a small catchment that is mostly in scrub, regenerating forest and mature indigenous forest. The stream discharges via a culvert to the western end of Petone Beach. The Wellington Harbour shoreline at Korokoro consists of a predominantly gravel beach flanked at each end by man-made boulder fields.
	ii. Values	4	Korokoro Stream is situated within Belmont Regional Park. Schedule F1 of the PNRP identifies Korokoro Stream as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Schedule F4 identifies the Kaiwharawhara estuary as a site with significant biodiversity value (providing passage for migratory fish). Schedule C4 lists Korokoro Stream mouth as a site of significance for mahinga kai & wahi tapu. Petone Beach is a popular beach for walking, sunbathing, shell gathering and offers safe swimming in most places. Toilets, changing rooms, parks, playgrounds and plenty of parking can be found at this beach. The beach is groomed and a swimming raft is anchored off Oriental Street making it a very popular recreation area and a recognised bathing beach. Wellington Harbour is identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. It is also identified in Schedule F2 as providing significant biodiversity values for indigenous birds in the coastal marine area.
	iii. State and trends		
	• Hydrology	2	Little information on stream hydrology
	• Freshwater ecology	3.5	KMA (2005) surveyed the invertebrate community at three locations on Korokoro Stream, in an upper reach, a lower reach and at the stream mouth. The stream mouth site is downstream of a culverted section that passes under the urban areas of Cornish Street and the Hutt Road. Metric scores show "excellent" invertebrate community quality at the upstream site, decreasing to "fair/good" in the lower reaches and "poor/fair" near the stream mouth. Fish species recorded in Kororkoro Stream include banded kokopu, bluegill bully, common bully, common smelt, giant kokopu, inanga, koaro, longfin eel, redfin bully and shortfin eel.
	• Coastal ecology	3.5	The Petone Beach foreshore has been identified as an important conservation area, providing a valuable roosting and feeding ground for variable oyster catchers, gulls, pied stilts and terns that feed on the invertebrate fauna of the beach (Wear and Hatton 1992). The results of infaunal sampling conducted at Petone Beach in 2004 showed that overall the infauna was dominated by bivalve shellfish (pipi) and numerous polychaete worms (Stevens, et al, 2004).
	• Sediment quality	3.5	Stevens et al (2004) reported Cu and Zn levels below sediment quality guidelines in nearshore sandy sediments at Petone Beach.

			GWRC's Wellington harbour marine sediment quality investigations conducted in 2006 and 2011 (Stephenson et al 2008, Milne 2010, and Oliver 2014) found that Cu and Zn were below guideline levels at two sites off Petone Beach while DDT, Pb, and Hg exceeded sediment quality guidelines at those locations. Diffuse Sources (2014) considered that DDT, Pb and Hg are not currently being discharged in sufficient quantities in urban stormwater to have led to these levels of contamination, and this is most likely legacy contamination.
	• General coastal water quality	2	General water quality information, except for microbiological water quality, is not available for Wellington Harbour at Korokoro.
	• General freshwater quality	2	General water quality information, except for microbiological water quality, is not available for Korokoro Stream.
	• Contact recreation (micro.)	4	Routine monthly microbiological monitoring conducted by HCC indicate low levels of faecal contamination in Korokoro Stream. The median value comfortably achieved the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100ml). While two constructed wastewater overflow structures are located within the catchment they have not had an obvious effect on water quality in the lower stream. Three sites on Petone Beach are monitoring as part of the GWRC recreational water quality monitoring programme. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Fair" at Petone – Water Ski Club, "Fair" at Petone – Sydney St and "Fair" at Petone – Kiosk. Two "alert" and one "action" triggers were recorded at Petone Beach during the 2015/16 bathing season.
	• Monitoring (historic and current)	4	• Ongoing routine monthly microbiological monitoring at one site on Korokoro Stream. • Ongoing GWRC recreational water quality monitoring at three sites on Petone Beach
	• Known key problems	3.5	No known issues.
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of 5-yearly monitoring of contaminant levels in marine sediments, and benthic biota community composition, at existing sites.
	• Future trends		Not required
	• Source / investigation)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	**49 (of 75)**	


Stormwater Reticulation Network
Korokoro
Bathing Water Quality Sites
State of the Environment Monitoring
Catchment
Sewer Overflows
Stormwater Outlet
Open Channels
Sewer Main Trunk
Stormwater Pipes
N
1:20,390
0
225
450
675
900
1,125
m
Wellington
Water

11. Waiwhetu			
Step	**Component**	**Level of adequacy (scores 1-5)**	**Comments**
1	**Collate information/data**	90%	
2	**Characterise**		
a)	Network	4	The Waiwhetu Stream is a small low elevation watercourse which flows from the bush covered Eastern Hutt Hills, through urban areas of Naenae, Epuni, Waterloo, Waiwhetu and Gracefield, to its confluence with the Hutt River Estuary at Seaview. The stormwater network has been developed gradually from 1940's onwards, and generally reflects the age of the main housing subdivisions. The total public stormwater length is 120m. The open channel stormwater length has not be assessed.
b)	Land use characterisation	4	The total catchment area is 18.7 km² of which 59% is served by a stormwater network and an estimated 55% is impervious surfaces. Land use is predominantly residential and commercial, however, within the Gracefield sub-catchment adjacent to the lower stream land-use is mostly light industrial, including bulk fuel storage.
c)	Contaminant sources	4	Catchment-wide sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from major city streets and parking lots. Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. Thirteen constructed wastewater overflows are located in the Waiwhetu catchment. Contaminant hot spots include the Gracefield industrial area, including vehicle dismantling & metal recycling (Macaulay Metals, The Heavy Metal Company), metal galvanising (Perry Metals), spray painting and panel beating, truck transport yards, bulk fuel oil storage, and extensive areas of Zn roofing.
d)	Volume/loads	2	Reliable contaminant load predictions are not available
e)	Receiving environment		
	i. Nature	3.5	The Waiwhetu Stream is a small low elevation urban watercourse which has a stony bed in its upper reaches but for most of its length the streambed substrate is soft and muddy. Historically the lower estuarine reach was situated within a much wider area of salt-marsh and low lying wetland at the Hutt River mouth, although the Waiwhetu Stream Estuary would have had relatively small areas of intertidal flats and saltmarsh. However, over the last 100 years the stream corridor and estuary has been extensively modified by flood protection works, reclamation, and removal of the natural vegetated margin. Over the same period the stream has received an extensive range of contaminant inputs from sewage overflows, stormwater and from industrial discharges.
	ii. Values	3.5	Wellington Harbour (including the Hutt/Waiwhetu estuary) is identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. Schedule F1 of the PNRP identifies the lower reach of the Hutt River, including the Waiwhetu Stream mouth, inanga spawning habitat (also see., Taylor & Marshall, 2016). Schedule F2 of the PNRP identified the lower reach of the Hutt River, including the Waiwhetu Stream mouth as indigenous bird habitat. Schedule F4 identifies the Waiwhetu Estuary as a site with significant biodiversity value (providing passage for migratory fish).
	iii. State and trends		
	• Hydrology	4	GWRC flow gauge station on Waiwhetu Stream
	• Freshwater ecology	4	RSoE results indicate that the macroinvertebrate community in the lower stream is in poor condition. The community includes no sensitive EPT taxa (mayflies, stoneflies, caddisflies), and is dominated by pollution tolerant taxa (e.g., snails, crustaceans, worms, midge larvae). The average MCI score for the years 2013/14, 2014/15 and 2015/16 is 68. KML (2005) surveyed invertebrate communities at eight locations in the Waiwhetu Stream and reported invertebrate metrics showing mostly "poor" or "fair" quality throughout the stream, although the most upstream site, near the urban edge, indicated "good" quality.
	• Estuarine ecology	4	Robertson & Stevens (2012) reported that while the remediation and flood control works within the estuarine reach have resulted in some improvements to habitat, and a very significant removal of contaminated sediment, overall there has been limited improvement to the ecological quality of the estuary which continues to be rated poorly in terms of eutrophication, sedimentation, toxicity and habitat loss.
	• Sediment quality	4	The lower reaches of the stream have historically been highly contaminated with heavy metals and organic compounds. An extensive programme of flood control and contaminated sediment remediation was undertaken in the lower reaches of the stream by GWRC and HCC during 2009. Robertson & Stevens (2012) reported on a before/after investigation of the tidal reach, observing that post remediation, stream sediments exceeded ANZECC (2000) ISQG-High trigger values for Zn and Pb at several locations, while ISQG-Low

			trigger values for arsenic, cadmium, Cu, mercury, nickel and PAHs were all exceeded at one or more locations. These results indicate an ongoing risk of toxicity for invertebrates living in stream sediments in the lower Waiwhetu Stream.
	• General coastal water quality	3	Not applicable.
	• General freshwater quality	4	The GWRC RSoE site located at White Line East on the Waiwhetu Stream had or 'poor' WQI grade for the 2015/2016 year and was ranked 50 out of 53 sites in the Wellington Region. Additional routine monthly microbiological monitoring conducted at five Waiwhetu Stream sites by HCC shows elevated faecal coliforms historically in the upper reaches of the stream (median values above 2000 cfu/100ml) although improvements are evident over the period 2013 to 2016 (Appendix H). During the 2015/16 monitoring year 25% of RSoE samples exceeded the ANZECC (2000) trigger value for Cu and 67% exceeded the trigger value for Zn, indicating that the stream environment may be toxic to sensitive aquatic organisms (Appendix D). A stormwater study conducted by KML (2005) included monitoring sites at culverts discharging to Waiwhetu Stream at Hutt Park Road Parkside Road. The results show that stormwater runoff at both locations carried very high concentration of dissolved Cu and Zn, which would potentially cause and exceedance of trigger levels in the receiving waters of Waiwhetu Stream. The results of HCC/WW stormwater monitoring within the Gracefield sub-catchment to the Waiwhetu Stream show elevated concentrations of dissolved Cu, Pb, Zn, all of which are significantly in excess of ANZECC trigger values. Base flow contaminant levels were considerably lower, although Cu and Zn still exceeded trigger values. During 2015 HCC established a monitoring site in the estuarine reach of Waiwhetu Stream at Seaview Road, downstream of the industrial area of Gracefield, which was sampled once each month for 12 months, on the outgoing tide (Cameron, 2016). The results show that ANZECC (2000) trigger values were consistently exceeded for Zn, occasionally exceeded for Cu, but not exceeded for Pb, mercury, cadmium, chromium, nickel or arsenic. The maximum *E. coli* concentration recorded was 1300 cfu/100ml.
	• Contact recreation (micro.)	4	The median and maximum *E. coli* values for the 2015/16 monitoring years were 700 and 3,600 cfu/100ml, respectively, indicating a moderate degree of faecal contamination. The median value achieved the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100ml). Faecal source tracking conducted on samples collected at this site during 2013 and 2014 indicate a predominantly human source, but dog, wildfowl and ruminant sources were also detected (Milne & Morar, 2017).
	• Monitoring (historic and current)	4	Ongoing routine monthly RSoE monitoring on Waiwhetu Stream; HCC/WW consent monitoring of stormwater in the Gracefield sub-catchment, for duration of the consent.
	• Known problems	4	Contaminant runoff (Cu, Pb, Zn) from Gracefield industrial area.
3	**Identify knowledge gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of GWRC RSoE monitoring on lower Waiwhetu Stream 2. **Continuation** of 5-yearly monitoring of contaminant levels in marine sediments, and benthic biota community composition, at existing sites offshore of Hutt River mouth.
	• Future trends		3. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Source / investigation		4. **New investigation:** Establish an automated stormwater quality and flow monitoring station at site 1A in the Gracefield catchment. This information would be used to better characterise the quality of stormwater runoff from this light industrial catchment, to establish event mean concentrations and contaminant loads and for use in calibrating and validating catchment models. 5. **New Investigation:** Investigate sources of stormwater contamination, including Cu and Zn, and investigate mitigation options.
	• Effectiveness of existing solutions		
	Total Score	**58 (of 75)**	



Stormwater Reticulation Network

Waiwhetu

- Bathing Water Quality Sites
- State of the Environment Monitoring
- Catchment
- Sewer Overflows
- Stormwater Outlet
- Open Channels
- Sewer Main Trunk
- Stormwater Pipes

N

1:25,870

0 190 380 570 760 950 m

Wellington Water

12. Hutt – Speedy's

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	100%	
2	**Characterise**		
a)	Network	3.5	Speedy's Stream drains a small steep catchment on the western side of the Hutt River valley adjacent to the suburb of Kelson. The stormwater network has been developed gradually over time from the 1950's onwards, and generally reflects the age of the main housing subdivisions. Less than 20% of the current network was constructed prior to the 1960's. The total public stormwater length is 7.5 km. The great majority of the stream remains an open channel stream (however, the open channel stream length has not been calculated).
b)	Land use characterisation	4	The total catchment area is 11.6 km² of which 12% is served by a stormwater networks and an estimated 8% is impervious surface. The urban area is predominantly residential but also includes a short length of SH2. The remaining catchment area is open space, predominantly in pasture, scrub and indigenous forest.
c)	Contaminant sources	4	Catchment-wide sources are dominated by runoff from pasture, regenerating forest and scrub. Within the small residential urban area at the bottom of the catchment, sources includes roofs and other building materials found in urban areas, road surfaces, other permeable pavements and vehicles (tyres, brake linings, oil leakage, exhaust). No landfills in catchment. Belmont magazines historically used for ordnance production and storage. No constructed wastewater overflows in the catchment. In summary, significant sources of contamination are not anticipated.
d)	Volume/loads	1	Contaminant load predictions are not available.
e)	Receiving environment		
	i. Nature	3.5	Speedy's Stream drains a small steep forested catchment on the western side of the Hutt River valley adjacent to the suburb of Kelson, and joins the Hutt River on its true right bank immediately downstream of the Kennedy Good Bridge. The watercourse is well entrenched into the greywacke base rock, and confined at the bottom of steep sided valleys.
	ii. Values	3.5	Schedule C4 of the PNRP identifies the confluence of Speedy's Stream with the Hutt River as a site of significance to Taranaki Whānui ki te Upoko o te Ika a Maui. Schedule F1 of the PNRP identifies Speedy's Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. Fish species recorded in Speedy's Stream included banded kokopu, bluegill bully, common bully, giant bully, giant kokopu, lamprey, longfin eel, redfin bully and shortfin eel.
	iii. State and trends		
	• Hydrology	2	Hydrology information is limited
	• Freshwater ecology	3	KML (2005) surveyed the invertebrate community in the lower reach of Speedy's Stream, reporting invertebrate metric which indicate "excellent" quality (MCI = 128, QMCI = 8.6, %EPT taxa = 85.6, Taxa richness = 26).
	• Coastal ecology	3	Not applicable
	• Sediment quality	1	Sediment quality information is not available
	• General coastal water quality	3	Not applicable
	• General freshwater quality	1	General water quality information is not available
	• Contact recreation (micro.)	4	Routine monthly microbiological monitoring conducted by HCC indicate low levels of faecal contamination in Speedy's Stream (median *E. coli* value is 68 cfu/100ml). The results reflect the low level of urban development in the Speedy's catchment and the absence of wastewater overflow structures within the catchment.
	• Monitoring (historic and current)	3	Ongoing HCC routine monthly microbiological monitoring at one location on Speedy's Stream
	• Known key problems	3.5	No issues or problems have been identified.
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised.
b)	Values		Well characterised
c)	Receiving environment state		Partially characterised.
4	**Further Investigations**		

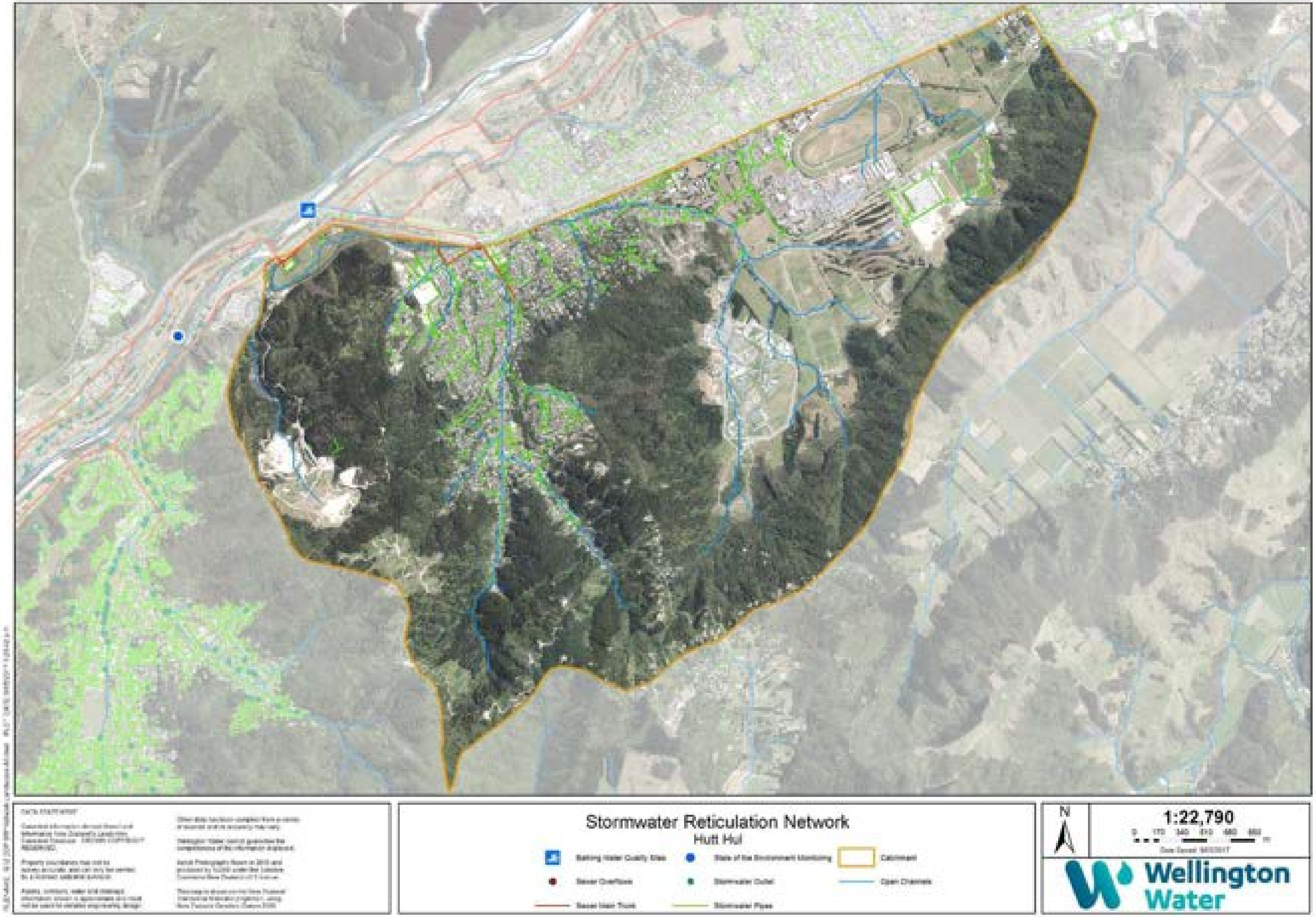
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		Not required
	• Future trends		Not required
	• Source / investigation		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	43 (of 75)	


Stormwater Reticulation Network
Hutt Spe
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:13,730
0 150 300 450 600 750 m
Wellington Water

13. Hutt – Hull

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	90%	
2	**Characterise**		
a)	Network	4	The Hulls Creek (Silverstream) catchment is made up of low lying hills in the Blue Mountains, Pinehaven, and Trentham/Wallaceville areas and low gradient areas around Heretaunga and Silverstream. The stormwater network has been developed gradually over time from the 1950's onwards and generally reflects the age of the main housing subdivisions. The total public stormwater length is 30 km. The remaining open channel stream length has not been calculated.
b)	Land use characterisation	5	The Hulls Creek catchment is made up of low lying hills in the Blue Mountains, Pinehaven, and Trentham/Wallaceville areas and low gradient areas around Heretaunga and Silverstream. The dominant land cover classes in the Hulls Creek catchment is scrub, urban and indigenous forest. In its upper catchment, Hulls Creek receives runoff from scrub and indigenous forest as well as the Rimutaka Prison farm. Just below the prison farm a tributary draining the northern catchment, which includes the Trentham Racecourse, a golf course, the old General Motors factory and areas of pastoral farming, enters the stream. The mid catchment is drained by the Pinehaven Stream which is dominated by plantation forestry and scrub in its headwaters and urban residential areas in its middle and lower reaches. The lower catchment is drained by Tip Stream which includes the Silverstream Landfill in its headwaters and indigenous forest and scrub in its lower reaches (Warr, 2007).
c)	Contaminant sources	3.5	Catchment-wide sources include roofs and other building materials found in older largely residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source. No constructed wastewater overflows are located in the catchment. Contaminant hot spots include Silverstream Landfill, Trentham Racecourse and Trentham Riffle Range
d)	Volume/loads	1	Contaminant load predictions are not available.
e)	Receiving environment		
	i. Nature	3	Hulls Creek is a small tributary of the Hutt River than runs through the suburbs of Trentham, Silverstream and Pinehaven in Upper Hutt. Hulls Creek is identified in Greater Wellington Regional Council's Regional Policy Statement (RPS) as having impaired water quality that is in need of enhancement and restoration (Wellington Regional Council 1995). Though not officially documented, it is likely that the main reason for the inclusion of Hulls Creek in the RPS was that, up until 1993, it received treated sewage from the Trentham Military Camp.
	ii. Values	3	Hulls Creek is not listed Schedule F1 of the PNRP as a watercourse with significant indigenous ecosystem values. Indigenous fish species recorded in the watercourse include banded kokopu, bluefin bully, common bully, giant kokopu, inanga, longfin eel, redfin bully, and shortfin eel.
	iii. State and trends		
	• Hydrology	2	Limited hydrology information is available.
	• Freshwater ecology	2.5	Invertebrate sampling results from Hulls Creek and Pinehaven Stream taken as part of Kingett Mitchell's (2005) study of urban stream ecology in the Wellington region shows "Poor" to "Fair" quality on the lower and middle reaches, and "excellent" quality in Pinehaven headwater tributary.
	• Coastal ecology	3	Not applicable
	• Sediment quality	3	Streambed sediments exceeded the ANZECC (2000) ISQC-Low trigger value for dissolved Zn and Total DDT. No other trigger values were exceeded at this site. Contaminated runoff from urban areas around Pinehaven is likely to be the main source of zinc in Hulls Creek.
	• General coastal water quality	3	Not applicable
	• General freshwater quality	1	General water quality information is not available for Hulls Creek.
	• Contact recreation (micro.)	1	No routine microbiological monitoring data is available for this watercourse
	• Monitoring (historic and current)	1	No routine water quality monitoring data is available for this watercourse
	• Known key problems	3	Historic microbiological contamination has been an issue.

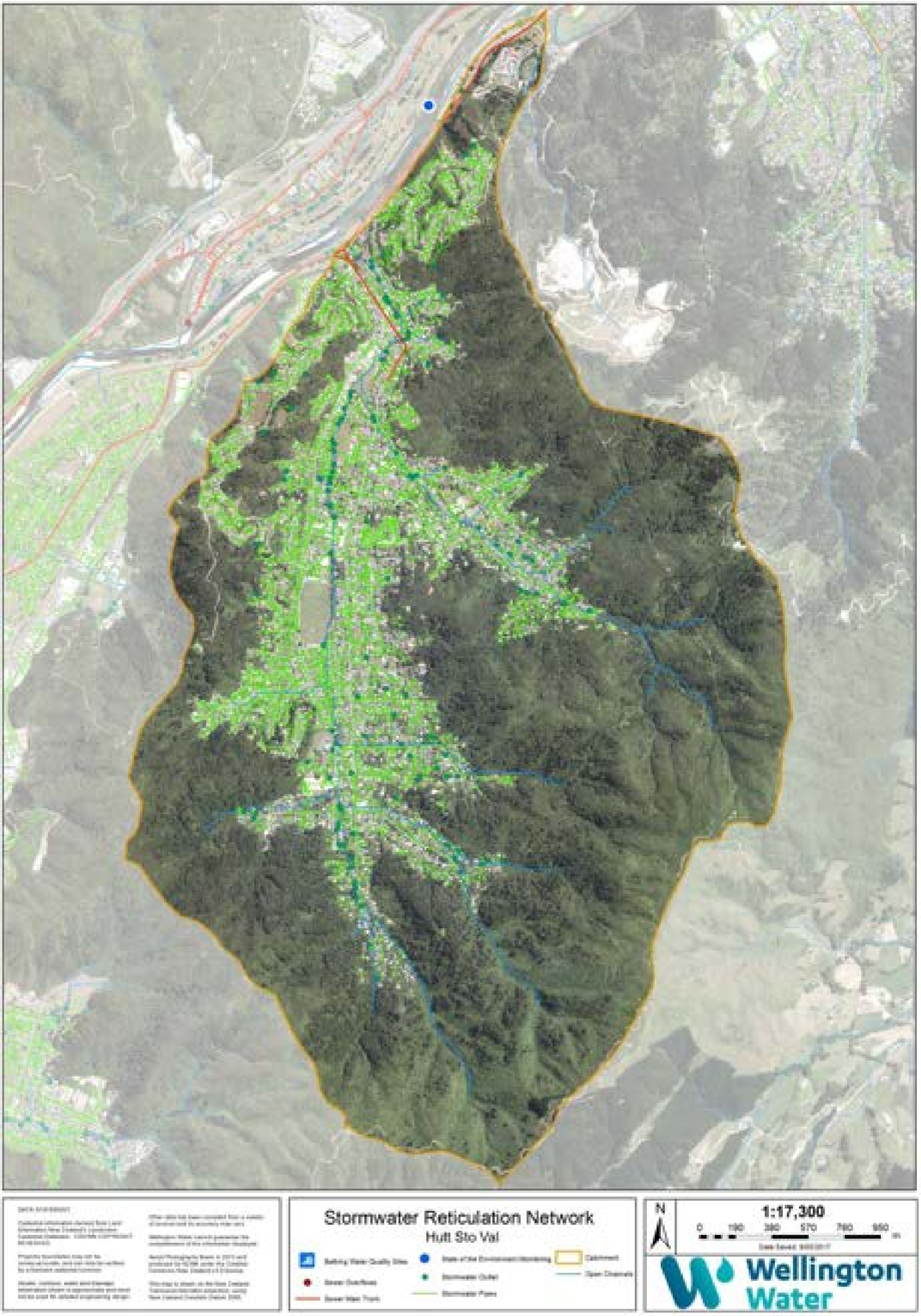
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised.
b)	Values		Well characterised
c)	Receiving environment state		Not well characterised.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Establishment** of one temporary RSoE monitoring site on the lower reaches of Hull Creek, monitoring all standard RSoE parameters plus Cu and Zn for a minimum period of two years
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	37 (of 75)	


Stormwater Reticulation Network
Hutt Hul
Bathing Water Quality Sites
State of the Environment Monitoring
Catchment
Sewer Overflows
Stormwater Outlet
Open Channels
Sewer Main Trunk
Stormwater Pipes
N
1:22,790
Wellington Water

14. Hutt – Stokes Valley

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	100%	
2	**Characterise**		
a)	Network	3	The Stokes Valley catchment extends from the forested headwaters through the urban area of Stokes Valley to its confluence with the Hutt River. The stormwater network has been developed gradually over time from the 1950s onwards, and generally reflects the age of the main housing subdivisions. The total public stormwater length is 52 km. The remaining open channel stream length has not been calculated.
b)	Land use characterisation	3.5	The total catchment area is 11.96 km² of which 39% is served by a stormwater network and an estimated 37% is impervious surface. The urban area is predominantly residential and light commercial while the remaining 61% of the catchment is open space, mostly regenerating indigenous vegetation.
c)	Contaminant sources	3.5	Catchment-wide sources are dominated by regenerating indigenous vegetation. Sources within the urban area and include roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from suburban streets and parking lots, but traffic volumes are relatively low. There are no known landfills or contaminated sites in the catchment. Significant sources of contamination are not anticipated.
d)	Volume/loads	1	Contaminant load information is not available
e)	Receiving environment		
	i. Nature	3	Stokes Valley Stream begins as a relatively natural watercourse in regenerating bush in the upper valley but once it enters the valley floor it becomes channelised, straightened and is enclosed by culverts at a number of locations, including the reach passing under the Stokes Valley Shopping centre. Beyond Stokes Valley Road the stream bed substrate takes on a more natural character of cobbles, gravels and fine sediment. It retains, however, a straightened 'engineered' channel with sloping grassed banks throughout the lower reach to its confluence with the Hutt River.
	ii. Values	3	Schedule F1 of the PNRP identifies the Stokes Valley Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish. Fish species recorded include the banded kokopu, common bully, giant kokopu, longfin eel and shortfin eel.
	iii. State and trends		
	• Hydrology	2	Little stream hydrology information available
	• Freshwater ecology	3.5	The middle and lower reaches of the stream are in a degraded condition due to loss of forest cover, removal to riparian vegetation, loss of shade and cover over the streambed, channel modifications, loss of connectivity to the flood plain, loss of hydraulic complexity and loss of woody inputs to the stream. These factors contribute to a low abundance and diversity of habitat for invertebrates and fish. KMA (2005) reported invertebrate metrics indicating "excellent" quality on the upper stream above the urban edge (MCI = 153, QMCI = 8.8, %EPT taxa = 98, taxa richness = 19) with a sharp reduction to "poor" quality within the urban reach (MCI = 75, QMCI = 1.3, %EPT taxa = 0.1, taxa richness = 24).
	• Coastal ecology	3	No applicable.
	• Sediment quality	3	Streambed sediments sampled at Stokes Valley Stream in 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Total DDT (Milne & Watts, 2008). No other trigger values were exceeded at this site.
	• General coastal water quality	3	Not applicable
	• General freshwater quality	1	General water quality information is not available.
	• Contact recreation (micro.)	3.5	Routine monthly microbiological monitoring conducted by HCC indicates that the annual median *E. coli* value frequently exceeds the NPS-FM 'national bottom line' for secondary contact recreation. Although there are no known wastewater overflow structures located within the catchment the monitoring results indicate wastewater faults or leaks.
	• Monitoring (historic and current)	3	Ongoing routine monthly microbiological monitoring by HCC
	• Known key issues/ problems	3	No issues identified.
3	**Identify knowledge gaps**		
a)	Source/network		Partially characterised
b)	Values		Well characterised

c)	Receiving environment state		Not well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Establish** one temporary RSoE site on the lower reaches of Stokes Valley Stream (including Cu and Zn); monitor for a minimum of 2 years
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		2. **New Investigation**: In response to the poor conditions of the macroinvertebrate community on the lower stream, identify sources of stormwater contamination, including Cu and Zn, and investigate mitigation options.
	• Effectiveness of existing solutions		Not required
	Total Score	42 (of 75)	



Stormwater Reticulation Network
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N
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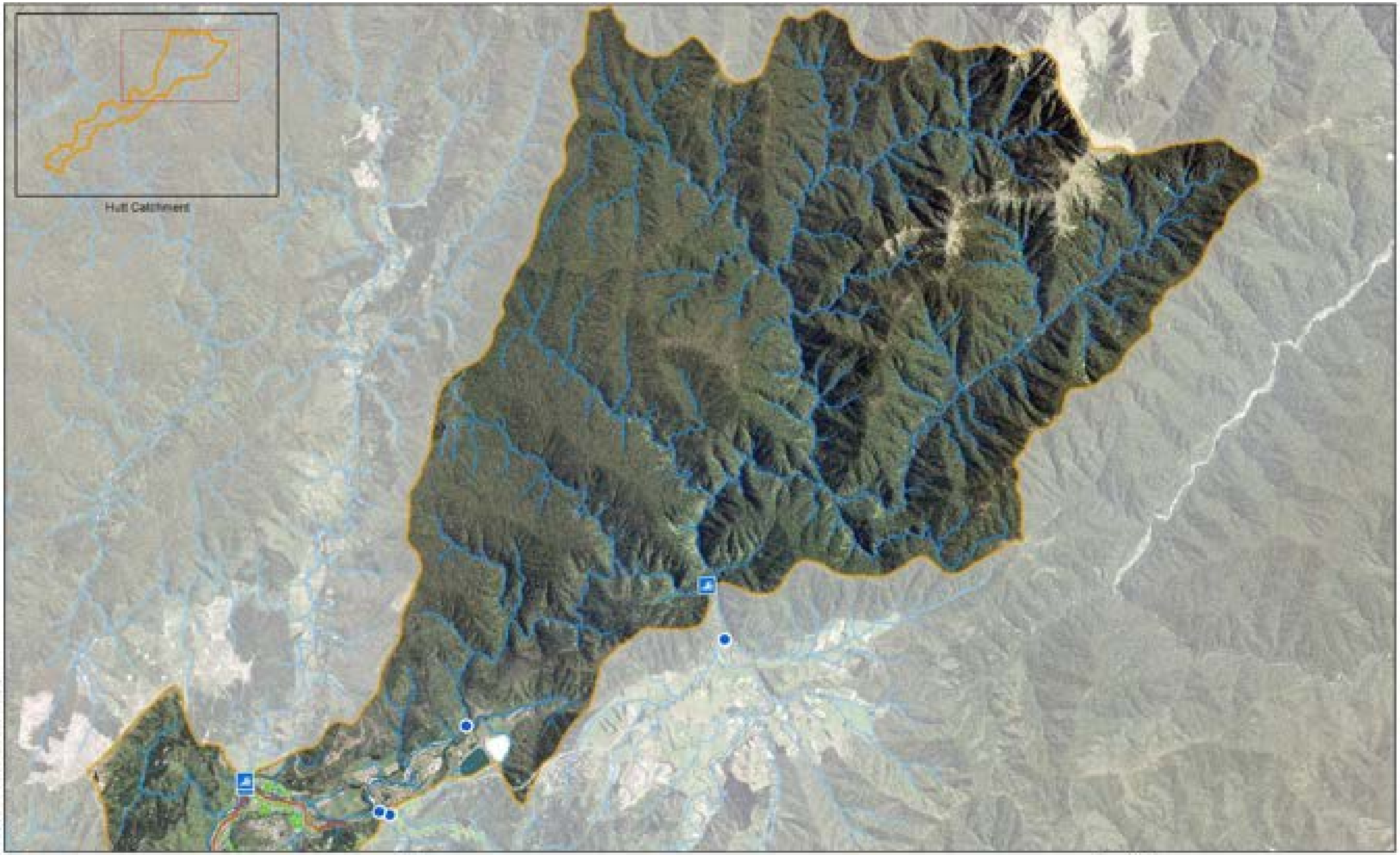
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
Wellington Water

15. Hutt – Mainstem			
Step	**Component**	**Level of adequacy (scores 1-5)**	**Comments**
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	2.5	The Hutt River stormwater catchment characteristics are described here in 9 sub-catchments, these being Hutt mainstem, Speedy's, Waiwhetu, Stokes Valley, Hulls, Whakatikei, Akatarawa, Mangaroa and Pakuratahi. The Hutt mainstem (i.e., not including the tributaries) includes urban areas of Te Marua, Birchville, Brown Owl, Timberlea, Moanbank, Totara Park, Upper Hutt City, Lower Hutt City and Petone. These areas include multiple stormwater networks, most of which have developed from the 1940's onwards. The total public stormwater length is 362. All of the Hutt River mainstem flows as an open channel watercourse while a large number of minor tributaries within the 'mainstem' catchment have been piped. The remaining length of open channel watercourse in this catchment has not been assessed.
b)	Land use characterisation	2.5	The Hutt River total catchment area is 655 km². The % land cover types in the contributing catchment are: indigenous forest and scrub (70.7%), exotic forest (11%), pasture (15.7%), and urban (6.1%). The Hutt River 'mainstem' catchment (i.e., not including main tributaries) has a total area of 199 km² of which 26% is served by a stormwater network and an estimated 11% is impervious surface.
c)	Contaminant sources	3	Catchment-wide sources are dominated by runoff from indigenous forest and scrub. Within the residential, commercial and light industrial areas of the Hutt Valley, sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from major city streets and parking lots and Hutt motorways (SH2). Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. There are 10 known wastewater overflow structures in the Hutt catchment (excluding the Waiwhetu catchment), including 3 upstream of Melling. The most significant of these is a consented discharge from the Silverstream Storm Tank which overflows to the river several times each year during periods of sustained wet weather when the capacity of the storage tank is exceeded (at which time the river is usually in flood). Contamination hot spots include the Hutt motorway, major city streets, and the main trunk railway.
d)	Volume/loads	1	Contaminant load predictions are not available.
e)	Receiving environment		
	i. Nature	3	The Hutt River is a steep gravel-bearing river which originates in the indigenous forest covered slopes of the southern Tararua Ranges and flows some 50 km to Wellington Harbour at Seaview. The main tributaries of the Hutt River are the Pakuratahi, Mangaroa, Akatarawa and Whakatiki Rivers.
	ii. Values	3	The main stem of the Hutt River is identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. Schedule F1 of the PNRP identifies the mainstem of the Hutt River as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, habitat for migratory fish, and habitat for more than six species of indigenous fish. The tidal reach of the Hutt River has potential to provide inanga spawning habitat. The PNRP also identifies the main stem of the Hutt River a site of significance by mana whenua iwi (C3 & C4), as providing indigenous bird habitat (F2), significant biodiversity values (F4), regionally significant primary contact recreation (H1), and important trout habitat (I1)
	iii. State and trends		
	• Hydrology	4.5	The hydrology of the Hutt River is well characterised.
	• Freshwater ecology	3.5	Invertebrate survey results from RSoE monitoring together with HREMP monitoring for the Kaitoke Weir water abstraction consent, show a downstream decrease in invertebrate community quality from "Excellent" quality to "Good" quality, which is inversely related to periphyton biomass and soluble inorganic nitrogen concentrations. Hutt River QMCI scores were 8.1 above Kaitoke Weir, 8.1 at Te Marua, 6.3 below the Mangaroa River, 6.5 below the Akatarawa River, 5.3 at Manor Park and 5.5 on the lower river at Boulcott. The average MCI score at Boulcott for the years 2013/14, 2014/15 and 2015/16 is 111. Fish species recorded in the Hutt River include bluegill bully, common bully, Cran's bully, dwarf galaxias, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully and shortfin eel.
	• Coastal/ estuarine ecology	4	The Hutt Estuary is a moderate sized (3km long) "tidal river mouth" type estuary which drains into Wellington Harbour at Petone. It has been extensively reclaimed and modified, and the banks clad with large rip-rap boulders.

			The estuary has been highly modified from its original state. As a result the estuary now has extremely low habitat diversity. High value habitats such as tidal flats, saltmarsh and seagrass beds are virtually absent (Stevens, et al, 2016). Stevens et al (2016) observed that the estuary currently receives high inputs of nutrient and sediment from the large catchment and consequently growths of green nuisance macroalgae are common along its banks, and the bed near the mouth is muddy and enriched. The Petone Beach foreshore has been identified as an important conservation area. It is considered to be a valuable roosting and feeding ground for variable oyster catchers, gulls, pied stilts and terns that feed on the invertebrate fauna of the beach (Wear and Hatton 1992). The results of infaunal sampling conducted at Petone Beach in 2004 showed that overall the infauna was dominated by bivalve shellfish (pipi) and numerous polychaete worms (Stevens, et al, 2004).
	• Sediment quality	4	Sediment quality data is not available for the Hutt River. Streambed sediments sampled in the Opahu Stream (which runs through Lower Hutt City CBD to the Hutt River at Whites Line West) in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger values for silver (Ag), mercury (Hg), Pb, Zn, Total PAH, Dieldrin and Total DDT on at least one occasion, and the ISQC-High trigger values for Zn and Total HMW PAH were both exceeded during the 2006 round (Milne & Watts, 2008). The water quality and sediment results indicate that the stream environment at this location may be toxic to some aquatic organisms. Stevens *et al* (2004) reported Cu and Zn levels below sediment quality guidelines in nearshore sandy sediments at Petone Beach. GWRC's Wellington harbour marine sediment quality investigations conducted in 2006 and 2011 (Stephenson et al 2008, Milne 2010, and Oliver 2014) found that Cu and Zn were below guideline levels at two sites off Petone Beach while DDT, Pb, and Hg exceeded sediment quality guidelines at those locations. Diffuse Sources (2014) considered that DDT, Pb and Hg are not currently being discharged in sufficient quantities in urban stormwater to have led to these levels of contamination, and this is most likely legacy contamination. Cu and Zn are now the contaminants of most concern in terms of toxic effects in these environments, but neither are predicted to increase rapidly (Diffuse Sources 2014). Stevens et al (2016) reported that Hutt Estuary sediment concentrations of Cd, Cr, Cu, Hg, Pb, Hg and arsenic, are present at "Very Low" to "Moderate" concentrations with all non-normalised values below ANZECC (2000) ISQG-Low trigger values (and therefore unlikely to pose a toxicity threat to aquatic life). However, the heavy metal nickel exceeded the ISQG-Low trigger values at the majority of lower estuary sites, but not the ISQG-High values.
	• General coastal water quality	1	No chemical or general water quality data are available for Petone Beach.
	• General freshwater quality	4	All RSoE sites on the Hutt River received an 'excellent' WQI grading for the 2015/2016 year. An upstream site at Te Marua was ranked 1st of 53 sites across the region while sites on the middle and lower river were ranked 16th and 17th. Dissolved Cu and Zn concentrations are consistently below ANZECC (2000) trigger values in the Hutt River main-stem, as would be expected given the small proportion of urban land cover in the catchment. While water quality is normally very good, it can deteriorate markedly during rainfall events. This is particularly the case in respect of suspended solids which is typically present in river water at <1 mg/L in baseflow conditions, but can increase as by as much as 700 mg/L during flood events. This material is likely to be sourced from throughout the catchment and, given the small proportion of urban land-cover, the contribution from urban stormwater is likely to be small. A stormwater study conducted by Milne & Watts (2008) included a monitoring site on the lower reach of Opahu Stream at Nikau Grove. Opahu Stream is minor tributary of the Hutt River running through urban Hutt City. The results show elevated concentrations of dissolved Cu and very high concentrations of Zn in first flush, composite and baseflow samples, all above ANZECC 95% protection trigger values.
	• Contact recreation (micro.)	4	Hutt River recreational water quality ranges from "Poor" (Melling Bridge) to "Good" (Moaribank & Poets Park) in the main stem of the Hutt River, with 5-year 95-percentile E. coli values ranging from 159 to 835 cfu/100ml. The poorest recreational water quality was recorded at the Melling Bridge site adjacent to the large urban area of Lower Hutt. . Three sites on Petone Beach are included in the GWRC recreational water quality monitoring programme. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Fair" at Petone – Water Ski Club, "Fair" at Petone – Sydney St and "Fair" at Petone – Kiosk. Two "alert" and one "action" triggers were recorded at Petone Beach during the 2015/16 bathing season.

	• Monitoring (historic and current)	4	• Ongoing monthly RSoE monitoring at 3 locations on the Hutt River mainstem; • Ongoing HCC monthly microbiological monitoring (E. coli) at 15 locations on minor streams and culverts within the Hutt River mainstem catchment; • Ongoing recreational water quality monitoring –freshwater (*E. coli*) at 5 recognised bathing areas on the Hutt River mainstem. • Ongoing recreational water quality monitoring – coastal (Enterococci) at 3 locations on Petone Beach.
	• Known key problems	3.5	Nuisance algae growths on the middle and lower reaches of the Hutt River during periods of sustained low river flow; High nutrient inputs to the Hutt Estuary; Elevated indicator bacteria concentration in the Hutt River at Melling.
3	**Identify knowledge gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of monthly RSoE monitoring at 3 locations on the Hutt River mainstem; 2. **Continuation** of GWRC recreational water quality monitoring –freshwater (E. coli) at 5 recognised bathing areas on the Hutt River mainstem. 3. **Continuation** of GWRC recreational water quality monitoring – coastal (Enterococci) at 3 locations on Petone Beach. 4. **Continuation** of 5-yearly monitoring of contaminant levels in marine sediments, and benthic biota community composition, at existing sites.
	• Future trends		5. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Source / investigation (e.g. hot spot identification)		6. **New investigation**: Investigate and remedy causes of elevated indicator bacteria concentration in the Hutt River at Melling.
	• Effectiveness of existing solutions		Not required
	Total Score	**47.5 (of 75)**	



Stormwater Reticulation Network

Hutt Hutt (Headwaters)

- Bathing Water Quality Sites
- State of the Environment Monitoring
- Catchment
- Sewer Overflows
- Stormwater Outfall
- Open Channels
- Sewer Main Trunk
- Stormwater Pipes

N

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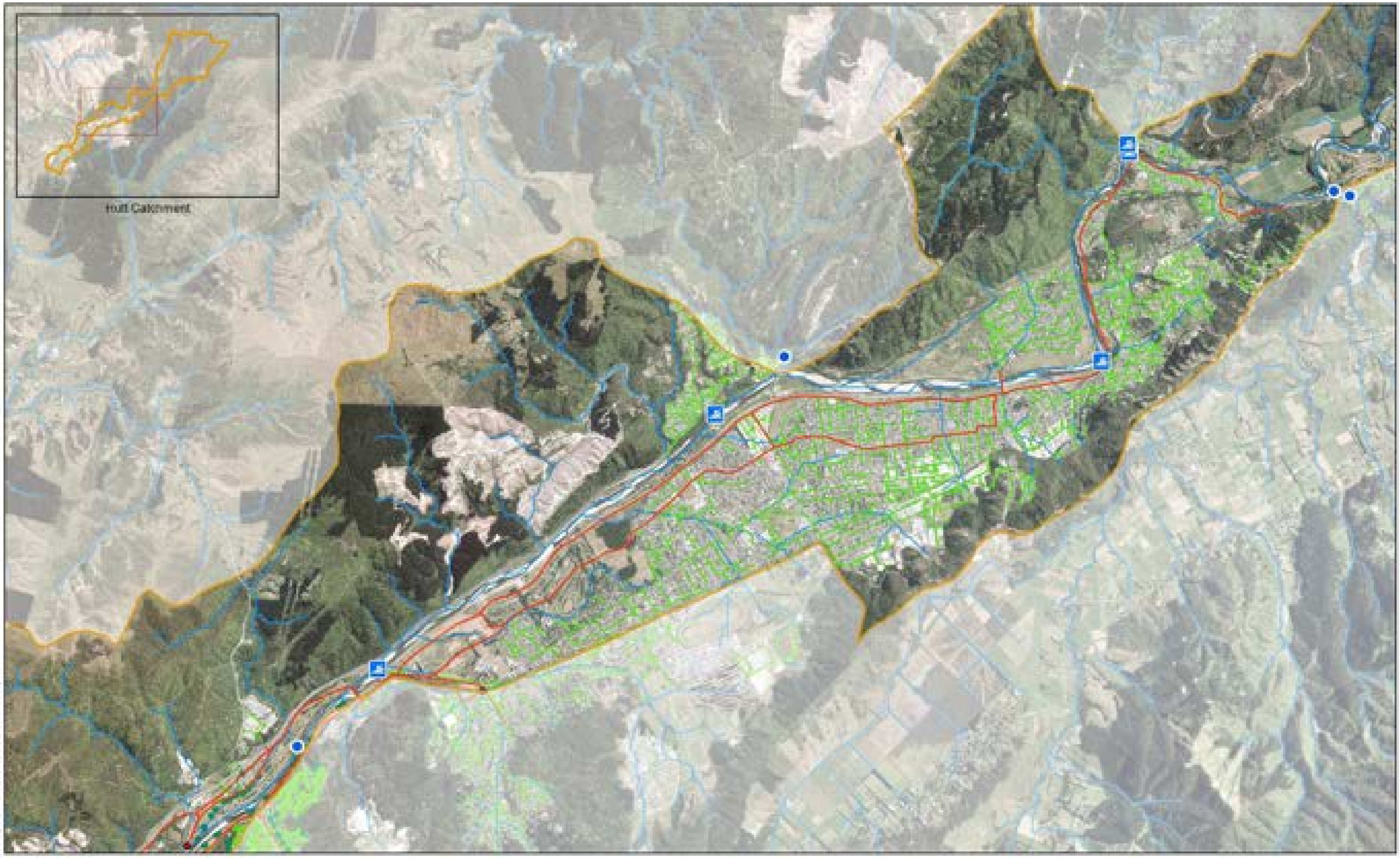
Wellington Water



Stormwater Reticulation Network

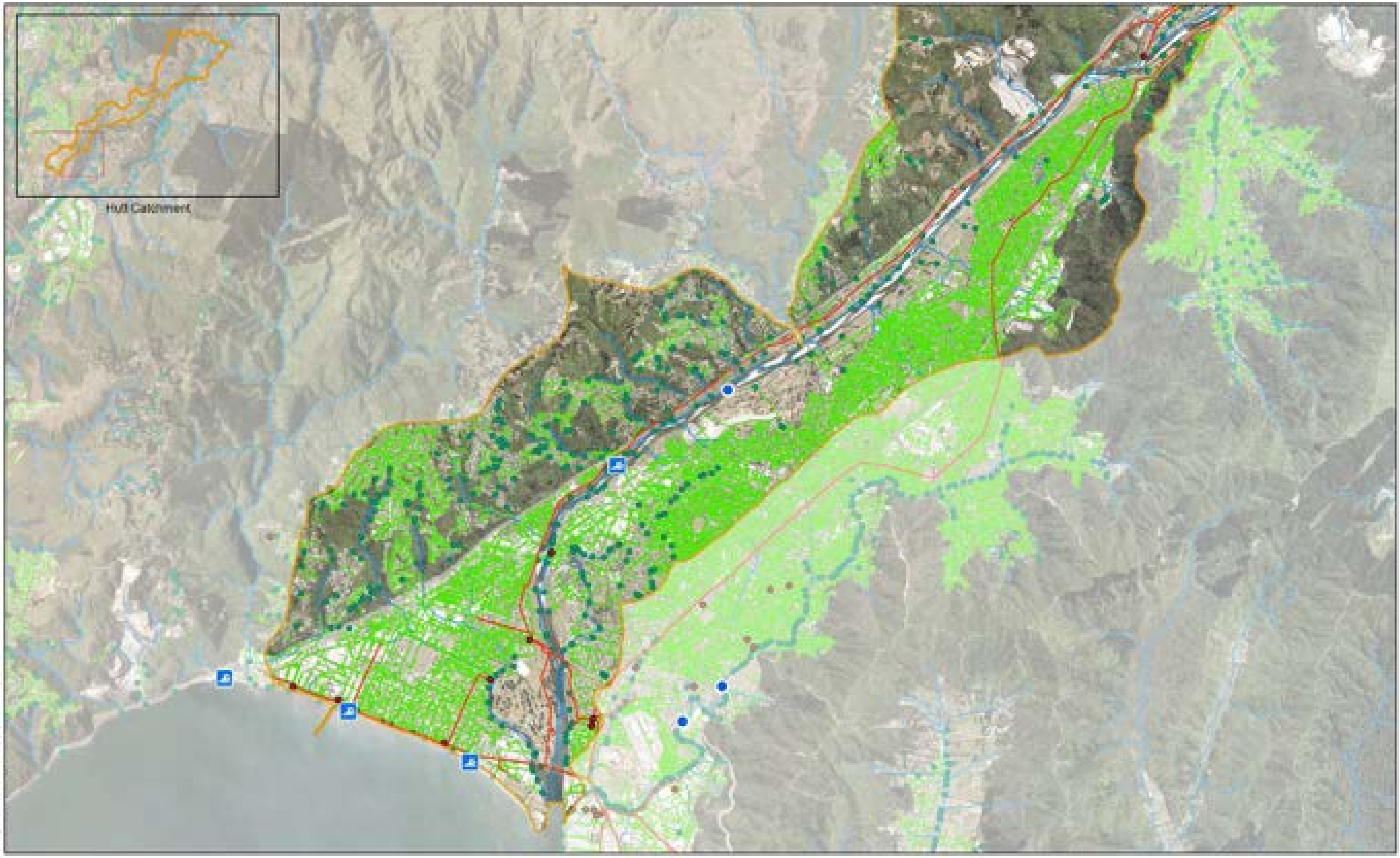
Hutt Hutt (Upper)

- Bathing Water Quality Sites
- State of the Environment Monitoring
- Catchment
- Sewer Overflows
- Stormwater Outlet
- Open Channels
- Sewer Main Trunk
- Stormwater Pipes

N

1:39,581

Wellington Water



Stormwater Reticulation Network

Hutt Hutt (Lower)

- Bathing Water Quality Sites
- State of the Environment Monitoring
- Catchment
- Sewer Overflows
- Stormwater Outlet
- Open Channels
- Sewer Main Trunk
- Stormwater Pipes

N

1:36,395

Wellington Water

16. Hutt – Whakatikei

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	100%	
2	**Characterise**		
a)	Network	4	A small stormwater network has been constructed as part of the Riverstone residential development from the 1990's onwards. The total public stormwater length is1.9 km.
b)	Land use characterisation	4	The total catchment area is 81.8 km² of which less than 0.5% is served by a stormwater network and less than 0.1% is impervious surface. The great majority of the catchment is open space with 65% of land cover in indigenous forest and scrub, 23% exotic forest, 9% pasture and 0.1% urban.
c)	Contaminant sources	4	Catchment-wide sources are dominated by runoff from regenerating forest, plantation forest and scrub. Within the very small residential urban area at the bottom of the catchment, sources includes roofs and other building materials found in urban areas, road surfaces, other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. No constructed wastewater overflows are located in the catchment. Significant contaminant sources are not anticipated.
d)	Volume/loads	1	Contaminant load modelling predictions are not available
e)	Receiving environment		
	i. Nature	3.5	The Whakatikei River flows into the Hutt River near Riverstone at Upper Hutt. It is situated on the north-western part of the Hutt Catchment between the Akatarawa and Horokiri rivers.
	ii. Values	3.5	Schedule F1 of the PNRP identifies the Whakatikei River as a watercourse with significant indigenous ecosystem values including high macroinvertebrate community health, habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish
	iii. State and trends		
	• Hydrology	4.5	The Hydrology of the Whakatikei River is well characterised.
	• Freshwater ecology	4.5	RSoE invertebrate survey results indicate "excellent" quality invertebrate community in the Whakatikei River at Riverstone (QMCI = 6.61, %EPT taxa = 61, Taxa richness = 28) which reflects the low levels of agricultural and urban development in the catchment. The average MCI score for the years 2013/14, 2014/15 and 2015/16 is 130. Indigenous fish species recorded in the Whakatikei River include bluegill bully, koaro and longfin eel. The river also provides trout spawning, rearing and adult habitat.
	• Coastal/ estuarine ecology	3	No applicable.
	• Sediment quality	1	Sediment quality information is not available
	• General coastal water quality	3	Not applicable
	• General freshwater quality	3.5	The GWRC RSoE site located at Riverstone on the lower Whakatikei River had an 'excellent' WQI grade for the 2015/2016 year and was ranked 3rd equal out of 53 sites in the Wellington Region.
	• Contact recreation (micro.)	3.5	Median and maximum E. coli values for the 2015/16 monitoring years were 16 and 32 cfu/100ml, respectively, indicating negligible faecal contamination and compliance with both primary and secondary contact recreation guidelines.
	• Monitoring (historic and current)	3.5	• Ongoing routine RSoE monitoring (water quality. Periphyton, invertebrates) on the Whakatikei River at Riverstone. • Ongoing recreational water quality monitoring on Whakatikei River at Hutt Forks
	• Known key problems	3.5	No water quality issues are anticipated in the catchment.
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		Not required
	• Future trends		Not required

	• Source / investigation (e.g. hot spots)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	45.5 (of 75)	


Stormwater Reticulation Network
Hutt Wha
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:38,470
0 430 860 1,290 1,720 2,150 m
Wellington Water

17. Hutt – Akatarawa

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	4	The total public stormwater length is 766m and the total area served by the network is estimated at 0.07 km². The river and stream system has not been much affected by stormwater network development.
b)	Land use characterisation	4	Very little urban development has occurred in the catchment. The total catchment area is 116 km² of which less than 0.1% is served by a stormwater network and less than 0.01% is impervious surface. The great majority of the catchment is open space with 84% of land cover in indigenous forest and scrub, 14% exotic forest, 2.2% pasture and <0.1% urban.
c)	Contaminant sources	4	Catchment-wide sources are dominated by runoff from regenerating forest, plantation forest, pasture and scrub. They include soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. No constructed wastewater overflows are located in the catchment. Significant contaminant sources are not anticipated.
d)	Volume/loads	1	Contaminant load modelling predictions are not available
e)	Receiving environment		
	i. Nature	3.5	The Akatarawa River flows into the Hutt River at Birchville near Upper Hutt. It is situated on the northern part of the Hutt Catchment, between the Whakatikei and Waikanae catchments. It drains a steep catchment of approximately 116 km2, predominantly of indigenous forest and scrub and with significant areas of pine plantation forestry (Table 3-9). Very little urban development has occurred in this catchment which has less than 0.01% urban land cover and <0.01% impervious surface.
	ii. Values	3.5	Schedule F1 of the PNRP identifies the Akatarawa River as a watercourse with significant indigenous ecosystem values including high macroinvertebrate community health, habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish.
	iii. State and trends		
	• Hydrology	4	The Hydrology of the Akatarawa River is well characterised.
	• Freshwater ecology	4	RSoE invertebrate survey results indicate "excellent" quality invertebrate community in the lower Akatarawa River (QMCI = 7.64, %EPT taxa = 67, Taxa richness = 33) which reflects the low levels of agricultural and urban development in the catchment. The average MCI score for the years 2013/14, 2014/15 and 2015/16 is 130. Fish species recorded in the Akatarawa River include banded kokopu, bluegill bully, Cran's bully, dwarf galaxias, koaro, lamprey, longfin eel, redfin bully and shortfin eel.
	• Coastal/ estuarine ecology	3	No applicable.
	• Sediment quality	1	Sediment quality information is not available
	• General coastal water quality	3	Not applicable
	• General freshwater quality	4	The GWRC RSoE site located on the Akatarawa River just above the Hutt River confluence had an 'excellent' WQI grade for the 2015/2016 year and was ranked 3rd equal out of 53 sites in the Wellington Region.
	• Contact recreation (micro.)	4	Median and maximum *E. coli* values for the 2015/16 monitoring year were 35 and 90 cfu/100ml, respectively, indicating low levels of faecal contamination and compliance with both primary and secondary contact recreation guidelines.
	• Monitoring (historic and current)	3	• Ongoing routine RSoE monitoring (water quality, periphyton, invertebrates) at 1 site on the Akatarawa River. • Ongoing recreational water quality monitoring at 1 site.
	• Known key problems	3.5	No water quality issues are anticipated in the catchment.
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised
b)	Values		Well characterised
c)	Receiving environment state		Well characterised

4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		Not required
	• Future trends		Not required
	• Source / investigation (e.g. hot spot)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	**49.5 (of 75)**	

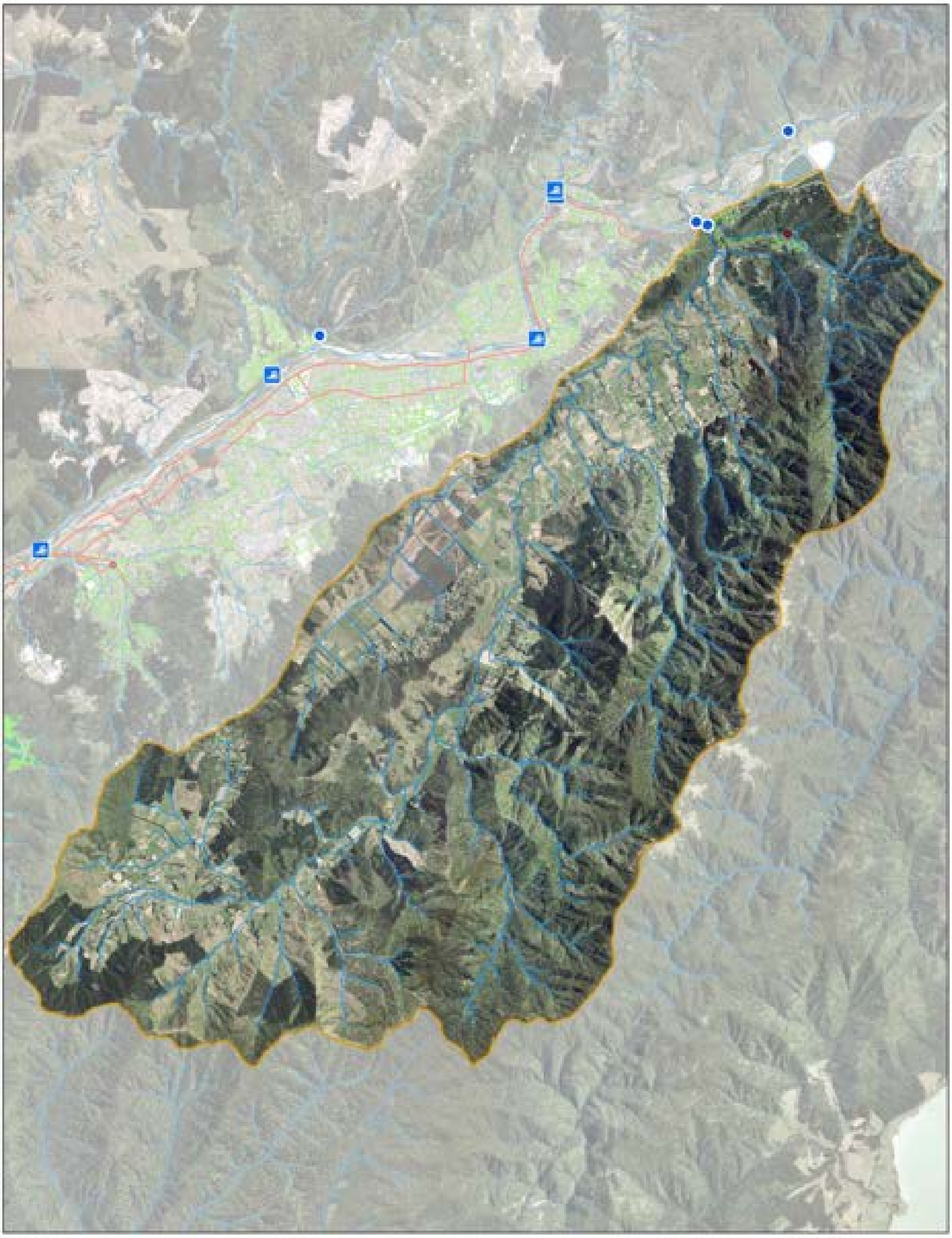
Stormwater Reticulation Network

Hutt Aka

18. Hutt – Mangaroa

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	4	The stormwater network is limited to the residential areas on Plateau and Maymorn roads in the lower Mangaroa Valley. The network was constructed in the 1960's and has a total public stormwater length of 3.9 km.
b)	Land use characterisation	4	The total catchment area is 104 km² of which 1% is served by a stormwater network and less than 0.1% is impervious surface. The catchment is predominantly open space with 53% of land cover in indigenous forest and scrub, 14% in exotic forest, 32% pasture and <1.3% urban.
c)	Contaminant sources	4	Catchment-wide sources are dominated by runoff from productive pasture and scrub. They include soil disturbance (farming, landscaping, surface soil damage), vegetation, wild and domestic animals. No constructed wastewater overflow structures are located in the catchment. Significant contaminant sources are not anticipated.
d)	Volume/loads	1	Contaminant load modelling predictions are not available
e)	Receiving environment		
	i. Nature	3	The Mangaroa River flows into the Hutt River at Te Marua north of Upper Hutt. It is situated on the western side of the Rimutaka Range, adjacent to the Pakuratahi River. It drains a broad low gradient valley which is predominantly indigenous forest and scrub with substantial areas of production pasture and pine plantation forestry.
	ii. Values	3	Schedule H1 of the PNRP identifies the Mangaroa River as an important trout spawning river.
	iii. State and trends		
	• Hydrology	4	The hydrology of the Mangaroa River is well characterised.
	• Freshwater ecology	4	RSoE invertebrate survey results indicate "good" quality invertebrate community in the lower Mangaroa River (QMCI = 5.98, %EPT taxa = 46, Taxa richness = 26) which has been slightly to moderately affected by agricultural development in the catchment.
	• Coastal/ estuarine ecology	3	Not applicable
	• Sediment quality	1	Sediment quality information is not available
	• General coastal water quality	3	Not applicable
	• General freshwater quality	4	The GWRC RSoE site located on the Mangaroa River just above the Hutt River confluence had a 'fair' WQI grade for the 2015/2016 year and was ranked 35th out of 53 sites in the Wellington Region.
	• Contact recreation (micro.)	4	Median and maximum *E. coli* values for the 2015/16 monitoring year were 160 and 650 cfu/100ml, respectively, indicating a moderate level faecal contamination reflecting the sheep and beef grazing activities in the catchment. The median value achieved the NPS-FM (MfE 2014) 'bottom line' for secondary contact recreation (<1,000 cfu/100ml).
	• Monitoring (historic and current)	4	• Ongoing monthly RSoE monitoring at 1 site on the Mangaroa River
	• Known key problems	3	No water quality issues are anticipated in the catchment.
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		Not required
	• Future trends		Not required

	• Source / investigation (e.g. hot spots)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	49 (of 75)	



Stormwater Reticulation Network

Hutt Main

- Bathing Water Quality Sites
- Sewer Overflows
- Sewer Main Trunk
- State of the Environment Monitoring
- Stormwater Outlet
- Stormwater Pipes
- Catchment
- Open Channels

N

1:56,920

0 630 1,260 1,890 2,520 3,150 m

Wellington Water

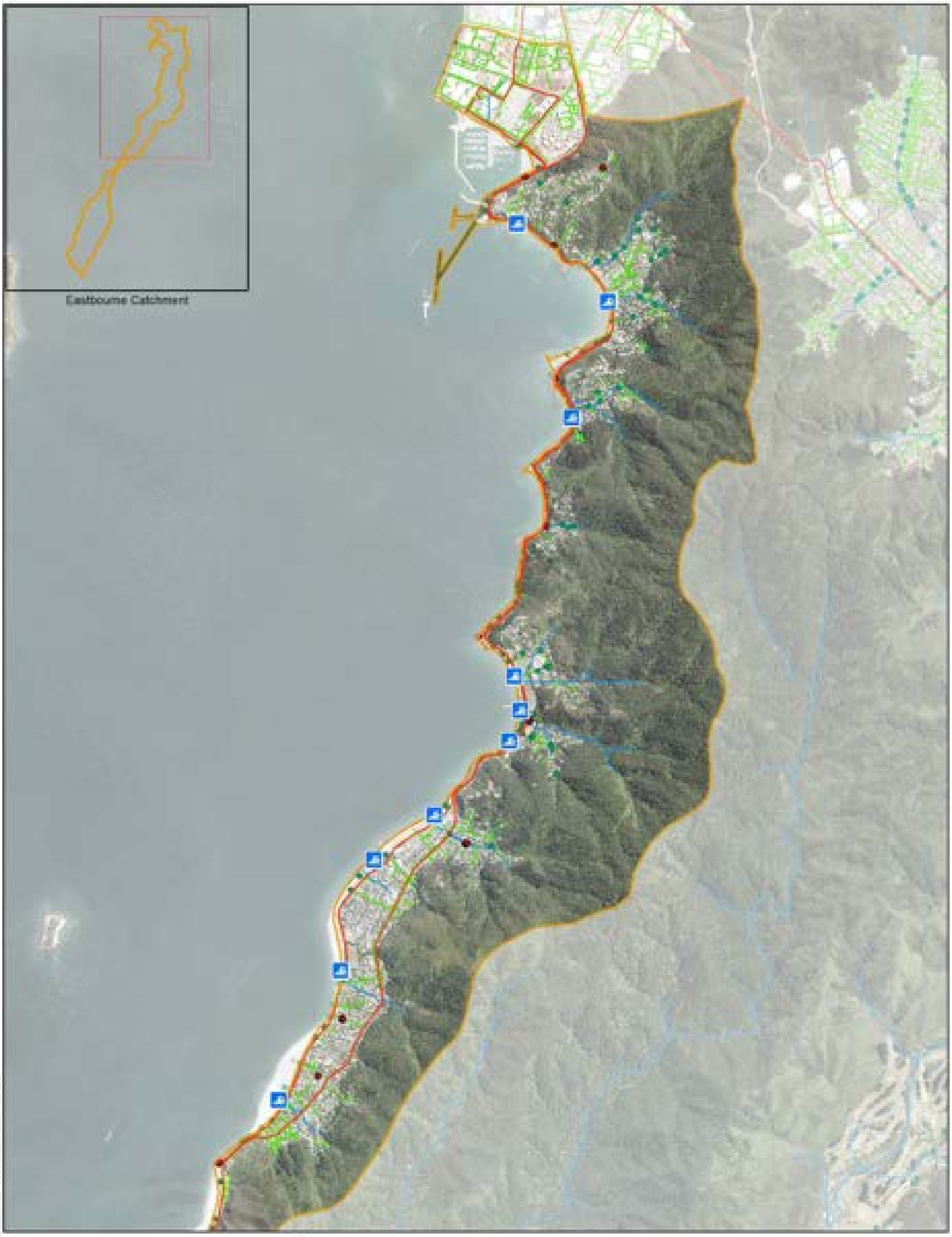
19. Hutt – Pakuratahi

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/**	90%	
2	**Characterise**		
a)	Network	5	The total public stormwater length is 0m and the total area served by the network is estimated at 0.00 km². There is no stormwater network in the catchment.
b)	Land use characterisation	4	The total catchment area is 81.4 km² of which less than 0.01% is served by a stormwater network and less than 0.01% is impervious surface. The catchment is almost entirely open space with 79.9% of land cover in indigenous forest and scrub, 6.7% in exotic forest, 13% pasture and <0.01% urban.
c)	Contaminant sources	4	Catchment-wide sources are dominated by runoff from regenerating forest, plantation forest, pasture and scrub. They include soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. There are no constructed wastewater overflows in the catchment. Significant contaminant sources are not anticipated.
d)	Volume/loads	1	Contaminant load modelling predictions are not available
e)	Receiving environment		
	i. Nature	3.5	The Pakuratahi River flows into the Hutt River at Kaitoke north of Upper Hutt. It is situated on the northern part of the Rimutaka Range adjacent to the Mangaroa catchment. It drains a steep catchment with a predominant land cover of indigenous forest and scrub with some production pasture and pine production forestry.
	ii. Values	3.5	Schedule F1 of the PNRP identifies the Pakuratahi River as a watercourses with significant indigenous ecosystem values including high macroinvertebrate community health and habitat for indigenous threatened or at risk fish
	iii. State and trends		
	• Hydrology	4	The hydrology of the Pakuratahi River is well characterised.
	• Freshwater ecology	4	RSoE invertebrate survey results indicate "good/excellent" quality invertebrate community in the lower Pakuratahi River (QMCI = 6.15, %EPT taxa = 42, Taxa richness = 26) which has been slightly affected by agricultural development in the catchment. Fish species recorded in the Pakuratahi River include bluegill bully, Cran's bully, dwarf galaxias, koaro, longfin eel, redfin bully, shortfin eel and upland bully.
	• Coastal/ estuarine ecology	3	Not applicable
	• Sediment quality	1	Sediment quality information is not available
	• General coastal water quality	3	Not applicable
	• General freshwater quality	4	The GWRC RSoE site located on the lower Pakuratahi River near Farm Creek had a 'fair' WQI grade for the 2015/2016 year and was ranked 35th out of 53 sites in the Wellington Region.
	• Contact recreation (micro.)	4	GWRC recreational water quality monitoring for the 2015/16 bathing season resulted in a suitability for recreation grade (SFRG) of "Good" in the Pakuratahi River at Hutt Forks
	• Monitoring (historic and current)	4	• Ongoing monthly RSoE monitoring at 1 site on the Pakuratahi Rover • Ongoing recreational water quality monitoring at 1 site on the Pakuratahi River
	• Known problems	4	No known water quality issues or problems
3	**Identify gaps**		
a)	Source/network		Well characterised
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		Not required
	• Future trends		Not required
	• Source / investigation		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	52	

20. Eastbourne & the eastern bays

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information/data**	90%	
2	**Characterise**		
a)	Network	2.5	The Eastbourne 'catchment' extends from Point Howard to beyond Burdens Gate. It includes Sorrento Bay, Lowry Bay, York Bay, Mahina Bay, Sunshine Bay, Days Bay, Rona Bay and Robinsons Bay. The stormwater system was constructed from the 1920's onwards. The total public stormwater length is 20 km. The remaining length of open stream channel has not been calculated.
b)	Land use characterisation	3	The total catchment area is 15 km² of which 23% is served by a stormwater network and 20% is impervious surface. Land-use in the Eastbourne catchment is mostly open space, predominantly indigenous forest on the eastern hills behind the residential area.
c)	Contaminant sources	3	Catchment-wide sources are dominated by runoff from the forested hills. Contaminant sources within the urban area are minor and include roofs and other building materials found in residential land, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source, but traffic volumes are relatively low. Ten constructed wastewater overflows are located in the catchment. In addition the main outfall pipeline from the Seaview Wastewater Treatment Plant that runs along the eastern bays is fitted with scour valves at low points along the route so that the pipeline can be emptied, if required, for maintenance works. Significant contaminant sources are not anticipated.
d)	Volume/loads	1	Contaminant load modelling predictions are not available
e)	Receiving environment		
	i. Nature	3.5	The Eastbourne 'catchment' consists of series of minor watercourses running off the hills to the eastern bays. The most significant of these is the Days Bay Stream. The eastern bays include sandy beaches and rocky shores. Moderately sheltered and sheltered rocky reef habitat is found on outcrops between Pt Howard and Eastbourne, with firm sandy beaches and gravel field at Lowry Bay, York Bay, Mahina Bay, Days and Eastbourne. South of Eastbourne, the rocky reef is moderately exposed, becoming very exposed south of Inconstant Point.
	ii. Values	4	Sorrento Bay is a small sandy beach located near Point Howard that is popular for sunbathing and swimming. No facilities are present at this site. Lowry Bay is a narrow gravel beach bounded by rocky outcrops. The road runs alongside the beach and while there are no facilities in the immediate area, parking and a boat ramp can be found at the southern end of the beach. York Bay is a sandy beach nestled between two rocky outcrops. It is popular for walking but not often used for swimming, and has not facilities. Days Bay is a sandy beach popular with swimmers and walkers. Parking toilets and changing facilities are located at the beach front while a café and parks are situated across the road. Sand and pebble beaches are found at Rona and Robinsons Bay adjacent to Eastbourne. Parks, toilets, and changing facilities are located at several locations along this long strip of beach, making this popular for bathing and walking. Wellington Harbour (including the Hutt/Waiwhetu estuary) is identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region. Schedule F1 of the PNRP identifies the Days Bay Stream as a watercourse with habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The east harbour coast is identified in as a site of significance in C4 for mahinga kai values
	iii. State and trends		
	• Hydrology	2	Limited hydrology information is available for the eastern bays.
	• Freshwater ecology	1	Benthic ecology information is not available for Days Bay Stream. Fish species recorded in the Days Bay Stream include banded kokopu, bluegill bully, inanga, koaro, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.
	• Coastal/ estuarine ecology	4	The shallow sub tidal, soft sediments of Lowry Bay provide habitat for bivalves such as cockles, pipi, clams (*Cylomactra*) and wedge shells. Further south mussels are found on rocky outcrops, while scallops occurs in deeper sub tidal waters. In a broad scale habitat assessment of intertidal habitats along the eastern bays McMertrie & Brennan (2016) found a total of 36 invertebrate taxa, with the snails *Melagraphia* (Diloma) *aethiops*, *D. nigerrima* and the

			porcelain crab *Petrolisthes elongates* the most widespread taxa. Based on density data the community was dominated by the columnar barnacle *Chamaesipho columna*, with the snails *D aethiops*, *D nigerrima*, and *Austrolittorina antipodum* the only other species representing more than 1% of total abundance. McMertrie & Brennan (2016) concluded that the community composition of the surveyed area was as expected for this general location and rocky shore habitat, and is similar to the rocky shore communities found elsewhere in Wellington Harbour. No taxa that are indicative of significant nutrient enrichment or fine sediment input were present in any great abundance, with exposure and substrate seeming to be the main factors influencing the communities of this area.
	• Sediment quality	3	Sediment chemistry surveys conducted by Stevens, *et al* (2004) indicated that Lowry Bay is relatively free of contaminants. Metal concentrations were very low and do not indicate contamination of the nearshore sediments. Wellington's harbour marine sediment quality investigations conducted by GWRC in 2006 and 2011 (Stephenson et al 2008, Milne 2010, and Oliver 2014) found that site WH17 located offshore of Eastbourne was probably the least contaminated site in the survey. None of the metals, PAH or other organic contaminants tested exceeded sediment quality guidelines at that location.
	• General coastal water quality	1	No general water quality data, except microbiological data, are available for coastal waters along the eastern bays.
	• General freshwater quality	1	No general water quality data are available for freshwater streams in the eastern bays.
	• Contact recreation (micro.)	4.5	During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Fair" at Sorrento Bay and Lowry Bay, "Good" at York Bay and three sites on Days Bay, "Fair" at two sites on Rona Bay and "Good" at adjacent to the HWS Recreation Ground and Nikau Street.
	• Monitoring (historic and current)	3	• Ongoing routine recreational water quality monitoring at ten locations within the Eastbourne catchment.
	• Known key problems	3	No known water quality issues or problems.
3	**Identify gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of monthly RSoE monitoring at the Riverstone site; 2. **Continuation** of recreational water quality monitoring at 1 site.
	• Future trends		3. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Source / investigation (e.g. hot spot)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	**39.5**	

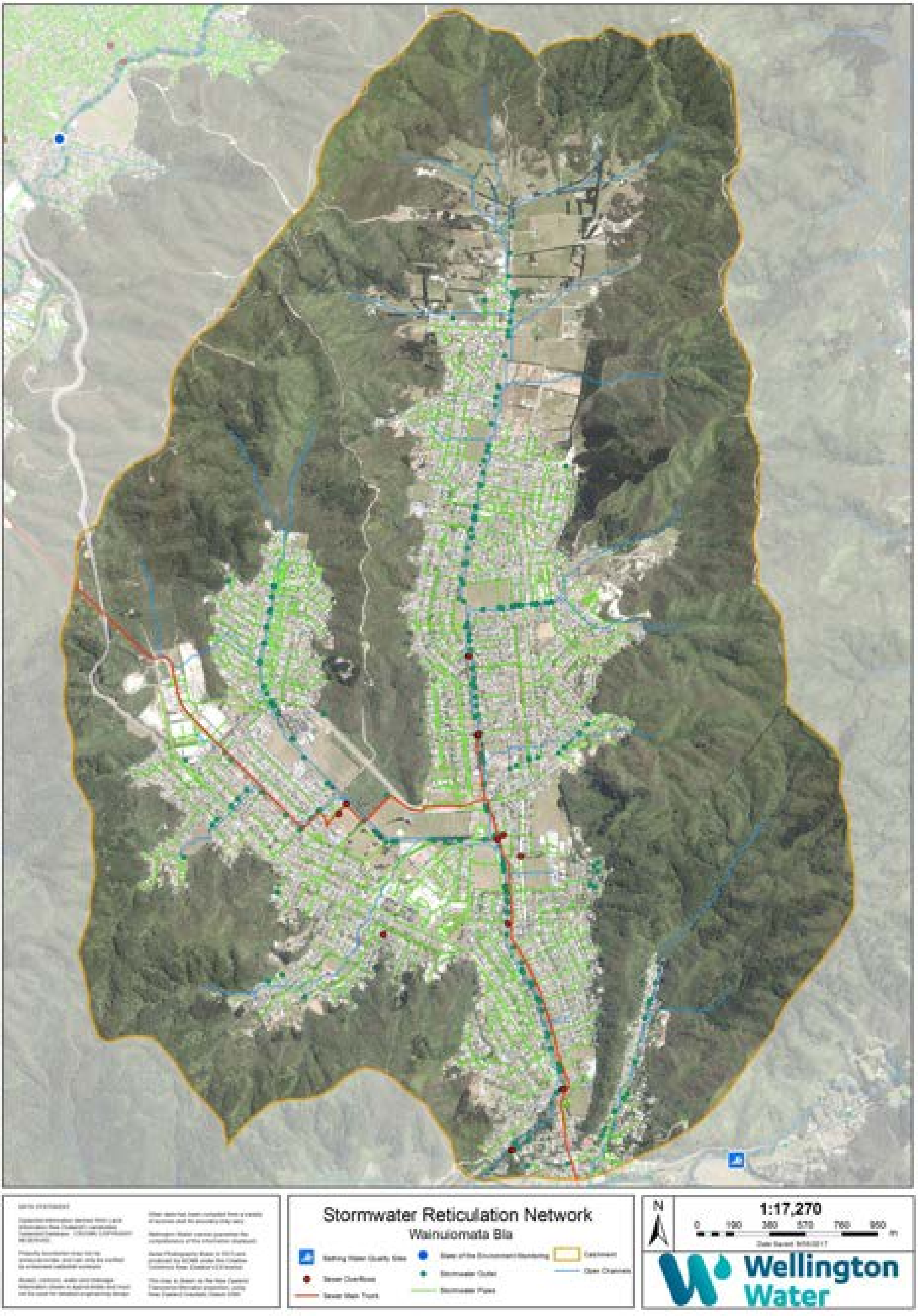


Stormwater Reticulation Network
Eastbourne

21. Wainuiomata

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	3	The urban area of Wainuiomata is concentrated in the Black Creek sub-catchment at northern end of the Wainuiomata catchment. The stormwater network developed from the 1950's onwards when Wainuiomata was developed as a residential suburb. The total public stormwater length is 91 km, 78 km of which is located in the Black Creek sub catchment.
b)	Land use characterisation	3	The total catchment area is 133 km², 7.5% of which is served by a stormwater network. Approximately 77% of the catchment land cover is indigenous forest and scrub, 3.7% is exotic forest, 10.4% is pasture and 6.3% is urban. The urban area is concentrated in the Black Creek sub-catchment which has a total area of 18.5 km² of which 44% is served by a stormwater network and 33% is impervious. The Black Creek sub-catchment is predominantly residential and light commercial. Traffic volumes are light to moderate.
c)	Contaminant sources	3	Catchment-wide sources are dominated by runoff from indigenous forest, scrub and low production pasture. These include soil disturbance by erosion during flood events, and wild animals. Within the Black Creek sub-catchment contaminant sources include roofs and other building materials found in residential land. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source. Sewage contamination of stormwater can occur through cross-connections, and from leaking sewerage pipes. Ten constructed wastewater overflows are identified in the catchment, 8 of which are in the Black Creek sub-catchment. Contamination hot spots include the wastewater overflows and Wainuiomata Landfill.
d)	Volume/loads	1	Contaminant load modelling predictions are not available
e)	Receiving environment		
	i. Nature	3.5	The Wainuiomata River originates in a native forest catchment of the south western Rimutaka Ranges, and flows southwest for a distance of approximately 35km, eventually discharging into Cook Strait east of Bearing Head. The Wainuiomata catchment shares a drainage divide with the Orongorongo catchment where elevations reach 800m in altitude. The catchment has a hard-sedimentary geology. While the upper catchment is steep the river bed gradient is fairly uniform downstream of the Wainuiomata Water Treatment Plant, dropping 5m per km in the upper part of the Wainuiomata Valley, then flattening to 2m per km over the last few km above the coast.
	ii. Values	3	Schedule F1 of the PNRP identifies the Wainuiomata River and all of its tributaries above and Black Creek as a watercourses with significant indigenous ecosystem values including high macroinvertebrate community health, habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The PNRP also identifies Wainuiomata River as providing indigenous bird habitat (F2), significant biodiversity values (F4), regionally significant primary contact recreation (H1), and important trout habitat (I1)
	iii. State and trends		
	• Hydrology	4	Wainuiomata River hydrology is well characterised
	• Freshwater ecology	4	RSoE invertebrate survey results together with the results of surveys conducted for HCC (Cameron, 2015), show "excellent" invertebrate community quality at the upstream reference site within the forested catchment, declining sharply to "fair" quality at the Main Road Bridge where the predominant land cover types are low production pasture and light residential. The invertebrate community composition remains relatively unchanged through the middle and lower reaches of the river where the dominant land-cover types are scrub and low production pasture. Black Creek, immediately downstream of the urban area, has a "poor" quality invertebrate community, reflecting the influence of urban stormwater discharges and reduce habitat quality. Nevertheless, stormwater inflows to the Wainuiomata River via Black have not had a measurable effect on invertebrate community composition of the river. KML (2005) surveyed invertebrate communities on Black Creek at one site above the urban area (BU) and one below it (BL). Metric scores for those location show a sharp decline that can be attributed to decreases in both habitat quality and water quality associated with the urban area. Fish species recorded in the Wainuiomata River include banded kokopu, bluegill bully, common bully, dwarf galaxias, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully, shortfin eel and shortjaw kokopu.
	• Coastal/ estuarine ecology	1	Coastal ecology information is not available.
	• Sediment quality	3	Milne & Watts (2008) included a monitoring site on the lower reach of Black Creek at Rowe Road. The results for 2005 show relatively low concentration of dissolved metals and no exceedance of concentrations of ISQC-Low trigger, except for DDT which was elevated at almost all stream sites.

	• General coastal water quality	1	Coastal water quality information is not available.
	• General freshwater quality	3.5	The GWRC RSoE sites located on the upper Wainuiomata River near Manuka Track and lower river near the coast both had a 'good' WQI grade for the 2015/2016 year and were ranked 25th and 27th out of 53 sites in the Wellington Region. Median and maximum E. coli values for the 2015/16 monitoring year were 4 and 15 cfu/100ml, respectively at Manuka Track, increasing to 75 and 390 cfu/100ml, respectively on the lower river. HCC microbiological monitoring at Moohan Street on Black Creek between 1995 and 2016 (n= 42) had a median *E. coli* value of 402 cfu/100ml and a maximum value of 6800 cfu/100ml.
	• Contact recreation (micro.)	3.5	Recreational water quality monitoring conducted in the Wainuiomata River at Richard Prouse Park for the 2015/16 year gave a "Poor" SFRG. The "action" trigger was exceeded on 1 occasion during the bathing season.
	• Monitoring (historic and current)	3.5	• Ongoing monthly RSoE monitoring at 2 sites on the Wainuiomata River; • Ongoing recreational water quality monitoring at 1 site on the Wainuiomata River; • HCC monthly monitoring at 2 sites on Black Creek and 3 sites on the Wainuiomata River
	• Known problems	3.5	Wet weather wastewater overflows to stormwater network and streams
3	**Identify knowledge gaps**		
a)	Source/network		Characterisation of wastewater overflows (location, frequency, flow rate, duration).
b)	Values		Well characterised
c)	Receiving environment state		Freshwater habitats not well characterised on Black Creek.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of monthly RSoE monitoring at 2 sites on the Wainuiomata River 2. **Continuation** recreational water quality monitoring at 1 site on the Wainuiomata River; 3. **Establish** one temporary RSoE site on the lower reaches of Black Creek (including Cu and Z). Monitor for at least 2 years
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		4. **New investigation**: Identify and remedy sources of stormwater contamination, including Cu and Zn, and investigate mitigation options.
	• Effectiveness of existing solutions		Not required
	Total Score	**43.5**	



Stormwater Reticulation Network
Wainuiomata Bla
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:17,270
0 190 380 570 760 950 m
Wellington Water

22. Taupo

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	3	The Taupo Stream catchment contains parts of Plimmerton and SH1 to the north of Porirua City centre. The drainage area extends from near Pukerua Bay to Plimmerton Beach. It covers an area of 10.6 km2, of which an estimated 12% is impervious. The catchment contains Taupo Swamp which is a nationally significant flax wetland and one of the most import flax swamps in the Wellington region. The stormwater network occupies a small area at the southern end of the catchment. It was constructed from 1945 onwards. The total stormwater pipe length is 5.9 km.
b)	Land use characterisation	3	The total catchment area is 10.6 km^2 of which 7.4% is served by a stormwater network and 12% is impervious surface. The catchment is predominantly pasture, scrub and regenerating indigenous forest.
c)	Contaminant sources	3	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance, vegetation, wild and domestic animals. In addition, as State Highway 1 runs through the catchment for a distance of 6.5 km, vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source.
d)	Volume/loads	1	Contaminant load modelling predictions are not available
e)	Receiving environment		
	i. Nature	3	The Taupo Stream is a minor watercourse which passes through a predominantly agricultural catchment, discharging to the coast at Plimmerton Beach
	ii. Values	3	Schedule B of the PNRP lists the Taupo swamp as a taonga by mana whenua iwi in the Wellington region. Schedule F1 of the PNRP identifies the Taupo Stream as a watercourse with significant indigenous ecosystem values including habitat for indigenous threatened or at risk fish, habitat for more than six species of indigenous fish and inanga spawning habitat. Schedule F4 identifies the Taupo Estuary as a site with significant biodiversity value (providing passage for migratory fish).
	iii. State and trends		
	• Hydrology	4	The hydrology of Taupo Stream is well characterised.
	• Freshwater ecology	2	The fish species recorded in Taupo Stream include banded kokopu, giant kokopu, inanga, longfin eel, redfin bully and shortfin eel.
	• Coastal/ estuarine ecology	1	Coastal ecology information is not available.
	• Sediment quality	1	Sediment quality information is not available.
	• General coastal water quality	1	General coastal water quality information is not available
	• General freshwater quality	3	PCC monthly monitoring for a suite of parameters between November 2011 and June 2014 indicated elevated levels of dissolved reactive phosphorus in Taupo Stream, while metal concentrations were consistently low with no exceedence of 95% protection trigger values (Milne & Morar, 2017).
	• Contact recreation (micro.)	3.5	Regular monthly monitoring of *E. coli* bacteria conducted by PCC from January 2015 to August 2016 gave a median value of 350 cfu/100ml and a maximum of 23,000 cfu/100ml. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100ml). Recreational water quality monitoring conducted at Plimmerton Beach resulted in a "Poor" suitability for recreation grade (SFRG) for the 2015/16 bathing season.
	• Monitoring (historic and current)	3	• Ongoing microbiological monitoring by PCC at 1 site on Taupo Stream; • Ongoing recreational water quality monitoring at 2 sites on Plimmerton Beach
	• Known key problems	3	Occasional elevated indicator bacteria concentration in Taupo Stream and Plimmerton Beach.
3	**Identify knowledge gaps**		
a)	Source/network		Wastewater overflows/ leaks
b)	Values		Well characterised
c)	Receiving environment state		No freshwater of coastal aquatic ecology information
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring at 2 sites on Plimmerton Beach

			2. **Establish** one temporary RSoE site on the lower reaches of Taupo Stream; monitoring all standard RSoE parameters plus Cu and Zn.
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		3. **Investigate and remedy** and causes of wastewater overflows or leaks to the stormwater system or Taupo Stream.
	• Effectiveness of existing solutions		Not required
	Total Score	37.5	


Stormwater Reticulation Network
Taupo
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:15,420
0 170 340 510 680 850 m
Wellington Water

23. Kakaho

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	3	The Kakaho Stream catchment lies to the northwest of Porirua City. The drainage area extends from the western side of the Paekakariki Hill to the Pauatahanui Inlet. The stormwater network was constructed from 1945 onwards. The total public stormwater length is 14 km.
b)	Land use characterisation	3	The total catchment area is 14.76 km2 of which 10% is served by a stormwater network and 8% is impervious surface. The catchment is predominantly in production pasture but contains area of regenerating indigenous vegetation and pine plantation, as well as most of urban Camborne.
c)	Contaminant sources	3.5	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance, vegetation as well as wild and domestic animals. There are no constructed wastewater overflows in the catchment.
d)	Volume/loads	1	Sediment loads have been modelled for the Porirua Harbour catchments, but no information is available for metal or PAH loads.
e)	Receiving environment		
	i. Nature	3	The Kakaho Stream has been modified by agricultural development which has removed most of the indigenous vegetation from the catchment.
	ii. Values	3.5	Schedule A of the PNRP identifies the tidal flats of Pauatahanui Inlet as an outstanding water body. Schedule B of the PNRP identifies Pauatahanui Inlet as a taonga by mana whenua iwi in the Wellington region. In addition, many locations around the harbour are identified in Schedule C of PNRP as sites with significant mana whenua values. Schedule F1 of the PNRP identifies Kakaho Stream as a watercourse with significant indigenous values including habitat for more than six species of indigenous fish, and as inanga spawning habitat. Schedule F2 identifies the Pauatahanui Inlet as providing significant habitat for indigenous birds.
	iii. State and trends		
	• Hydrology	2	Little hydrology information available.
	• Freshwater ecology	2	The fish species recorded in Kakaho Stream include banded kokopu, common bully, common smelt, giant bully, grey mullet, inanga, longfin eel, redfin bully and shortfin eel.
	• Coastal/ estuarine ecology	4	Saltmarsh occupies 51ha in the Pauatahanui Arm where it is dominated by wide beds of rushland (mostly searush and jointed wire rush) which, as the terrestrial influence increased, transitioned through areas dominated by saltmarsh ribbonwood and grassland (mostly tall fescue). Area of seagrass are relatively extensive, 41.2ha in the Pauatanui Arm. MacDiarmid, et al., (2012) identified Porirua Harbour as a site of significance for marine biodiversity. The authors noted that New Zealand's shallow harbours and estuaries are important centres of diversity for shore and wading birds, coastal fish and invertebrates, as well as a variety of marine algae and flowering plants such as seagrass and saltmarsh species. Harbours and estuaries are key breeding, nursery and foraging areas for many species. Porirua Harbour is typical in this general sense but because of the limited size of most estuaries within the Wellington region the biodiversity value of Porirua Harbour is considerably elevated. Blaschke et al. (2010) recently reviewed the available information on the benthic communities in Porirua Harbour. They concluded that of the macro-faunal species, polychaete worms dominated numerically (>50%), then bivalve molluscs, crustaceans, and gastropod molluscs. Stevens and Robertson (2008) described this as 'unbalanced' as it was dominated by species tolerant of moderate sedimentation and enrichment. However, because of its size and moderately healthy status, the Porirua Harbour is likely to be the most significant area for estuarine invertebrates in the Wellington region. In relation to the GWRC sub tidal sediment surveys, Oliver and Conwell (2014) concluded that "there is currently no clear evidence that any of the sub tidal sediment contamination has resulted in significant adverse effects on invertebrate communities, however, the combination of heavy metals, mud and organic carbon content at some sites, is linked with less diverse community structure. Adverse effects may eventuate as long as stormwater discharges continue in their present form and contaminants continue to accumulate in the harbour sediments."
	• Sediment quality	4	Sediment quality information is not available for Kakaho Stream. Oliver & Conwell (2014) reported that sediments in the Pauatahanui Inlet have a lower proportion of mud and lower levels of total organic carbon

			(TOC) relative to sediments in the Onepoto Inlet. Consistent with earlier surveys total metal concentrations (Cu, Pb, Zn, Hg, As, Cd, Cr, Ni, Ag) were all below early warning guideline levels (i.e., ARC ERC or ANZECC ISQG-Low). TOC-normalised total DDT and Dieldrin exceeded the ANZECC ISQG-Low trigger values at all sites.
	• General coastal water quality	1	General coastal water quality information is not available for Pauatahanui Inlet
	• General freshwater quality	1	General fresh water quality information is not available for Kakaho Stream.
	• Contact recreation (micro.)	3	Two sites in the Pauatahanui Inlet are monitored as part of the GWRC recreational water quality monitoring programme. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Fair" at the Water Ski Club and "Good" at Paremata Bridge. No "alert" or "action" triggers were recorded during the 2015/16 bathing season.
	• Monitoring (historic and current)	3	• No routine water quality monitoring is conducted in Kakaho Stream; • Ongoing recreational water quality at 2 sites in the Pauatahanui Inlet.
	• Known key problems	3	No known issues for this catchment.
3	**Identify knowledge gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Little information of the general water quality or aquatic ecology of Kakaho Stream.
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring at 2 sites on Pauatahanui Inlet
	• Future trends		Not required
	• Source / investigation (e.g. hot spot)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	**40**	

Stormwater Reticulation Network

Kakaho

- Bathing Water Quality Sites
- Sewer Overflows
- Sewer Main Trunk
- State of the Environment Monitoring
- Stormwater Outlet
- Stormwater Pipes
- Catchment
- Open Channels

N

1:21,980

0 240 480 720 960 1,200 m

Wellington Water

24. Horokiri

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	100%	
2	**Characterise**		
a)	Network	5	The Horokiri Stream catchment lies to the northwest of Porirua City. The drainage area extends from the Wainui saddle (at around 500m a.s.l) to the Pauatahanui Inlet, draining from north to south into the Inlet. There is no significant stormwater network in the Horokiri catchment; the total public stormwater length is 0 m.
b)	Land use characterisation	4	The total catchment area is 41 km^2 of which an estimated 0.6% is impervious surface. None of the catchment is served by a stormwater network.
c)	Contaminant sources	4	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance, vegetation as well as wild and domestic animals. There are no constructed wastewater overflows in the catchment.
d)	Volume/loads	3	Sediment loads have been modelled for the Porirua Harbour catchments, but no information is available for metal or PAH loads.
e)	Receiving environment		
	i. Nature	3	The Horokiri Stream runs through a catchment dominated by low production grazing pasture and exotic forestry, with no significant urban land-cover. The stream discharges to the head of the Pauatahanui Inlet
	ii. Values	3.5	Schedule F1 of the PNRP identifies Horokiri Stream as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, habitat for more than six species of indigenous fish, and for inanga spawning. Schedule A of the PNRP identifies the tidal flats of Pauatahanui Inlet as an outstanding water body. Schedule B of the PNRP identifies Pauatahanui Inlet as a taonga by mana whenua iwi in the Wellington region. In addition, many locations around the harbour are identified in Schedule C of PNRP as sites with significant mana whenua values.
	iii. State and trends		
	• Hydrology	3	Very limited hydrology information is available for Horokiri Stream.
	• Freshwater ecology	3.5	RSoE invertebrate survey results indicate "good" quality invertebrate community in the Horokiri Stream (QMCI = 5.98, %EPT taxa = 52, Taxa richness = 23) which has been slightly affected by agricultural development in the catchment. Boffa Miskell (2011) found that the aquatic ecology values of the Horokiri Stream were regionally significant, being high in terms of invertebrates and fish and moderate in term of habitat quality. KMA (2005) reported "fair" invertebrate community quality in the lower reaches of the stream (MCI = 87, QMCI = 4.2, %EPT taxa = 31.7, Taxa richness = 20). Fish species recorded include banded kokopu, black flounder, common bully, common smelt, giant bully, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully, shortfin eel, shortjaw kokopu and torrentfish.
	• Coastal/ estuarine ecology	3.5	The aquatic ecology of the Pauatahanui Inlet is as described for the Kakaho Stream.
	• Sediment quality	3.5	Streambed sediments sampled at Horokiri Stream in 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Total DDT (Milne & Watts, 2008). No other trigger values were exceeded at this site. The aquatic ecology of the Pauatahanui Inlet is as described for the Kakaho Stream.
	• General coastal water quality	0	General coastal water quality, except microbiological water quality, is not available for the Pauatahanui Inlet
	• General freshwater quality	3.5	The GWRC RSoE site located on the Horokiri Stream had a 'fair' WQI grade for the 2015/2016 year and was ranked 34th out of 53 sites in the Wellington Region. Water quality did not met GWRC guideline criteria for *E. coli* or nitrate/nitrite nitrogen, but did achieve guidelines for dissolved oxygen, visual clarity, ammoniacal nitrogen and dissolved reactive phosphorus.
	• Contact recreation (micro.)	4	Horokiri Stream median and maximum *E. coli* values for the 2015/16 monitoring year were 300 and 1,100 cfu/100ml, respectively. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100ml). Two sites in the Pauatahanui Inlet are monitored as part of the GWRC recreational water quality monitoring programme. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Fair" at the Water Ski Club and "Good" at Paremata Bridge. No "alert" or "action" triggers were recorded during the 2015/16 bathing season.
	• Monitoring (historic and current)	4	• Ongoing RSoE monitoring at one site on Horokiri Stream; • Ongoing recreational water quality monitoring at 2 sites on the Pauatahanui Inlet.
	• Known problems	4	No known issues or problems

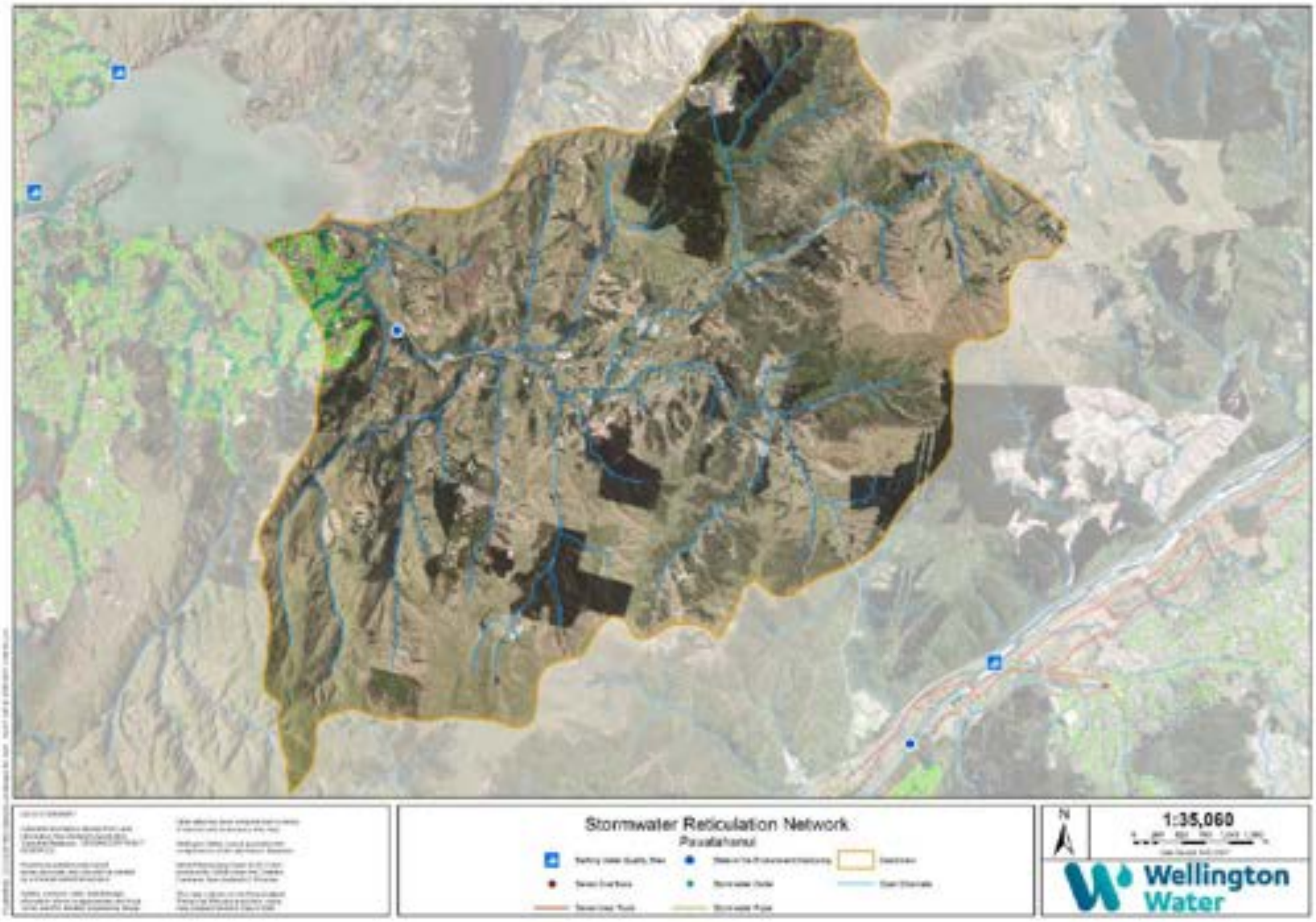
3	**Identify knowledge gaps**		
a)	Source/network		Well characterised
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		Not required
	• State of receiving environment		Not required
	• Future trends		Not required
	• Source / investigation (e.g. hot spots)		Not required
	• Effectiveness of existing solutions		Not required
	Total Score	**51.5**	


Stormwater Reticulation Network
Horokiri
N
1:31,500
0 350 700 1,050 1,400 1,750
m

25. Pauatahanui

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	3.5	The Pauatahanui Stream catchment lies to the east of Cannons Creek and Whitby. The drainage area extends from the western face of Haywards Hill to the eastern end of the Pauatahanui Inlet. The stormwater network was constructed from 1945 onwards, mostly in the 1950s, 60s and 70s. The total public stormwater length is 13.5 km. The remaining length of open channel stream has not been calculated but has not been greatly affected by development of the stormwater network.
b)	Land use characterisation	3.5	The total catchment area is 41.6 km² of which nearly 3% is served by a stormwater network and nearly 5% is impervious surface. Approximately 16% of the catchment land-cover is indigenous forest and scrub, 12% is exotic forest, 69% is grazing pasture and 3% is urban.
c)	Contaminant sources	3.5	Catchment-wide sources are dominated by runoff from pasture and scrub. They include soil disturbance, vegetation as well as wild and domestic animals. As State Highway 56 runs through the catchment, vehicles (tyres, brake linings, oil leakage, exhaust) are a secondary generic source. There are no constructed sewer overflows in the Pauatahanui catchment
d)	Volume/loads	2	Sediment loads have been modelled for the Porirua Harbour catchments, but no information is available for metal or PAH loads.
e)	Receiving environment		
	i. Nature	3	The Pauatahanui Stream runs through a catchment dominated by low production grazing pasture and exotic forestry. The stream discharges to the head of the Pauatahanui Inlet
	ii. Values	3.5	Schedule F1 of the PNRP identifies Pauatahanui Stream as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, habitat for more than six species of indigenous fish, as well as inanga spawning habitat. Schedule A of the PNRP identifies the tidal flats of Pauatahanui Inlet as an outstanding water body. Schedule B of the PNRP identifies Pauatahanui Inlet as a taonga by mana whenua iwi in the Wellington region. In addition, many locations around the harbour are identified in Schedule C of PNRP as sites with significant mana whenua values. Schedule F4 identifies the Pauatahanui Wildlife Reserve as a site with significant biodiversity value (saltmarsh and bird habitat).
	iii. State and trends		
	• Hydrology	2	The hydrology of Pauatahanui Stream is not well characterised.
	• Freshwater ecology	4	RSoE invertebrate survey results indicate "fair" quality invertebrate community in the Pauatahanui Stream (QMCI = 4.04, %EPT taxa = 33, Taxa richness = 27) which has been significantly affected by agricultural development in the catchment. Boffa Miskell (2011) found that the aquatic ecology values of the lower Pauatahanui Stream were high for fish, moderate for aquatic invertebrates and low for habitat quality. Fish species recorded in the Pauatahanui Stream include banded kokopu, common bully, common smelt, giant kokopu, inanga, lamprey, longfin eel, redfin bully and shortfin eel.
	• Coastal/ estuarine ecology	4	The aquatic ecology of the Pauatahanui Inlet is as described above for the Kakaho Stream.
	• Sediment quality	4	The sediment quality of the Pauatahanui Inlet is as described for the Kakaho Stream.
	• General coastal water quality	0	General coastal water quality, except for microbiological water quality, is not available.
	• General freshwater quality	3.5	The GWRC RSoE site located on the Pauatahanui Stream had a 'fair' WQI grade for the 2015/2016 year and was ranked 36th out of 53 sites in the Wellington Region. Water quality did not met GWRC guideline criteria for *E. coli* or dissolved reactive phosphorus, but did achieve guidelines for dissolved oxygen, visual clarity, ammoniacal nitrogen and nitrate/nitrite nitrogen.
	• Contact recreation (micro.)	3.5	Median and maximum *E. coli* values for the 2015/16 monitoring year were 205 and 430 cfu/100ml, respectively, indicating a low level of faecal contamination. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100ml). Two sites in the Pauatahanui Inlet are monitored as part of the GWRC recreational water quality monitoring programme. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Fair" at the Water Ski Club and "Good" at Paremata Bridge. No "alert" or "action" triggers were recorded during the 2015/16 bathing season.
	• Monitoring (historic and current)	3.5	• Ongoing monthly RSoE monitoring at 1 site on the Pauatahanui Stream • Ongoing recreational water quality monitoring at 2 sites on Pauatahanui Inlet

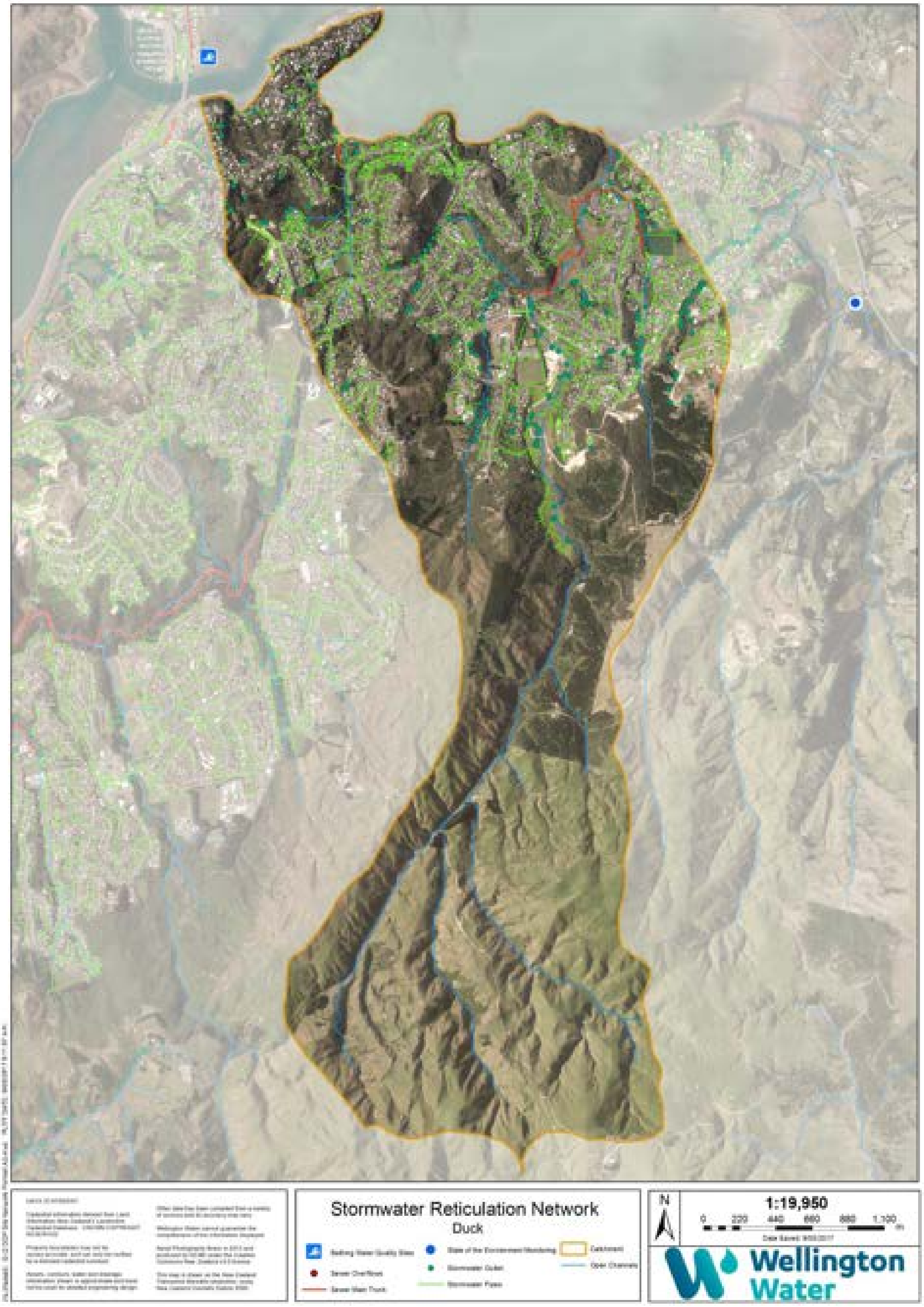
			• Porirua Harbour sediment quality and benthic biota surveys on Pauatahanui Inlet at approximately 3 year intervals.
	• Known problems	3.5	No known stormwater related issues
3	**Identify knowledge gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Well characterised
c)	Receiving environment state		Well characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of monthly RSoE monitoring at 1 site on Pauatahanui Stream 2. **Continuation** of Porirua Harbour sediment quality and benthic biota surveys on Pauatahanui Inlet at approximately 5 year intervals
	• Future trends		
	• Source / investigation (e.g. hot spots)		3. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Effectiveness of existing solutions		Not required
	Total Score	**45**	



26. Duck/Browns

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	90%	
2	**Characterise**		
a)	Network	3.5	The Duck Creek/Browns Creek catchment lies to the south of the Pauatahanui Inlet. The drainage area extends from the northern face of Round Knob, through Whitby to the southern side of the Pauatahanui Inlet. The stormwater network was mostly constructed in the 1980s, 1990s and 2000s. The total public stormwater network length is 64 km. The remaining length of open channel stream in the catchment is not known.
b)	Land use characterisation	3	The total catchment area is 12 km² of which 44% is served by a stormwater network and an estimated 34% is impervious surface. The catchment is predominantly in pine plantation, scrub and low production pasture, and also contains much of urban Whitby.
c)	Contaminant sources	3.5	Catchment-wide sources include roofs and other building materials found in residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a significant generic source. There are no constructed wastewater overflow in the catchment. No significant contaminant sources are anticipated.
d)	Volume/loads	2	Sediment loads have been modelled for the Porirua Harbour catchments, but no information is available for metal or PAH loads.
e)	Receiving environment		
	i. Nature	3.5	Duck Creek runs through a catchment dominated by low production grazing pasture and exotic forestry in its upper reaches and urban Whitby in its lower reaches. The creek discharges to the southern site of the Pauatahanui Inlet.
	ii. Values	4	Schedule F1 of the PNRP identifies Duck Creek as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reach has potential to provide inanga spawning habitat. Schedule F4 identifies the Duck Estuary as a site with significant biodiversity value (providing passage for migratory fish). Schedule A of the PNRP identifies the tidal flats of Pauatahanui Inlet as an outstanding water body. Schedule B of the PNRP identifies Pauatahanui Inlet as a taonga by mana whenua iwi in the Wellington region. In addition, many locations around the harbour are identified in Schedule C of PNRP as sites with significant mana whenua values.
	iii. State and trends		
	• Hydrology	2	The hydrology of Duck Creek is not well characterised.
	• Freshwater ecology	3.5	Boffa Miskell (2011) assessed the aquatic ecology values of the Duck Creek as being regionally significant, especially in the middle reaches where they were high for invertebrates and fish and moderate in terms of habitat quality. KMA (2005) reported "good" invertebrate community quality in the lower reaches of Duck Creek (MCI = 110, QMCI = 5.0, %EPT taxa = 35.6, Taxa richness = 20). Fish species recorded in Duck Creek include banded kokopu, common bully, common smelt, giant kokopu, inanga, koaro, lamprey, longfin eel, redfin bully and shortfin eel.
	• Coastal/ estuarine ecology	4	The aquatic ecology of the Pauatahanui Inlet is as described above for the Kakaho Stream.
	• Sediment quality	4	Streambed sediments sampled at Duck Creek in 2005 and 2006 were found to exceed the ANZECC (2000) ISQC-Low trigger value for Total DDT (Milne & Watts, 2008). No other trigger values were exceeded at this site. The sediment quality of the Pauatahanui Inlet is as described previously for the Kakaho Stream.
	• General coastal water quality	1	General coastal water quality, except for microbiological water quality, is not available.
	• General freshwater quality	3	PCC monthly monitoring between November 2011 and June 2014 indicated elevated levels of dissolved nutrients in Duck Creek, while both Cu and Zn exceeded 95% protection trigger values on only one occasion (Milne & Morar, 2017).
	• Contact recreation (micro.)	4	Regular monthly monitoring of *E. coli* bacteria conducted by PCC from January 2015 to August 2016 gave a median value of 240 cfu/100ml and a maximum of 17,000 cfu/100ml. The median value achieved the NPS-FM (MfE 2014) 'bottom line for secondary contact recreation (<1,000 cfu/100ml). Two sites in the Pauatahanui Inlet are monitored as part of the GWRC recreational water quality monitoring programme. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Fair" at the Water Ski Club and "Good" at Paremata Bridge. No "alert" or "action" triggers were recorded during the 2015/16 bathing season.

	• Monitoring (historic and current)	3.5	• Ongoing recreational water quality at 2 locations in Pauatahanui Inlet • Ongoing PCC monthly microbiological monitoring at 1 site in Duck Creek • Porirua Harbour sediment quality and benthic biota surveys on Pauatahanui Inlet at approximately 3 year intervals.
	• Known problems		No known issues in Duck Creek but significant wastewater contamination of stormwater in Browns Creek
3	**Identify knowledge gaps**		
a)	Source/network		Better contaminant load information is needed for input to metal sediment load modelling. Wastewater overflows to stormwater network in Browns Creek
b)	Values		Well characterised
c)	Receiving environment state		Partially characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring at 2 locations in Pauatahanui Inlet 2. **Continuation** of Porirua Harbour sediment quality and benthic biota surveys on Pauatahanui Inlet at approximately 5 year intervals
	• Future trends		
	• Source / investigation (e.g. hot spots)		3. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Effectiveness of existing solutions		Not required
	Total Score	**44.5**	


Stormwater Reticulation Network
Duck
Bathing Water Quality Sites
Sewer Overflows
Sewer Main Trunk
State of the Environment Monitoring
Stormwater Outlet
Stormwater Pipes
Catchment
Open Channels
N
1:19,950
0
220
440
660
880
1,100
Wellington
Water

27. Porirua			
Step	**Component**	**Level of adequacy (scores 1-5)**	**Comments**
1	**Collate information/data**	90%	
2	**Characterise**		
a)	Network	3	Porirua Stream catchment lies to the south and west of Porirua Harbour. The drainage area extends from Glenside and the Takapu Valley, through Tawa, Kenepuru and Porirua City to the western end of Porirua Harbour. Adjacent minor watercourses draining to the Onepoto Inlet are also included in this catchment description. The stormwater network developed gradually over time from the 1940's onwards. Mostly constructed in the 1950s, 1960s and 1970s. The total public stormwater length is 367 km. The remaining length of open channel stream is not known.
b)	Land use characterisation	4	The total catchment area is 66.5 km² of which 55% is served by a stormwater network and an estimated 29% is impervious surface. There are seven main sub-catchments (Kenepuru, Linden, Takapu, Belmont, Churton Park, Tawa and Mitchell) several of which have little vegetation other than pasture grass or residential gardens. The catchment is predominantly pasture and scrub in its upper reaches and urban in its lower reaches (14.6% indigenous forest and scrub, 11% exotic forest, 44% pasture and 31% urban).
c)	Contaminant sources	3	Catchment-wide sources includes roofs and other building materials found in urban areas, road surfaces and other permeable pavements. Vehicles (tyres, brake linings, oil leakage, exhaust) are probably the major generic source; from the Porirua Motorway (SH1), major city streets, and parking lots. Sewage contamination of stormwater can occur through cross-connections, from leaking sewerage pipes, and from overflows when the sewerage system become overloaded or fails. The only known constructed wastewater overflow in the catchment is located beside Porirua Stream immediately upstream of Pump Station 20 (PS20). A number of other uncontrolled overflows are likely to occur within the catchment. Potential hotspots include the Wellington to Porirua motorway, the rail network, a large operating landfill (Spicers Landfill) and closed landfills at Porirua Hospital, Northern Landfill, Sievers Grove and Churton Park.
d)	Volume/loads	1	Contaminant load modelling predictions are not available.
e)	Receiving environment		
	i. Nature	3.5	Porirua Stream drains a mixed catchment which is predominantly pasture and scrub in its upper reaches and intensively urban in its lower reaches. It discharges to the head of Onepoto Inlet, the southern arm of Porirua Harbour. The Porirua Harbour is a large, shallow, well flushed "tidal lagoon" type estuary consisting of two shallow drowned river valleys, the southern Porirua or Onepoto Arm and the northern Pauatahanui Inlet, meeting at a deep narrow confluence which opens to the west coast of the lower North Island opposite Mana Island. Porirua Harbour at 807 ha (524 ha in the Pauatahanui Inlet and 283 ha in the Onepoto Arm) is moderate in size compared to other New Zealand estuaries (Robertson & Stevens, 2007; Stevens & Robertson, 2008) but is the largest estuary system in the Wellington region.
	ii. Values	3.5	The Onepoto Inlet has moderate amenity and recreational uses including walking, fishing, sailing, rowing, windsurfing and paddle boarding. Schedule B of the PNRP identifies Onepoto Inlet as a taonga by mana whenua iwi in the Wellington region. In addition, many locations around the harbour are identified in Schedule C of PNRP as sites with significant mana whenua values. Schedule F1 of the PNRP identifies Porirua Stream and tributaries as a watercourse with significant indigenous values including habitat for indigenous threatened or at risk fish, and habitat for more than six species of indigenous fish. The tidal reaches of Porirua Stream and the Keneperu streams provide inanga spawning habitat. Schedule F2 identifies the Onepoto Inlet as providing significant habitat for indigenous birds.
	iii. State and trends		
	• Hydrology	4	The hydrology of Porirua Stream is well characterised
	• Freshwater ecology	3.5	RSoE invertebrate survey results indicate "excellent" quality invertebrate community in the Porirua Stream at Glenside (QMCI = 6.39, %EPT taxa = 40, Taxa richness = 25) and "fair" quality at the Wall Street site on the lower stream (QMCI = 4.32, %EPT taxa = 18, Taxa richness = 28) which has been significantly affected by both agricultural and urban development in the catchment. KML (2005) reported metric scores indicating only "fair" quality in Porirua Stream at Glenside and "poor" quality in the middle and lower stream. They also surveyed the Kenepuru Stream and reported metric scores indicating "fair" quality in the middle stream reach reducing to "poor" in the lower reach.
	• Coastal/ estuarine ecology	4	Saltmarsh is virtually non-existent in the Onepoto Arm but occupies 51ha in the Pauatahanui Arm where it was dominated by wide beds of rushland (mostly searush and jointed wire rush) which , as the terrestrial influence

			increased, transitioned through areas dominated by saltmarsh ribbonwood and grassland (mostly tall fescue). Area of seagrass were relatively extensive, 41.2ha in the Pauatanui Arm and 17.3ha in the Onepoto Arm. MacDiarmid, et al., (2012) identified Porirua Harbour as a site of significance for marine biodiversity. The authors noted that New Zealand's shallow harbours and estuaries are important centres of diversity for shore and wading birds, coastal fish and invertebrates, as well as a variety of marine algae and flowering plants such as seagrass and saltmarsh species. Harbours and estuaries are key breeding, nursery and foraging areas for many species. Porirua Harbour is typical in this general sense but because of the limited size of most estuaries within the Wellington region the biodiversity value of Porirua Harbour is considerably elevated. That assessment is reflected in Schedule F2c of the PNRP which lists both arms of the Porirua Harbour as being one of only a handful of relatively large estuaries in the Wellington Region, and a regionally important stop-over for several migrant shorebird species such as the NZ pied oystercatcher and bar-tailed godwit. Schedule F3 identifies the tidal flats of Pauatahanui Inlet as significant natural wetlands.
	• Sediment quality	4	Streambed sediments sampled in Porirua Stream at three locations in 2005 and 2006 (Redwood Station, Glenside & Kenepuru playing field) did not exceed ANZECC ISQC trigger values for metals or PAHs, but exceeded the ISQC-Low trigger value for Total DDT at all locations, and exceeded the ISQC-High trigger value for Total DDT at Glenside. An additional 2 sites sampled in 2006 (No. 2 Tunnel & Wingfield Place) both exceed the ISQC-Low trigger value for Total DDT. The Wingfield Place site also exceeded the ISQC- Low trigger value of Pb and the ISQC-High trigger value for Zn (Milne & Watts, 2008). Oliver (2016) described the sub tidal basins in each arm of the harbour as being dominated by fine muds and providing a 'sink' in which contaminants accumulate. To date GWRC has conducted four sub tidal sediment quality monitoring surveys at five sub-tidal sampling sites in Porirua Harbour, three in the Pauatahanui Inlet and two in the Onepoto Inlet (Figure 5 1). These sites were sampled in 2004, 2005, 2008 and 2010. Oliver and Conwell (2014) reported in relation to the 2010 survey report that concentrations of total Cu, Pb and Zn exceed 'early warning' sediment quality guidelines (i.e.ARC ERC or ANZRCC ISQG-Low) in sub tidal sediments of the Onepoto Inlet. Mercury concentrations are approaching guidelines levels but otherwise, along with the other five metals analysed, are below guideline levels in Onepoto Inlet. TOC-normalised total DDT and Dieldrin exceeded the ANZECC ISQG-Low trigger values at all sites.
	• General coastal water quality	1	General water quality data, except for microbiological data, is not available for Onepoto Inlet.
	• General freshwater quality	4	The upper and lower GWRC RSoE sites on the Porirua Stream both had a 'fair' WQI grade for the 2015/2016 year and were ranked 39th and 45th out of 53 sites in the Wellington Region. Water quality did not met GWRC guideline criteria for E. coli, nitrate/nitrite nitrogen or dissolved reactive phosphorus, but did achieve guidelines for dissolved oxygen, visual clarity and ammoniacal nitrogen. Dissolved Cu and Zn exceeded ANZECC 95% protection trigger values in 42% and 58% of samples, respectively, at the Wall Street RSoE site. GWRC conducted additional monthly monitoring in the Mitchell and Stebbings streams for 12 months between July 2011 and June 2012 (Milne & Morar, 2017). Samples were analysed for a similar suite of physic-chemical and microbiological variables to urban RSoE samples, in addition to chloride and a wider suite of dissolved metals at the Mitchell Stream site. Applying GWRC's water quality index to these sites results in grade of "fair" at for Mitchell Street and "poor" for the Kenepuru Site. The authors found that the Kenepuru Site was amongst the poorest in urban streams across the Wellington Region, with median values of four of the six core indicators failing to meet guideline values. In particular sewage contamination was highlighted as a known issue for Kenepuru Stream, in both wet and dry weather conditions. GWRC stream water quality results obtained from 12 separate wet weather sampling events between June 2012 and June 2014, reported by Milne & Morar (2017) characterises the quality of storm flows in terms of TSS, SS, turbidity TN, TP and *E. coli*. The authors observed that: • The single highest TSS, SSC and turbidity results were recorded in Stebbing Stream (and subsequently downstream in Porirua Stream, during a heavy rainfall event (25.2mm of rainfall in 6 hours); • Wet weather can contribute significant sediment inputs to Porirua Harbour via tributary streams, with the Kenepuru and Takapu streams, owing to their larger baseflow, likely to contribute the greatest contaminant load to Porirua Stream; • *E. coli*, where measured, was consistently over 2,000 cfu/100ml across all sites. The highest results were recorded in samples from Kenepuru Stream at Mepham Place; on four separate occasions exceeded 10,000 cfu/100ml, and highest being 31,000 cfu/100ml; • Concentrations of TN and TP were quite variable and lacked any consistent pattern.
	• Contact recreation (micro.)	4	Median and maximum *E. coli* values for the 2015/16 monitoring year at the lower Porirua site (RS16) were 1,450 and 4,900 cfu/100ml, respectively. The median value exceeds the NPS-FM 'bottom line for secondary

			contact recreation (<1,000 cfu/100ml). Faecal source tracking conducted on samples collected at both sites during 2013 and 2014 indicate a predominantly human source, but dog, ruminant and waterfowl sources were also detected. Human sources were detected in both wet and dry weather, suggesting that leaking pipes or cross connections exist (Milne & Morar, 2017). PCC fortnightly monitoring of *E. coli* at five sites on Porirua Stream and tributaries (Belmont Gully, Boscobel Lane and Lindon Park on Porirua Stream; Boscobel Lane at Takapu Stream; and Stebbings Stream at Gully) between July 2010 and June 2014 (n = 105) gave median values in the range 400-650 cfu/100ml and maximum values in the range 12,000 - 32,000 cfu/100ml (Milne & Morar, 2017). At these locations the NPS-FM bottom line for secondary contact recreation was achieved, but significant faecal contamination occurred from time to time. PCC monthly monitoring of *E. coli* at minor water courses including the lower Kenepuru Stream, the Semple Street culvert, Te Hiko, Gloaming Hill and Onepoto between Jan 2015 and August 2016 (n = 21) gave median values in the range 380-16,000 cfu/100ml and maximums from 6,200 to 420,000 cfu/100ml. Most of these locations did not achieve the NPS-FM bottom line for secondary contact recreation. One coastal/estuarine site on the Onepoto Inlet (Onepoto Rowing Club), and one just outside of the harbour (Onehunga Bay) are monitored as part of the GWRC recreational water quality monitoring programme, which is specifically designed to inform the public about the suitability of various sites across the region for swimming and other recreational activities. During the 2015/16 bathing season the suitability for recreation grade (SFRG) was "Poor" at the Rowing Club and "Good" at Onehunga Bay. One "alert" trigger was recorded at the Rowing Club during the 2015/16 bathing season, and none were recorded at Onehunga Bay.
	• Monitoring (historic and current)	4	• Ongoing recreational water monitoring at two locations in the Onepoto inlet; • Ongoing monthly RSoE monitoring at 2 sites on Porirua Stream; • Ongoing monthly microbiological monitoring at 5 sites in the Onepoto Inlet; • Marine sediment and benthic ecology monitoring at 2 locations in Onepoto Inlet in 2004, 2005, 2008 & 2010.
	• Known key problems	3.5	• Wastewater overflows during wet weather to fresh and estuarine receiving waters causing elevated indicator bacteria concentrations; • Elevated metal concentrations in stream waters and sediments during both wet and dry conditions; • Cu, Zn and Pb exceed 'early warning' sediment quality guidelines (i.e ARC ERC or ANZRCC ISQG-Low) in sub tidal sediments of the Onepoto Inlet.
3	**Identify gaps**		
a)	Source/network		Wastewater overflows to stormwater system; EMC and contaminant load information is needed for input to metal sediment load modelling.
b)	Values		Not required
c)	Receiving environment state		Microbiological contamination during wet weather wastewater overflow events Contaminant accumulation modelling
4	**Further Investigations**		
a)	Values		Not required.
b)	Modelling and Monitoring		
	• State of receiving environment		1. **Continuation** of recreational water quality monitoring a 2 locations in Onepoto Inlet. 2. **Continuation** of RSoE monitoring at 2 sites on Porirua Stream; 3. **Continuation** of marine sediment and benthic ecology monitoring in Onepoto Inlet at intervals of no more than 5 years
	• Future trends		4. **New investigation:** Contaminant load/freshwater quality modelling and harbour sediment quality modelling (likely to be undertaken as part of Whaitua process).
	• Source / investigation (e.g. hot spots)		5. **New Investigation:** Characterisation of wastewater overflows to stormwater network (location, frequency, flow rate and duration) in Porirua Stream and Kenepuru Stream 6. **New Investigation:** Establish an automated stormwater quality and flow monitoring station at a representative culvert outlet (Semple Street Culvert?). Establish event mean concentrations and annual contaminant loads.
	• Effectiveness of existing solutions		Not required
	Total Score	49	


Stormwater Reticulation Network
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28. Porirua Coast

Step	Component	Level of adequacy (scores 1-5)	Comments
1	**Collate information**	100%	
2	**Characterise**		
a)	Network	3	The Porirua Coast 'catchment' is a series of minor catchments, often separate minor stormwater networks draining to minor watercourse or the coast between Pukerua Bay and Rukatane Point. The stormwater networks were mostly constructed from the 1950s onwards. The total public stormwater length is 24km. The length of remaining open channel watercourses is not known, but is some place the watercourse have been piped.
b)	Land use characterisation	3	The total area is 14.4 km^2, of which 16% is served by a stormwater network and an estimated 20% is impervious surfaces. Land use is mostly in scrub, interspersed with small urban settlements at Pukerua Bay, Plimmerton and Titahi Bay.
c)	Contaminant sources	3	Catchment-wide sources include roofs and other building materials found in residential urban areas, road surfaces and other permeable pavements, soil disturbance (gardening, landscaping, surface soil damage), vegetation, wild and domestic animals. Vehicles (tyres, brake linings, oil leakage, exhaust) are a minor generic source. There are no constructed wastewater overflows in the catchment. No significant contamination sources are anticipated.
d)	Volume/loads	1	Contaminant load predictions are not available
e)	Receiving environment		
	i. Nature	3	Minor unnamed, mostly intermittent stream and/or the coastal area between Pukerua Bay and Rukatane Point.
	ii. Values	3	Wellington's south and west coastal waters are identified in Schedule B of the PNRP as a taonga by mana whenua iwi in the Wellington region.
	iii. State and trends		
	• Hydrology	1	The hydrological characteristics of these waters are not known.
	• Freshwater ecology	1	Freshwater ecology information is not available for these minor and often watercourses
	• Coastal/ estuarine ecology	1	Coastal ecology information is not available for these catchments.
	• Sediment quality	1	Sediment quality information is not available for these catchments
	• General coastal water quality	3	General coastal water quality, other than microbiological water quality, is not available for this area
	• General freshwater quality	1	General coastal water quality, other than microbiological water quality, is not available for this area.
	• Contact recreation (micro.)	3	Routine monthly monitoring conducted at the Titahi Bay South stream show a median value of 2,200 E. coli per 100ml, well above the NPS-FM bottom line for secondary contact recreation, indicating significant faecal contamination. The nearshore waters of Titahi Bay have exhibited variable levels of microbiological contamination resulting in a "Fair" Suitability for Recreation Grade (SFRG) grade at the northern and centre beach and a "Poor" at the southern end of Titahi Bay. Sites further north at Onehunga Bay and Pukerua Bay received a "Good" grade while Plimmerton Beach was graded "Poor".
	• Monitoring (historic and current)	3	• Ongoing PCC monthly microbiological monitoring at Titahi Bay South Access Stream; • Ongoing recreational water quality monitoring at 3 coastal sites on Titahi Beach.
	• Known problems	3	Occasional high indicator bacteria concentrations in coastal bathing waters
3	**Identify knowledge gaps**		
a)	Source/network		Wastewater overflows to stormwater network and minor streams
b)	Values		Partially characterised
c)	Receiving environment state		Partially characterised
4	**Further Investigations**		
a)	Values		Not required
b)	Modelling and Monitoring		
	• State of receiving environment		• Continuation of monthly monitoring of Titahi Bay South stream • Continuation of recreational water quality monitoring at 3 coastal sites on Titahi Beach
	• Future trends		Not required

	• Source / investigation (e.g. hot spots)		• Investigate and remedy causes of elevated indicator bacteria concentrations in Titahi Bay South Access Road Stream
	• Effectiveness of existing solutions		Not required
	Total Score	33	


Stormwater Reticulation Network
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Appendix G: Relevant Objectives and Policies Assessment

Objectives and Policies	Assessment
National Policy Statement for Freshwater Management (NPSFM)	
Objectives A1, A2, B1, B4, C1, CB1, D1	These objectives seek to safeguard the life supporting capacity, ecosystem processes and indigenous species and the health of people and communities, with regard to secondary contact with freshwater. Objectives A1 seeks the need to sustainably manage the discharge of contaminants to safeguard the life-supporting capacity, ecosystem processes and indigenous species, including their ecosystems, of freshwater and the health of people/communtis affected by secondary contact with fresh water. The AEE has specifically addressed the effects of stormwater on contact recreation values and identified the catchments which have been categorised as being in a 'poor' freshwater state, based on monitoring identifying exceedance of bottom lines for secondary contact recreation specified in the NPSFM. The draft SMP proposes monitoring in areas where information is currently lacking and utilising existing stormwater, coastal bathing beaches, River SoE monitoring, and sediment/benthic ecology monitoring. Further, the management framework detailed in section 7 of the draft SMP details how WWL will manage and mitigate the acute effects of stormwater discharges on human health detected during monitoring. Objective A2 relates to maintaining or improving the overall quality of fresh water whilst protecting significant values of outstanding freshwater bodies/wetlands and improving the quality of fresh water in water bodies that have been degraed by human activities to the point of being over-allocated. The purpose of this Stage One global stormwater discharge consent is to undertake a monitoring and modelling programme to monitor stormwater discharges to enable knowledge gaps to be filled and obtain enough monitoring data to assess whether water quality is being maintained, and then developing long-term management strategies for improving stormwater quality going forward in a Stage Two SMS. Objective CB1 seeks the monitoring of progress towards the achievement of fresh water objectives. The development of the draft SMP directly aligns with this objective, as monitoring the discharge of stormwater over the next five years will provide a good snapshot of whether freshwater objectives are being achieved or worsening with degraded water quality. The objectives of the NPSFM also provide for involvement of iwi and hapu to ensure tangata whenua values and interest are identified and reflected. This has been reflected in the consultation undertaken during this consent process, WWL's commitment to contributing to the development of the RKMF, the continued consultation with iwi through the establishment of a Stormwater Working Party and development of the Stage Two consent application and SMS. Overall, the continued discharge of stormwater and the associated monitoring and mitigation proposed is consistent with these objectives, as the aim is to improve water quality in the long-term.
New Zealand Coastal Policy Statement (NZCPS)	
Objectives 1, 2, 3, 6 **Policies 2,4, 11, 13, 15, 21, 22, 23**	The approach to managing stormwater management is consistent with these objectives and policies because WWL is: • Seeking to safeguard the function and resilience of the coastal environment and preserve its natural character; • Providing for tangata whenua involvement, through consultation with iwi as part of this consent process, contributing to the development of the Regional Kaitiaki Monitoring Framework, and involving iwi in a SWP during the term of the consent; • Providing for the social, economic and cultural wellbeing of communities by ensuring the stormwater network is operating effectively; • Taking an integrated 'global' approach to stormwater management; • Seeking to enhance the quality of water in the coastal environment; • Proposing to assess and monitor sediment and benthic ecology and other water quality impacts on the coastal environment where appropriate; • Continuing to take steps to manage the avoidance of adverse effects from stormwater discharge to the coastal environment, by limiting sewage contamination where possible, promoting integrated management and promoting design options that reduce wastewater flows to stormwater reticulation systems at source.
Regional Policy Statement for the Wellington Region (RPS)	
Objective 6, 10,12 **Policies 39, 40**	The RPS seeks to maintain or enhance the quality of coastal waters and freshwater to a level suitable for the health and vitality of ecosystems. WWL propose the establishment of five new temporary River State of the Environment (SoE) monitoring sites, in addition to the existing River SoE monitoring programme managed by GWRC. The temporary River SoE sites will be assessed for ecological condition, involving semi-quantitative assessments of macroinvertebrate communities and periphyton biomass during stable/low flows in summer or autumn. Habitat assessments are also proposed to be made annually during summer or autumn (at the time biological samples are collected). This assessment provides an indication of the condition of the physical habitat and its ability to support stream biota. It incorporates fine sediment cover, invertebrate habitat abundance and diversity, fish habitat abundance and diversity, hydraulic heterogeneity, bank stability, channel modification, and riparian buffer width, integrity and shade. This targeted monitoring in conjunction with one recommended sediment and benthic ecology survey during the term of the consent, will provide sound evidence for the development of long-term options to maintain and where possible enhance fresh water and coastal water quality. The RPS also seeks to recognise and protect the benefits of regionally significant infrastructure. The stormwater networks subject to this application are regionally significant infrastructure that provide an important service to the community.
Regional Coastal Plan (RCP)	
Objectives 4.1.1 , 4.1.2, 4.1.4, 4.1.5, 4.1.6, 4.1.7, 4.1.13, 4.1.14, 4.1.15, 4.1.16 4.1.18, 4.1.19, 4.1.20 **Policies 4.2.1, 4.2.3, 4.2.5, 4.2.10, 4.2.11, 4.2.20, 4.2.30, 4.2.34, 4.2.36**	This consent application is consistent with the environmental objectives and policies of the Regional Coastal Plan (RCP) because stormwater discharges are necessary to provide an essential public service. It is noted that regard must be had to the extent to which the community as a whole benefits from the proposed activity. Measures are proposed, as far as practicable, by WWL to protect public health, important ecosystems, intrinsic values, and important cultural areas by managing incidents and spills, managing/responding to overflow events, and managing acute effects on human health detected during monitoring. Further, long-term, the management of stormwater discharges will be enhanced through the monitoring undertaken to inform a SMS. This consent application is consistent with the RCP management objectives and policies because the proposed monitoring will contribute to information and monitoring data generation to enable WWL and GWRC to gain a better picture of how stormwater discharges are affecting the freshwater and costal receiving environments. In the accordance with Policy 4.2.36, the AEE has had regard to the significance of adverse effects, the extent to which stormwater discharges contribute to these adverse effects and how the SMP initiates a process that will avoid, remedy or mitigate these effects. The consultation undertaken seeks to recognise tangata whenua values. This will be further realised when WWL work with iwi and GWRC by providing or engaging suitably qualified personnel to contribute to the development of the RKMF. Continued iwi involvement through the proposed Stormwater Working Party will increase opportunities for iwi and hapu to exercise kaitiakitanga and contribute to their development of cultural health monitoring.
Regional Freshwater Plan (RCP)	

Objectives and Policies	Assessment
Objective 5.1.1, 5.1.2, 5.1.3 **Policies 5.2.10, 5.2.13, 5.2.14**	The proposed monitoring will assist with the development of a SMS in Stage Two, leading to improved water quality outcomes. This will help to ensure that fresh water meets the range of uses and values for which it is required, the life supporting capacity of water and aquatic ecosystems is safeguarded, and is of a quality consistent with tangata whenua values. Policies 5.2.1 to 5.2.9 relate to water bodies with values identified in the RFP appendices. As the receiving environment covers a vast area, the values have not been identified on a site-specific basis. However the AEE has discussed the effects of stormwater discharges on receiving water quality, aquatic ecosystem health, benthic habitats, mahinga kai, human health and contact recreation, amenity values and Māori customary use in a holistic sense. The AEE determined that the effects of these discharges to freshwater receiving environments will be sufficiently remedied or mitigated to an acceptable level for the five year term of this consent. Policy 5.2.13 encourages discharges to land when effects can be avoided, remedied or mitigated. Whilst targeted discharges to land are less common in this region, this practice can occur when it is culturally, environmentally, technically and financially feasible. Policy 5.2.14 encourages the treatment of stormwater discharges. This is not a current feasible option for stormwater discharges across this vast network during the term of this Stage One consent, but will be considered in the development of the SMS.
Regional Discharges to Land Plan (RDLP)	
Objective 4.1.5, Policy 4.4.19	In some cases stormwater is discharged to land, which may then enter water. The Regional Discharges to Land Plan (RDLP) objective 4.1.5 and policy 4.4 seeks to avoid, remedy or mitigate adverse effects from the discharge of liquid contaminants (e.g. stormwater), and to allow discharge to land which is not likely to have adverse effects on soil and water quality, and/or where the effects would be greater if they were discharged directly to water.
Proposed Natural Resources Plan (PNRP)	
Ki uta ki tai: mountains to the sea **Objectives O1. O3, O4, O5** **Policies P1, P4**	This consent application, and the wider process of developing the SMP promotes the concept of integrated management (through taking a global approach and acknowledging the connectivity of land and water environments); adaptive management (through proposing management that is responsive to monitoring); and seeks to achieve coordinated management based on the best information available. The links between environmental, social, cultural and economic sustainability have been recognised and provided for, including through consultation to identify key values and concerns that need to be considered to inform the monitoring approach. Monitoring of the receiving environments of stormwater discharges will inform the SMS. Policy P4 discusses the minimisation of adverse effects. This consent application has provided a consideration of alternatives for discharging stormwater and identified the management approach to reduce adverse effects detected during monitoring, consistent with this policy. Due to the nature of this activity and the investment in stormwater networks it is not possible to relocate the stormwater outfalls such that there are no discharges within area identified in Schedules A, C, E and F.
Beneficial use and development **Objective O12** **Policies P7, P10, P12, P13**	Stormwater networks are regionally significant infrastructure; the discharge of stormwater provides a social and economic benefit through mitigating and reducing flood risk in developed areas. The network provides for economic development, by proving an essential utility service. It is necessary to take account the operational requirements of this infrastructure. Stormwater that is captured is required to be discharged in an alternative location, for this system to be functioning effectively. There are no practical alternatives for stormwater discharges into freshwater and the coastal environment. Policy P7 notes that the cultural, social and economic benefits of using land and water for the treatment, dilution and disposal of stormwater are to be recognised. Taking account of these factors, it is considered that the functioning of stormwater networks, and therefore stormwater discharge is a beneficial and generally appropriate activity.
Maori relationships **Objective O14. O15** **Policy P17, P19, P20**	Consultation has been an important part of the preparation of this consent application, to identify areas where the relationship of Māori with water can be recognised, maintained and improved through the proposed monitoring regime. This will continue to be a part of the management of stormwater discharges through involvement with the SWP and development of the RKMF for cultural health monitoring.
Objective O16 **Policy P18**	Ngā Taonga Nui a Kiwa sites have been recognised in this application, the approach taken to stormwater monitoring and management will seek to have regard to the values and involve the relevant iwi.
Natural character, form and function **Objective O17, O18,** **Policies P22, P23, P25**	The discharge of stormwater is not considered an inappropriate use. The natural character of the receiving environments is recognised and the management of stormwater discharges seeks to protect this. The ecological, recreational, mana whenua, and amenity values of estuaries is recognised, and through the SMP and subsequent SMS, adverse effects will be identified so they can be avoided, remedies or mitigated. Initiatives such as education campaigns and physical infrastructure such as sumps and baffles, seeks to reduce the sediment and pollutant contamination of stormwater such that the ecological health of the significant values of Te Awarua-o-Porirua Harbour and Wellington Harbour are restored over time, or at least not made worse from contaminated stormwater. It is important to consider pursuant to Policy P25 that there is a functional need to discharge stormwater to freshwater and the CMA. Further the stormwater network is existing infrastructure that cannot be relocated.
Water quality **Objective O23, O24**	An inherent goal of this two stage consenting approach, which results in the development of the SMP and subsequently a SMS is the maintenance and where possible the improvement of water quality in the rivers and CMA which receive stormwater discharges, consistent with Objective O23. Efforts to improve water quality will contribute to ensuring that rivers/streams and the CMA are suitable for contact recreation, mahinga kai and Māori customary use.
Biodiversity, aquatic ecosystem and mahinga kai **Objective O25** **Policy P32, P33**	Effects on biodiversity, aquatic health and mahinga kai are a key consideration when assessing the effects of stormwater discharges. WWL's management approach seeks to safeguard these values through avoiding significant adverse effects, where this is not possible remedying, and when this is not possible mitigating effects. Policy P33 seeks that more than minor adverse effects on the species known to be present in any water body identified in Schedule F1, F1b, or F1a shall be avoided. The AEE has identified the presence of acute effects on freshwater benthic ecology and concluded that the greatest effects on aquatic ecology come from a combination of contaminants, with temporary adverse effects predominantly from wastewater overflows.
Sites with significant mana whenua values **Objective O33** **Policy P44** **Policy P45**	Sites with significant mana whenua values have been recognised in this application. Efforts have been made to understand how cultural health monitoring can help to maintain and protect these values primarily through consultation with Ngāti Toa, the PNBST and the Wellington Tenths Trust. Iwi have responded positively to the progression of cultural health monitoring as a way of further developing their current progress of developing cultural health indicators. This expression of interest is directly relevant to WWL's proposed approach to contributing to the development the RKMF, to enable a consistent regional approach to cultural health monitoring. Ultimately maintaining or improving stormwater quality will be a positive effect on sites with mana whenua values for the mauri of the water. The AEE concluded that overall the effects of the continued discharge of stormwater is not inappropriate and continues to provide many benefits to the community by predominantly reducing the risk of flooding to people and property. WWL is committed to contributing to the development of the RKMF by providing personnel or engaging suitably qualified and experienced personnel to attend meetings/other forums, provide any information WWL holds to help GWRC, review documentation; and contribute to any other relevant matter. By enabling the RKMF to be further developed will enabling cultural health indicators to be monitored during this Stage One consent, and contribute to the long-term management strategies to be developed in an SMS to mitigate any adverse effects on sites with significant mana whenua values.

Objectives and Policies	Assessment
Sites with significant indigenous biodiversity value **Objective O35** **Policy P40**	This application has identified numerous sites within Schedule F of the PNRP. By contributing towards existing monitoring programmes that measure a number of coastal and freshwater sites identified in Schedule F, as well as additional sites and one more round of sediment and benthic ecology monitoring, management of acute adverse effects on human health detected during monitoring, and the development of a SMS, these values will be as far as practical maintained.
Discharges to land and water **Policy P63**	This policy requires the water quality of waterbodies identified in Schedule H2 as priorities for improvement for contact recreation and Māori customary use. Improvements are to include stormwater management strategies having particular regard to improving water quality in fresh water bodies and coastal water identified in Schedule H2 that are adversely affected by discharges from stormwater networks. The development of the monitoring programme for the next five years takes into account the need to contribute or collaborate with GWRC to utilise existing recreational fresh and coastal water monitoring programmes, as well as implementing additional monitoring to identify adverse effects from stormwater discharges. The presence of acute effects on human health in catchments are identified in Table 1-1 of the draft SMP. Management and mitigation actions for acute effects on human health detected during monitoring identified in section 9.6 of this aligns with this policy.
Policy P66	Policy P66 recognises the NPSFM and the matters a consent authority shall have regard to. However, this policy only applies to new or a change or increase in any discharge and is therefore not applicable.
Discharges to water **Policies P71, P72, P73,**	Policies P71 and P72 are directly relevant as these relate to the quality of discharges and minimising the adverse effects on the receiving water after a zone of reasonable mixing using measures that achieve water quality standards identified in Policy P71 . Policy P72 identifies that a zone of reasonable mixing shall be minimised and be determined on a case-by case basis, with regards to the clauses identified in Policy P72. Discussions with the TRG sub-group identified that a zone of reasonable mixing of 50m for coastal receiving waters is appropriate. However, identifying a freshwater zone of reasonable mixing is more challenging as there are often many stormwater outlets located in close proximity to each other, thus creating 'overlaps'. Advice was sought from GWRC's technical specialists on this issue and their recommendation was to seek GWRC's input in identifying an appropriate zone of reasonable mixing. WWL is keen to work with GWRC regarding the zone of reasonable mixing for fresh water in accordance with guidance from Policies P71 and P72. Policy P73 states that the adverse effects of stormwater discharges shall be minimised, including by: a. using good management practice, and b. taking a source control and treatment train approach to new activities and land uses, and c. implementing water sensitive urban design in new subdivision and development, and d. progressively improving existing stormwater, wastewater, road and other public infrastructure, including during routine maintenance and upgrade. WWL's management framework for complaints received, responses to incidents and spills, and the proposed management of acute effects on human health detected during monitoring is consistent with this policy. Further WWL invests significant capital for the maintenance and renewal of the stormwater network as identified in **section 4.7** of this report.
Coastal Management **Objective O53** **Policy P132**	The discharge of stormwater into the CMA is a functional need of this regionally significant infrastructure in accordance with Objective O53 and Policy P132.

Appendix H: Project Information Sheet

Wellington Water

Wellington Water

Global Stormwater Consent

Information Sheet

Background

The Proposed Natural Resources Plan (PNRP) was publicly notified by Greater Wellington Regional Council (GWRC) on 31 July 2015. All provisions in the PNRP have immediate legal effect from the date of notification.

As a result, stormwater discharges from a local authority network now require a resource consent. Wellington Water is required to take a "global" approach to stormwater management within the jurisdictions of the Wellington, Porirua, Hutt and Upper Hutt city councils.

This project has two stages:

STAGE 1

- A consent application for the discharge of stormwater from a local authority network is required to be lodged within two years of the PNRP being notified
- This consent application will be considered as a Controlled Activity with a maximum consent duration of five years, and will establish a stormwater monitoring programme
- The aim is to lodge the consent application with GWRC by late June 2017

STAGE 2

- A subsequent application to renew the consent will need to be lodged together with a Stormwater Management Strategy five years after the Stage 1 consent is granted
- This consent application will utilise data obtained from the stormwater monitoring undertaken over the five-year Stage 1 consent

What are we up to?

We are now preparing the **Stage 1** consent application and Stormwater Monitoring Plan.

The purpose of the Stage 1 stormwater consent is to:

- Establish a Stormwater Monitoring Plan that is practical, cost-effective, and fit-for-purpose. The plan will direct the monitoring of Wellington Water's stormwater network and receiving environments (coastal and freshwater) over the next five years
- Obtain data to inform the Stage 2 consent application and development of a Stormwater Management Strategy
- Set out a framework for managing acute adverse effects detected during monitoring
- Set out a timeline for the development of a Stormwater Management Strategy

Can you help us?

We are **seeking your input into the development of the Stormwater Monitoring Plan** and would like to know if you're interested in providing us with your thoughts.

If yes:

- What specific areas of Wellington Water's stormwater network and/or the stormwater receiving environment (coastal and freshwater) are a concern to you?
- Are there specific aspects or areas of Wellington Water's stormwater network and/or the stormwater receiving environment (coastal and freshwater) that would benefit from being monitored?
- What would you like the Stormwater Monitoring Plan to achieve?

For more information on the project and to provide feedback, please contact:

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