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80508475

14 September 2016

Environment Southland
Private Bag 90116
INVERCARGILL 9840
Attention: Daniel Smith
Team Leader Consents

Dear Daniel

Application for Discharge Permits for Invercargill Stormwater Network

Please find enclosed an application from Invercargill City Council for a discharge permit to replace five existing discharge permits[1] authorising the discharge of water and contaminants to surface water from the Invercargill City Council's reticulated stormwater network, in accordance with Rule 2 of the Southland Regional Water Plan. The application is made in accordance with Section 124(2) of the Resource Management Act 1991 (RMA), being in that period between 3 and 6 months prior to the expiry of the exiting consent(s), being 15 December 2016.

We are providing the application to you electronically, as discussed with Daniel Smith. A cd with the electronic document will be delivered by hand shortly. Please note that the pdf of the application document has been formatted to print double sided.

Invercargill City Council is arranging payment of the appropriate fee direct to Environment Southland.

Please note that Janan Dunning of MWH is listed in the application as the address for service. Therefore, please address all correspondence and enquiries about the application to him, with copies to Malcolm Loan, Invercargill City Council. Please direct invoices for the processing of the application to Invercargill City Council.

Yours sincerely

Sue Bennett
Principal Environmental Scientist
MWH New Zealand Limited

Encl.: 1 x cd with Application Document
Copy to: Malcolm Loan, ICC

[1] Waihopai River: 206936, Waikiwi Stream: 206937, Otepuni Stream: 206938, Kingswell Creek: 206939, Clifton Channel: 206940.

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MWH, now part of Stantec
Please visit www.stantec.com to learn more about how Stantec designs with community in mind.

STORMWATER DISCHARGES – APPLICATION DOCUMENT

Prepared for the Invercargill City Council

September 2016

This document has been prepared for the benefit of the Invercargill City Council. 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 Environment Southland and other persons for an application for permission or approval to fulfil a legal requirement.

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
Paul Flint	Susan Bennett

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CHECKED BY		
Allan Leahy / Peter White		14/9/2016
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Invercargill City Council

Stormwater Discharges

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Part One – Resource Consent Application Form

Form 9 of the Resource Management Act 1991

Application for Resource Consents under section 88 of the Resource Management Act 1991

To: Environment Southland
Private Bag 90116
INVERCARGILL 9840

From: Invercargill City Council
101 Esk Street
INVERCARGILL 9840

The Invercargill City Council applies for the following discharge permit for a term of 35 years:

- A discharge permit to replace five existing discharge permits[1] authorising the discharge of water and contaminants to surface water from the Invercargill City Council's reticulated stormwater network, in accordance with Rule 2 of the Southland Regional Water Plan. The application is made in accordance with Section 124(2) of the Resource Management Act 1991 (RMA), being in that period between 3 and 6 months prior to the expiry of the exiting consent(s), being 15 December 2016.

1 The name and address of the owners of land where discharges from stormwater network occur are:

- The Invercargill City Council, 10 Esk Street, Invercargill 9840

- Environment Southland, Private Bag 90116, Invercargill 9840

- The Crown, c/- Invercargill City Council, 10 Esk Street, Invercargill 9840

- Lianhua Trading Group Limited, Level 8, BDO Tower, 120 Albert Street, Auckland 1140.

2 The locations of the proposed discharges are:

- Waikiwi Stream encompassing a drain bordering Gloucester Street and the main stem upstream of West Plains Road.

- Waihopai River between Racecourse Road and North Road

- Otepuni Stream between Rockdale Road and Bond Street

- Kingswell Creek between Chesney Street and Bluff Highway

- Clifton Channel between Bain Street and Wicklow Street

3 A description of the activities to which this application relates is:

The discharge of water and contaminants to surface water from reticulated stormwater systems in Invercargill City.

4 There are no additional resource consents required in relation to the stormwater discharges.

[1] Waihopai River: 206936, Waikiwi Stream: 206937, Otepuni Stream: 206938, Kingswell Creek: 206939, Clifton Channel: 206940.

5 Attached in accordance with the Fourth Schedule of the Resource Management Act 1991 is an assessment of effects on the environment in the detail that corresponds with the scale and significance of the effects that the proposed activity may have on the environment in accordance with section 88 of, and the Fourth Schedule to, the Resource Management Act 1991.

Please refer to the information contained in Section 8 of the attached Assessment of Environmental Effects.

6 Attached is information (if any) required to be included in the application by the district plan, regional plan, and the Resource Management Act 1991 (or any regulations made there under).

…………………………………………………..

Signature of applicant or person authorised

to sign on behalf of applicant.

13 September 2016

Address for Service:

MWH New Zealand Limited
PO Box 13-052
Christchurch 8141

Attention: Janan Dunning

Telephone No. 03-341 4790

Email janan.dunning@mwhglobal.com

Part Two – Supporting Information

1 Introduction

1.1 Background

The Invercargill City Council (ICC) holds discharge permits authorising the discharges of stormwater and contaminants from reticulated stormwater networks owned and operated by the ICC into the Waihopai River, Waikiwi Stream, Otepuni Stream, Kingswell Creek and Clifton Channel as follows:

1. Waihopai River: 206936
2. Waikiwi Stream: 206937
3. Otepuni Stream: 206938
4. Kingswell Creek: 206939
5. Clifton Channel: 206940.

The consent applied for will also replace consent 204383 which was transferred to the ICC from Ascot Projects Ltd on 22 February 2016. Consent 204383 will be surrendered once the new consents are granted because it will be included in the scope of the new consent. The other consents granted for the discharge of stormwater from new developments which discharge to the ICC network have not been transferred to the ICC.

The existing permits authorise the discharge of stormwater and contaminants from the ICC reticulated network to surface water. There are no discharges to land from the stormwater network.

The consents were granted as non-complying activities under Rule 2 of the Water Plan on the basis that they could not comply with Rule 1 (given that the discharges may reduce water quality to less than the relevant Water Quality Standards) or Rule 11 (given that the discharges are from reticulated stormwater systems).

The existing consents expire on 15 December 2016. The ICC are applying to Environment Southland for a single consent which will cover all five catchments, rather than individual consents for each catchment. This application is made in accordance with the timeframes set out in s124(2)(d) of the Resource Management Act 1991 (RMA) such that the discharges can lawfully continue until this application is determined.

The ICC has undertaken a review of the various options for treatment of stormwater within the Invercargill system. This review involved the following two phases:

- Phase 1 - A desk top review of the Invercargill stormwater discharges that are currently monitored (18 in number) to determine whether there are any areas where treatment could be implemented and a preliminary engineering assessment of the suitability of stormwater treatment facilities that have been used around the country.
- Phase 2 - A field survey of the monitored discharges to confirm the nature of the treatment facilities that could be incorporated into the network either at the point of discharge or within the network.

The findings of the two phases are documented in a report titled "*Invercargill Stormwater Consent Treatment Review - Phase 1 and Phase 2*" which forms Appendix A to this document. The report includes recommended solutions to managing and minimising contaminants in the stormwater. A summary of these solutions is outlined in Section 5.

It is intended that the overall programme to managing and minimising contaminants in the stormwater will be incorporated as a condition of consent spanning a long term programme of managing and minimising contaminants across the network.

1.2 Scope of Application

This application is for a discharge permit authorising the discharge of stormwater and contaminants to surface water, to replace the existing consents being the discharge from the stormwater network to water outside of the Coastal Marine Area (CMA). The CMA is defined by the following boundaries as given in Schedule 1 of the Coastal Plan:

- Waihopai River boundary is located downstream side of SH 6 bridge
- Otepuni Creek boundary is downstream side of Bond Street bridge
- Kingswell Creek boundary is located downstream side of railway bridge
- Clifton Channel boundary is downstream side of tide gates
- Waikiwi Stream discharges to the Oreti River and the CMA boundary on the Oreti is downstream of Dunns Road Bridge.

The ICC stormwater network includes a number of areas which discharge to the CMA. These discharges are not included in the application.

A term of 35 years is sought based on a programme of works to identify and address the sources of contamination over time.

ICC expect that the scope of the consent conditions will allow stormwater systems from new developments to connect to the existing system without requiring modifications to the capacity of the existing outfalls. If new developments are added to the network which require modifications to the outfalls or the construction of new outfalls, it is intended that these will be addressed through a variation to this consent.

The application has been prepared in accordance with the requirements of Section 88 of the Resource Management Act 1991 (RMA). Part One of this document contains the application form (Form 9) for the discharge permit. Part Two comprises the Assessment of Effects on the Environment (AEE). The AEE includes a description of the discharge activity, the nature of the receiving surface water environments, an assessment of the actual and potential effects of the stormwater discharges on the receiving environments, alternative treatment and discharge measures and the ways in which adverse effects of the discharges can be “avoided, remedied or mitigated”.

2 Description of the Activity

2.1 Nature of Discharge

The discharge from the reticulated stormwater network into surface water encompasses the following.

- Surface water runoff subsequent to precipitation and includes contaminants which are picked up by the stormwater as it flows over the surface prior to entry into the network.
- Drainage water from sub-surface drains within the catchments.
- Groundwater, from dewatering works which are discharged to the stormwater network and from infiltration into the network due to "leaky" pipes and elevated groundwater.
- Surface water from adjacent rural catchments which enter the head of the municipal storm water network.
- Discharges into the stormwater network of wash down water and other sources from residential, commercial and industrial sources.
- Sewage resulting from illegal connections to the stormwater network.
- Sewage resulting from cross-contamination between the sewage network and the stormwater network. This can occur in the older and hence "leakier" parts of the city's infrastructure. The sewer and stormwater pipes can be laid in the same trench and hence sewage can pass between the systems if significant leaks are present.
- Overflows from the sewerage network that discharge sewage into the stormwater network during storm events.

We note that the sewage components of the discharge are not included in this application. The discharge of untreated sewage to surface or coastal water is prohibited under Rule 14 of the Southland Regional Water Plan, and as such resource consent cannot be sought for that activity.

2.2 Nature of the Stormwater Network

Invercargill City has 412 km of stormwater pipes and 364 km of sewerage pipes. As shown in Figure 2-1 and Figure 2-2 from the 2014 Invercargill Asset Management Plans, the majority of these pipes are in excess of 50 years old and are earthenware.

ICC report that repair records indicate a relatively small number of pipe system blockages have occurred (less than 20 per 100km of pipe per annum) indicating that for its age, the system is in 'reasonable' condition. However, there are a number of issues within the stormwater network that potentially allow the ingress of water other than stormwater into the system, and contribute to the degree of contamination identified in the discharges from the system. These include:

- Root Intrusion: Open joints on pipes laid can allow the intrusion of roots which can restrict capacity and eventually block the pipe, and is a major maintenance cost, particularly in areas with street trees, and stormwater pipes laid in grass berms
- Sub-base Cavities: Open joints on pipes have also led to the washing of fine particles from trench backfill material, resulting in the formation of cavities surrounding pipes, and eventually, in some cases, to the collapse of road surfaces. This was particularly a problem in the 1980's, and was a significant maintenance cost, but road collapses have been less frequent since 1990. However, it is likely that there remains significant areas where there are cavities surrounding stormwater drains within the city
- Manholes: Many of the manholes constructed before 1950 were of brick construction, and some of these have partially collapsed, with subsequent slumping of road surfaces and have, therefore, required replacement. There is a potential for more of these manholes collapsing.

The age of the sewer network also results in inflow and infiltration to the system which can result in overflows from the sewer network, and deterioration with age can lead to cross contamination between the systems.

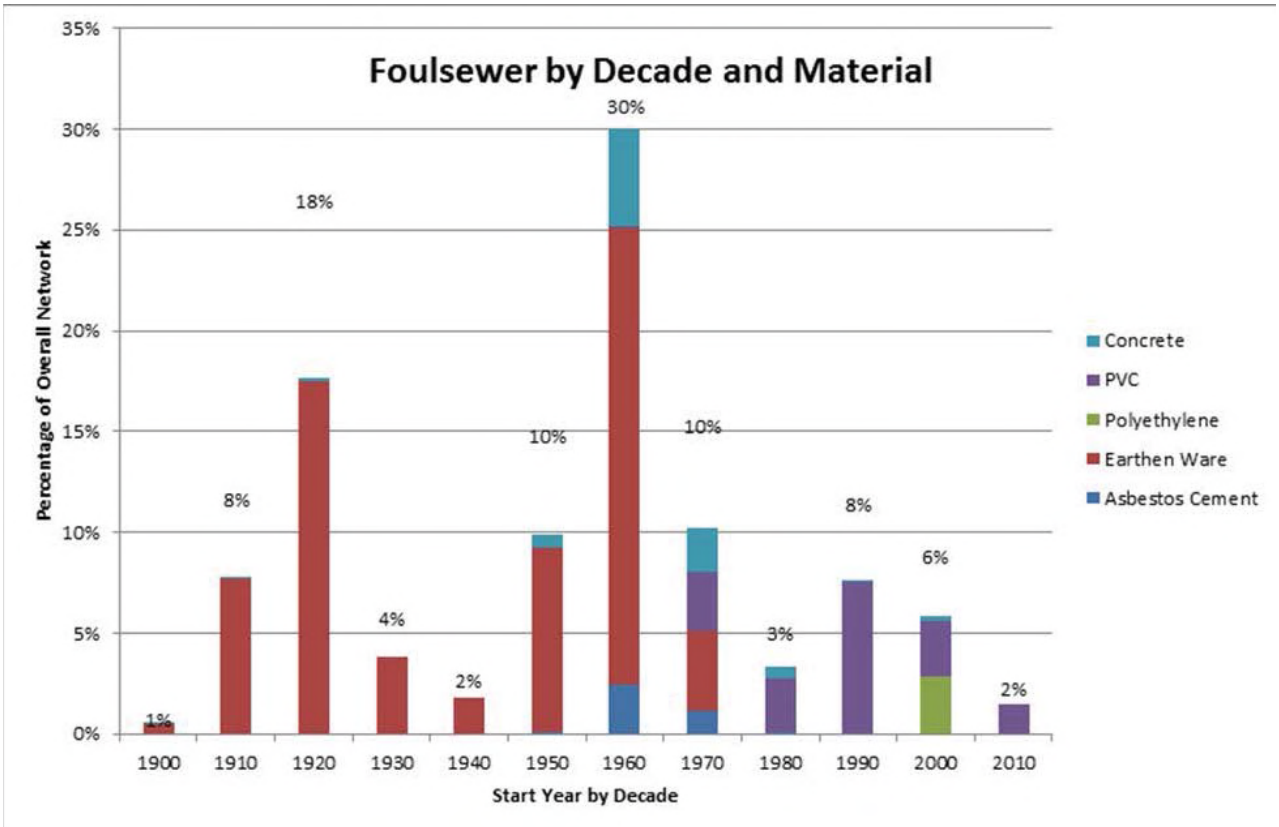


Figure 2-1: Length of sewer pipes by decade of construction and material

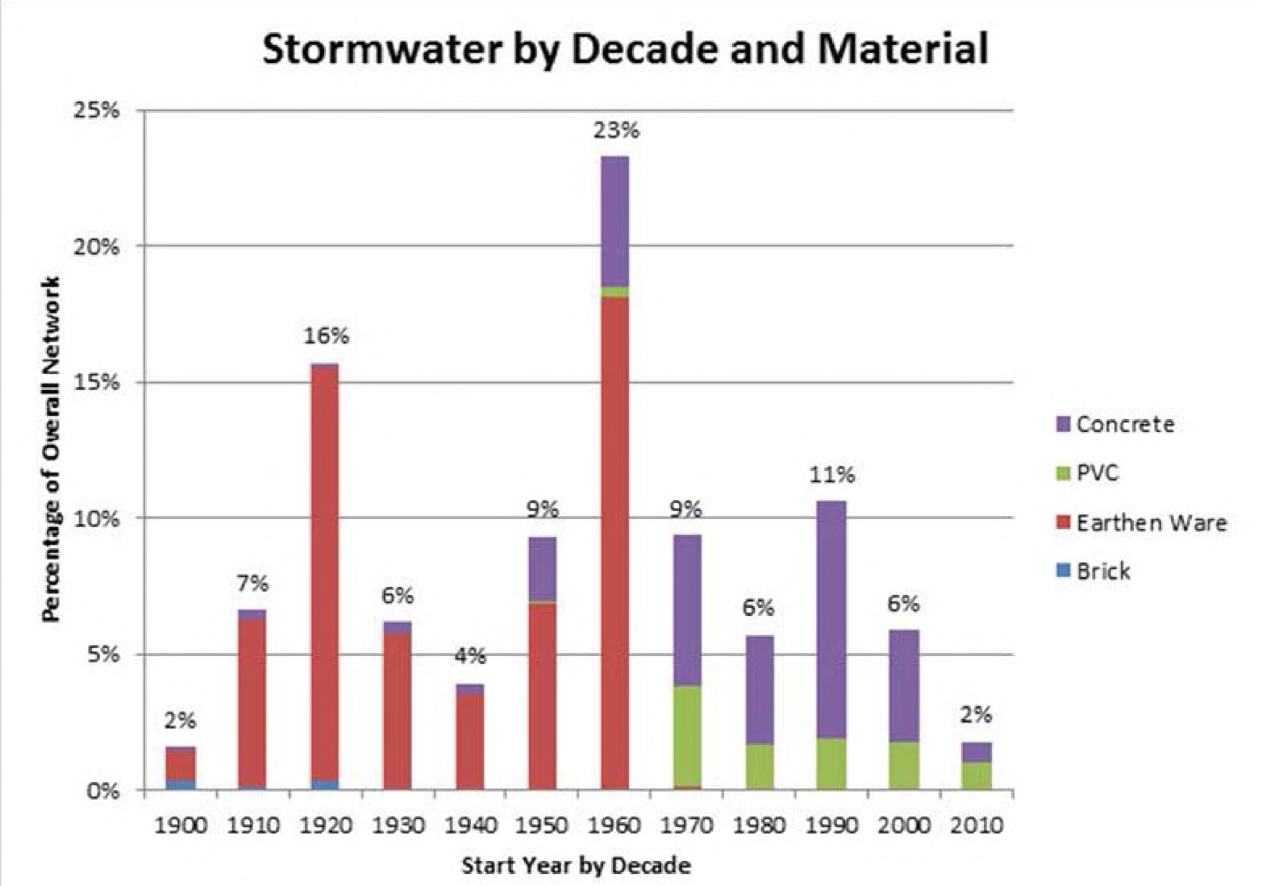


Figure 2-2: Length of stormwater pipes by decade of construction and material

2.3 Stormwater Catchments and Location of Outfalls

2.3.1 Catchments

The catchments of the stormwater network which discharge into the five streams running through Invercargill City are shown in Figure 2-3 below. The area within Invercargill City to the west of the catchments shown is served by a stormwater network which discharges to the CMA and is not included in this application.

2.3.2 Outfalls

Appendix C contains maps of the extensive stormwater networks within each of these catchments with the outfall locations shown as large green circles and the individual pipes in the network are green. The individual manholes within the system are shown as small green circles, showing the complexity of the system and the number of assets.

The locations at which monitoring has been undertaken (18 locations in all) are shown as blue circles. The catchment which contribute to those monitored discharges are shown. No discharges were monitored in Clifton.

There are a number of pumped stormwater outfalls within the city as well as gravity fed outfalls. The locations of these pumped discharges are shown in Appendix A.

2.3.3 Ownership

A spatial interrogation of the outfall locations using Emap[2] indicates that the majority of the outfalls are located on land owned by ICC and ES. Several outfalls in the Waihopai and Otepuni catchments lie on Crown land.

Outfalls situated within a drain bordering Gloucester Street in the Waikiwi Stream catchment and bordering Bain Street and Wicklow Street in the Clifton Channel catchment are located within road reserve. One outfall next to Waikiwi Stream north of West Plains Road is located on private land.

2.3.4 Soil Quality

The nature of the underlying soils in which the stormwater network is built impacts upon the potential discharge pathways from the network.

Soils maps detail dominant soil types as: Mokotua, Woodlands, Waikiwi, Dacre and Titipua. In general these soils have compact subsoil that is slowly permeable, and causes short-term waterlogging and limits aeration during wet periods. The texture is silt loam with topsoil clay content between 20-35% with higher variability in Titipua soils. These soils are typically stone free.

Given the relative impermeability of the underlying soils, it is likely that exchange between the stormwater and sewage networks are only practical when they are located in the same trench or where they have been inadvertently connected. The networks will provide a preferential flow path for groundwater and hence it is likely that groundwater will enter the network if gaps, fractures or openings in the pipe system are present.

[2] Emap is an online mapping application for land and property information.

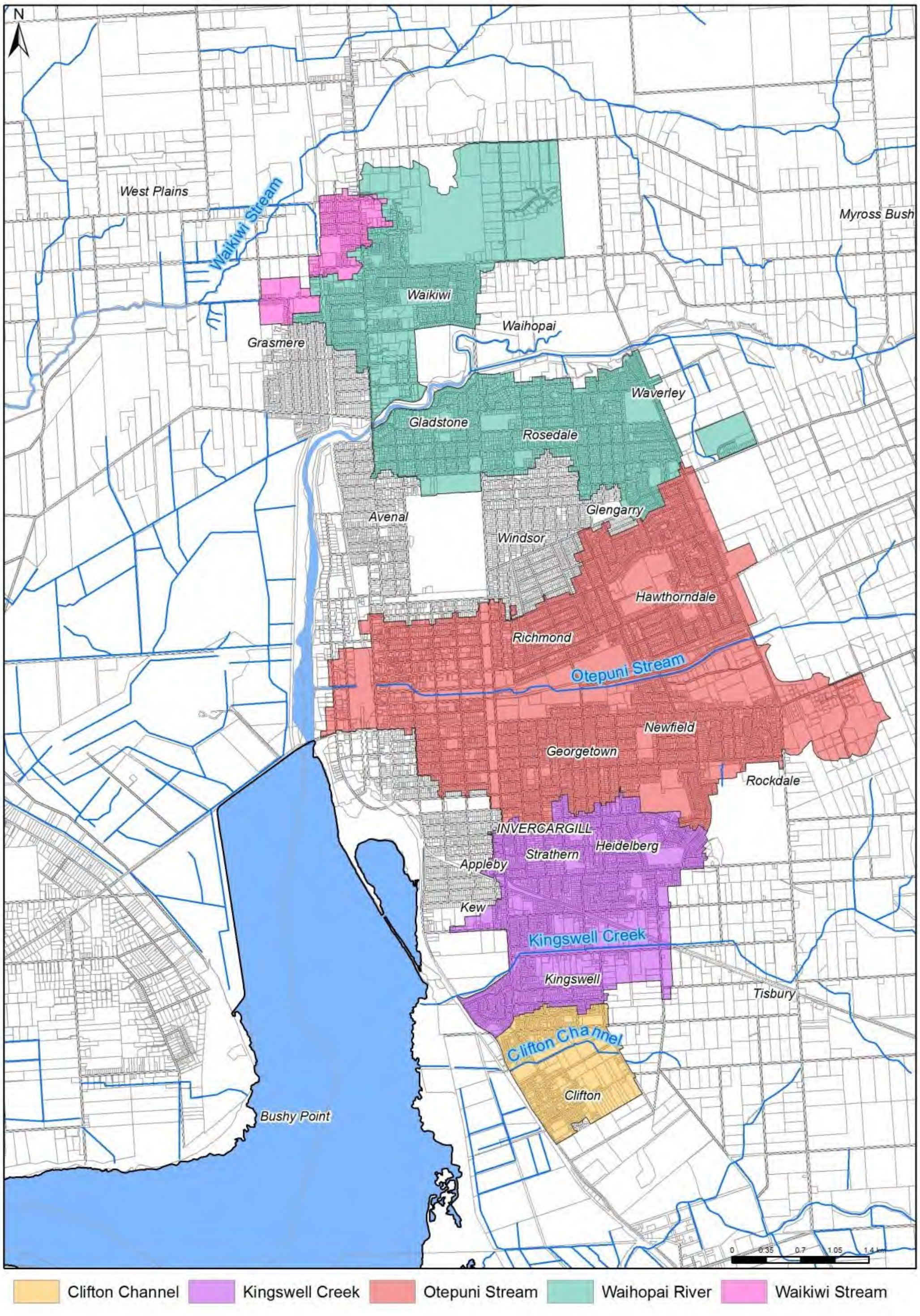


Figure 2-3: Stormwater catchments to Fresh Water Bodies within Invercargill City

2.4 Monitoring of Discharges

2.4.1 Introduction

The current consents specify a monitoring programme which ICC were to undertake up to June 2013. From that point, ICC were to specify a programme that would be implemented on an annual basis and register this with Environment Southland (ES). This programme has included monitoring of the discharges themselves, the water quality in the water bodies to which the stormwater discharges and the sediment in these water bodies.

Monitoring of the discharges was conducted for a representative sample (18 in number) of all the discharges from the network as a whole. The full data set for all parameters is included in Appendix B. The locations at which the discharge monitoring has been undertaken are shown in Appendix C for each catchment. Sampling of the discharges was often undertaken at a manhole upstream of the actual outfall due to access constraints and because many of the stormwater pipes are underwater.

The sampling was through collection of grab samples. No composite sampling was conducted. The dry weather samples were collected when there had been minimal rainfall for at least 72 hours prior and hence represent the baseflow in the system without inflow from rain related flows. The wet weather samples were taken in a period of wet weather, and were not timed to represent first flush but indicated the general quality of discharge during wet weather. The rainfall in defined periods before the sampling was recorded and is presented in Appendix B.

As part of the Treatment Review reported in Appendix A, the catchments of each of these monitored discharges were investigated to determine the size and nature of the catchment and the potential for retro-fitting treatment devices at the base of each catchment. A detailed map of each monitored discharge is included in Appendix A. The size and nature of each catchment is indicated in Table 2-1.

Table 2-1 contains the average of the recorded stormwater concentrations split between the dry and wet weather samples for a number of parameters. The columns in Table 2-1 are colour coded so that the highest concentration in each column is red and the lowest is green. This has been used in the following discussion to highlight where particular issues are noted in the catchment.

2.4.2 Sewage Contamination

The current consent states that the definition of an elevated *E.coli* count shall be where a dry weather sample exceeds 1,000 MPN/100mL, or where the difference between an up and down stream surface water site exceeds 1,000 MPN/100mL. The consent assumes that such concentrations indicate the presence of sewage, and requires that an investigation be undertaken to source and eliminate the sewage.

The trigger was exceeded in dry weather discharges on a number of occasions but the difference in the surface water sites was never exceeded. The investigations undertaken as a result of this requirement is discussed further in Section 2.8.

Table 2-1 indicates that there are four locations (sites 2, 3, 6, and 14) where highly elevated concentrations of *E.coli* were recorded, as indicated by the red squares. These sites also had elevated ammoniacal nitrogen in comparison to other sites, which is also an indicator of sewage. Sites 7 and 8 had elevated *E.coli* over the trigger and slightly elevated ammoniacal nitrogen which is less conclusively due to sewage.

The wet weather discharges are well above the trigger of 1,000 MPN/100mL at a number of locations, indicating the typically elevated concentrations in stormwater as a result of contamination from surface run-off.

Table 2-1: Summary of ICC Discharge Monitoring

Monitored Discharges	Contributing Catchment (ha)			Geomean of *E.coli* (MPN/100mL)		Average of Ammonia (mgN/L)		Average of Nitrate (mgN/L)		Average of Suspended Solids (mg/L)		Average of Total Copper (mg/L)		Average of Total Zinc (mg/L)		Average of Total Lead (mg/L)		Average of Total Nickel (mg/L)	
	Res	Com	Ind	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet
Kingswell																			
1. Bluff Highway Up Stream South Drain	2.8			6	475	0.11	0.05	3.5	0.2	6.7	3.7	0.003	0.003	0.10	0.32	0.0008	0.0034	0.001	0.002
2. Brown Street North West Drain	55.7			12,662	13,885	0.71	0.09	3.4	0.1	3.8	11.5	0.006	0.007	0.08	0.21	0.0009	0.0047	0.001	0.002
3. Elles Road North Drain	30.3	35.3		10,377	16,554	0.45	0.09	3.9	0.1	0.9	6.5	0.004	0.006	0.05	0.17	0.0008	0.0035	0.001	0.002
Otepuni																			
4. 16 Onslow Street Manhole	9.8		12.2	525	5,160	0.04	0.09	1.1	1.0	1.7	21.3	0.002	0.007	0.04	0.28	0.0003	0.0078	0.002	0.003
5. 34 Onslow Street Manhole	52.8			104	2,322	0.05	0.10	1.5	0.9	2.1	14.0	0.003	0.006	0.05	0.25	0.0004	0.0059	0.001	0.003
6. Camden Street Drain	36.2			15,896	1,863	0.89	0.13	4.9	0.6	1.2	5.3	0.004	0.003	0.09	0.30	0.0007	0.0039	0.001	0.001
7. Leven Street Bridge North West Drain		53.8		1,610	4,302	0.19	0.11	3.6	1.1	1.5	8.1	0.004	0.010	0.06	0.29	0.0013	0.0047	0.001	0.004
8. Lindisfarne Street Bridge	65.2			1,755	6,995	0.20	0.09	2.4	0.4	1.4	8.5	0.004	0.008	0.08	0.34	0.0006	0.0042	0.001	0.001
9. Ythan Street Drain	4.84			78	518	0.31	0.14	3.0	0.7	10.9	6.7	0.005	0.005	0.05	0.42	0.0006	0.0028	0.003	0.003
Waihopai																			
10. 126 Gladstone Terrace	5.8			29	48	0.01	0.14	4.1	2.4	0.6	5.2	0.006	0.336	0.03	0.08	0.0311	0.0010	0.001	0.002
11. 274 Talbot Street	4.4			28	443	0.04	0.02	4.7	1.1	6.7	5.2	0.003	0.002	0.07	0.19	0.0021	0.0023	0.001	0.001
12. 61 Rosewood Drive	6.8			10	45	0.01	0.01	5.4	3.0	1.6	1.9	0.003	0.001	0.02	0.07	0.0003	0.0003	0.001	0.001
13. Prestonville Discharge	43.5		30.5	193	2,335	0.12	0.10	2.3	1.6	7.8	21.1	0.003	0.005	0.03	0.12	0.0007	0.0029	0.004	0.003
14. Queens Drive Bridge	78.2			20,911	160,549	1.50	1.22	4.3	1.1	1.5	7.7	0.007	0.008	0.07	0.16	0.0013	0.0030	0.001	0.001
15. Russell Street	45			1,893	1,916	0.09	0.09	2.9	0.4	0.8	4.1	0.002	0.005	0.05	0.16	0.0006	0.0025	0.001	0.001
16. Thomsons Bush Backwash Discharge										1.5	2.4								
17. Thomsons Bush Backwash Inflow	33.8			80	592	0.08	0.13	1.7	0.5	2.3	10.2	0.002	0.002	0.02	0.07	0.0020	0.0011	0.002	0.002
Waikiwi																			
18. Discharge to Waikiwi Stream	43.3		10.9	65	647	0.13	0.22	1.0	0.7	10.3	10.4	0.002	0.004	0.05	0.06	0.0008	0.0013	0.004	0.004

Note:

For most locations, 15 samples were collected in dry weather and 5 samples were collected in wet weather.

Colour code is

Highest concentration in column
..
..
..
Lowest concentration in column

Figure 2-4 presents the range of *E.coli* data from the ICC monitoring as compared to the nationally available data from URQIS[3]. Each quartile of the data sets are shown in a different colour, ie the lowest 25% of each data set is in the green band. The interface between the blue and purple band is the median and the orange band is the top 25% of the data. The ICC data set was split between dry weather data, wet weather data and that from sites 2, 3, 6, and 14 grouped for in both conditions, which appeared to contain sewage.

Figure 2-5 presents the ammoniacal nitrogen data and includes the 95% trigger value for protection against toxicity, which indicates that most of the data is less than the trigger value indicating minimal risk of toxicity effects due to the toxicity from the discharges, except where sewage is understood to be present.

These figures show that the wet weather concentrations is similar to the national data and the dry weather results are generally lower.

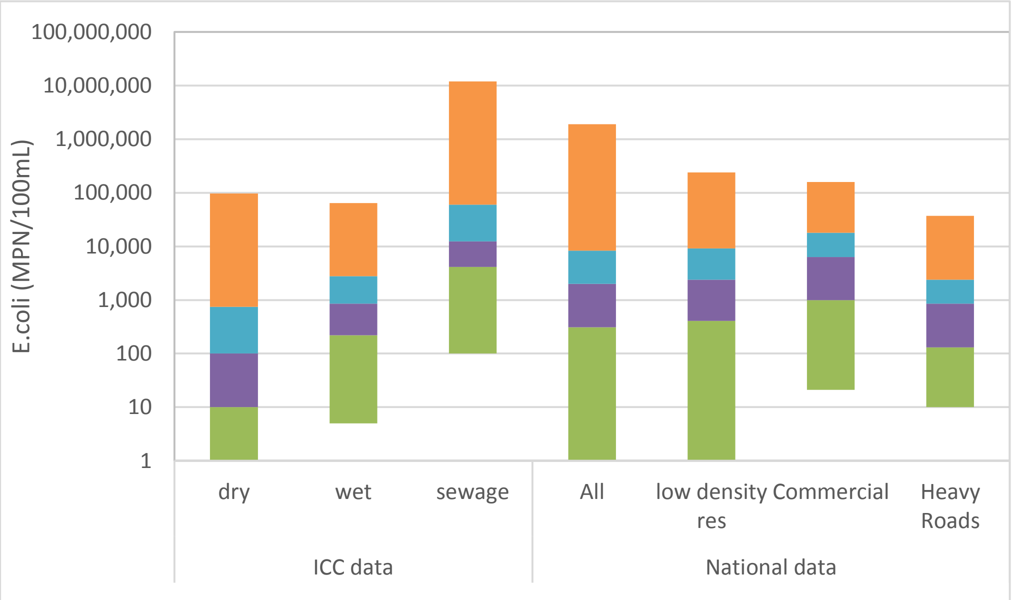


Figure 2-4: Comparison of ICC *E.coli* concentrations against national data[4]

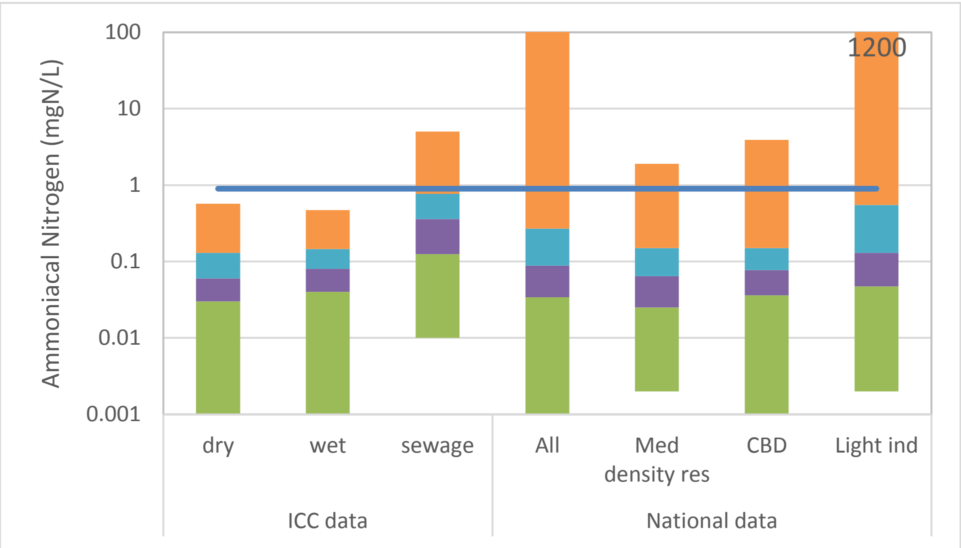


Figure 2-5: Comparison of ICC Ammoniacal Nitrogen concentrations against national data

[3] URQIS is a nationally available resource for the New Zealand public, institutions and companies who need access to urban runoff data. The database is updated with new data at irregular intervals. http://urqis.niwa.co.nz/
[4] Each quartile of the data sets are shown in a different colour, ie the lowest 25% of each data set is in the green band. The interface between the blue and purple band is the median and the orange band is the top 25% of the data.

The size of the catchment and the resultant wet weather *E.coli* concentrations were related as shown in Figure 2-6. This is consistent with wet weather bacterial contamination being largely due to surface contamination picked up by rainfall run-off, unless it is from direct sewage connection.

All of the highly elevated *E.coli* sites (>10,000 MPN/100mL), which indicate sewage contamination, were located in larger catchments of over 30 ha, which impacts upon the ability to find the source of the contamination.

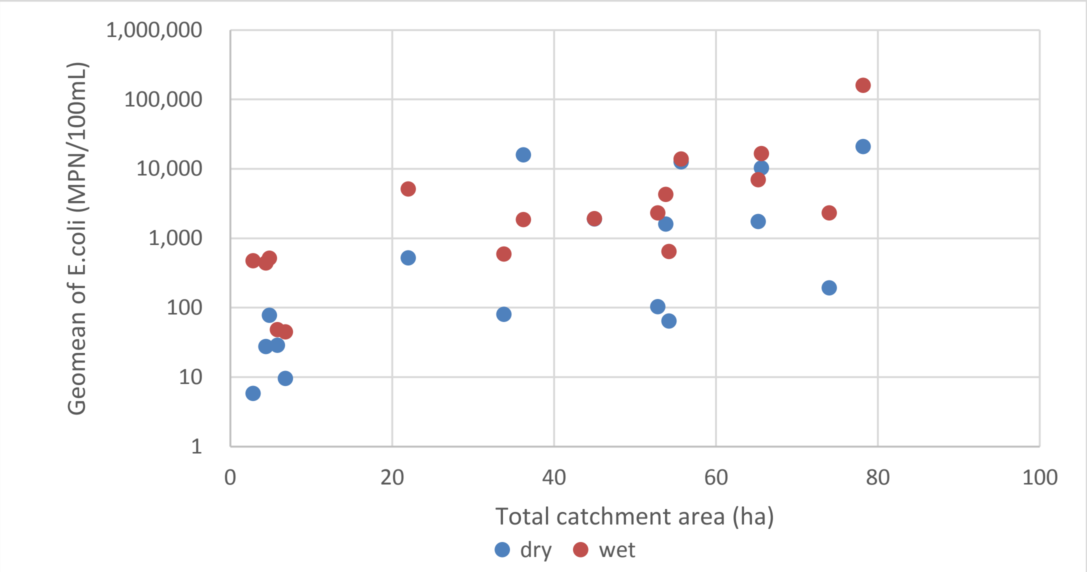


Figure 2-6: Relationship between *E.coli* concentrations and catchment size

2.4.3 Suspended Solids

Figure 2-7 summarises the data for suspended solids concentrations in the discharges. This shows that concentrations were generally similar between wet and dry sampling, with slightly higher concentrations in sewage affected discharges. Compared to the national data set, the suspended solids concentrations in the ICC discharge are low.

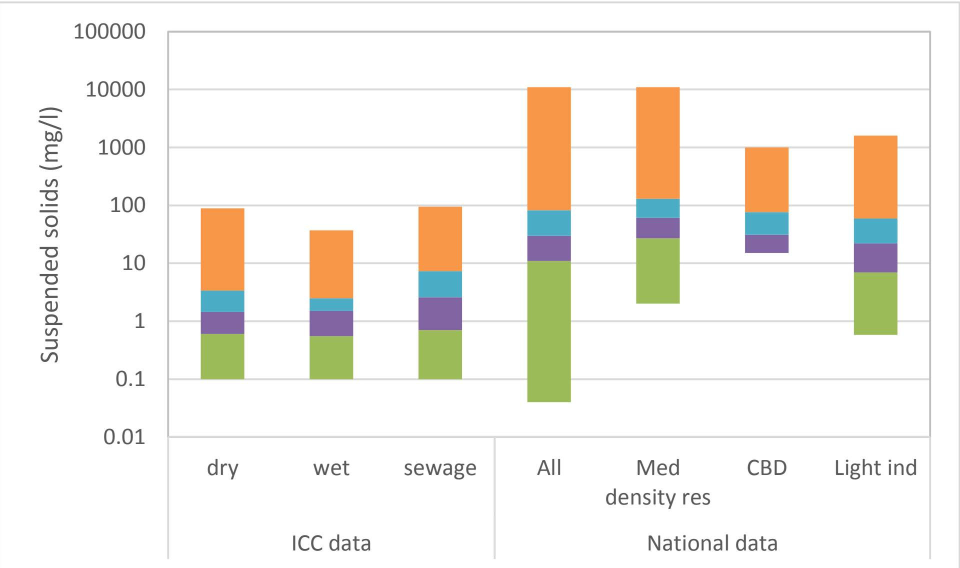


Figure 2-7: Comparison of ICC Suspended Solids concentrations against national data

2.4.4 Metals

All discharge samples were analysed for a range of metals. Analysis was undertaken of the total concentrations of metals rather than the dissolved fraction. Typically, arsenic, cadmium and chromium were less than the detection limit which was less than the 95% trigger value for protection against toxicity. There were occasional samples with detectable concentrations which exceeded the 95% trigger value, indicating that there is some but minimal environmental risk from the discharges for these metals.

A summary of the concentrations of copper, zinc, lead and nickel are included in Table 2-1. Generally, the wet weather concentrations are significantly higher than the dry weather samples, indicating the importance of surface contamination as the source of the contaminants.

Figure 2-8 presents the range of metals data from the ICC monitoring as compared to the nationally available data from URQIS. The 95% trigger value for prevention of toxicity is shown as a blue line.

For nickel and lead, the ICC data is generally similar to the national data and is generally less than the toxicity trigger value, indicating minimal risk of toxicity due to these metals in the discharges, especially given that the analysis is for the total fraction rather than the dissolved fraction which is more bioavailable. It is noted that this differs from the findings of the sediment monitoring for nickel as described in Section 3.4.

For copper and zinc, the recorded concentrations in ICC are lower than those in the national data set, but still exceed the 95% trigger value for prevention of toxicity. Generally, a dilution of 5 to 30 fold respectively would be required to be less than the toxicity trigger value. From the median concentrations of the URQIS data, the dissolved component of copper is 50% of the total, and for zinc, the dissolved phase is 30% of the total. Therefore, it is considered that there is minimal risk of toxicity effects posed by the copper in the discharges, but there is a moderate risk of a toxicity effects from zinc.

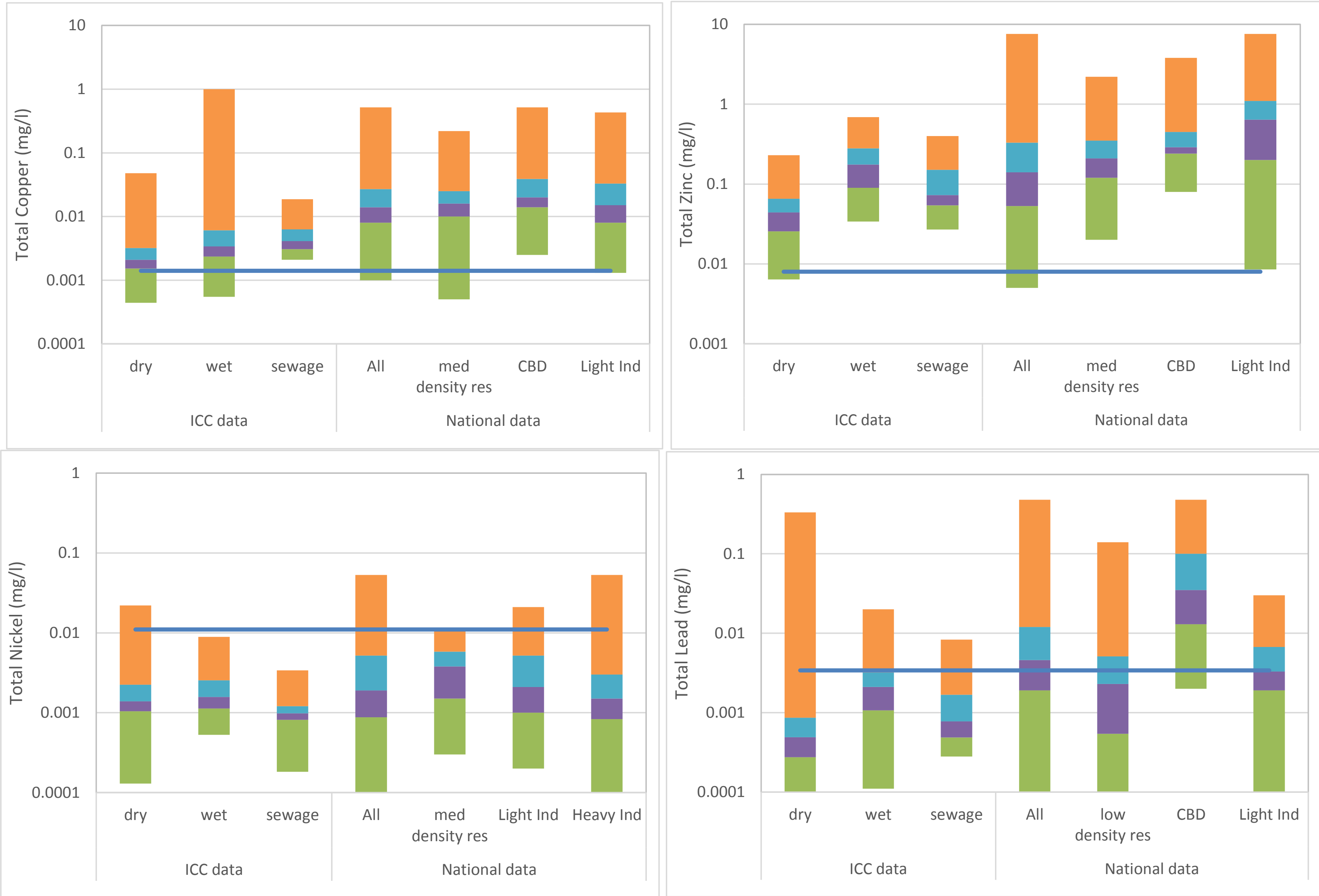


Figure 2-8: Comparison of ICC Metal concentrations against national data and the toxicity trigger value

2.4.5 Nutrients

The monitoring indicated that the discharges contained significant concentrations of nutrients, which were similar to the national data set as shown in Figure 2-9 and Figure 2-10.

The pattern of concentration between wet and dry weather was different with nitrate concentrations generally being higher in dry weather, and the DRP being higher in wet weather. This probably reflects the different sources of the nutrients, with particularly elevated nitrate being present in the low lying catchments probably as a result of groundwater infiltration, which is then diluted in wet weather conditions. Whereas, the DRP is sourced from surface contamination and hence is higher in wet weather conditions due to run-off.

It is noted that both nitrate nitrogen and dissolved reactive phosphorus are in soluble form and are not associated with sediments, and hence cannot be reduced by physical means. Reduction in these parameters would need to be through either source control or biological treatment of the discharge which is problematic for retro-fitting of existing systems, as discussed in the Treatment Review in Appendix A.

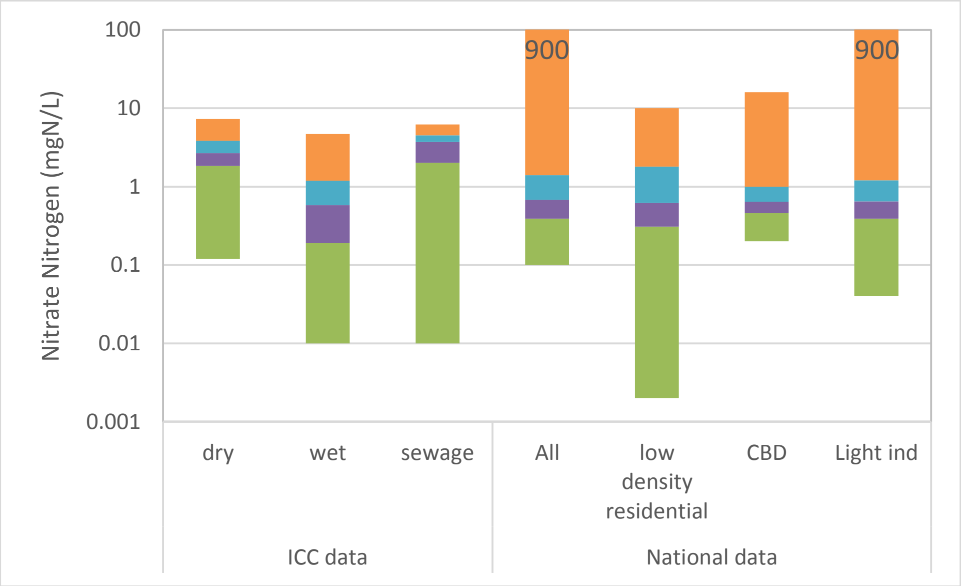


Figure 2-9: Comparison of ICC Nitrate Nitrogen concentrations to national data

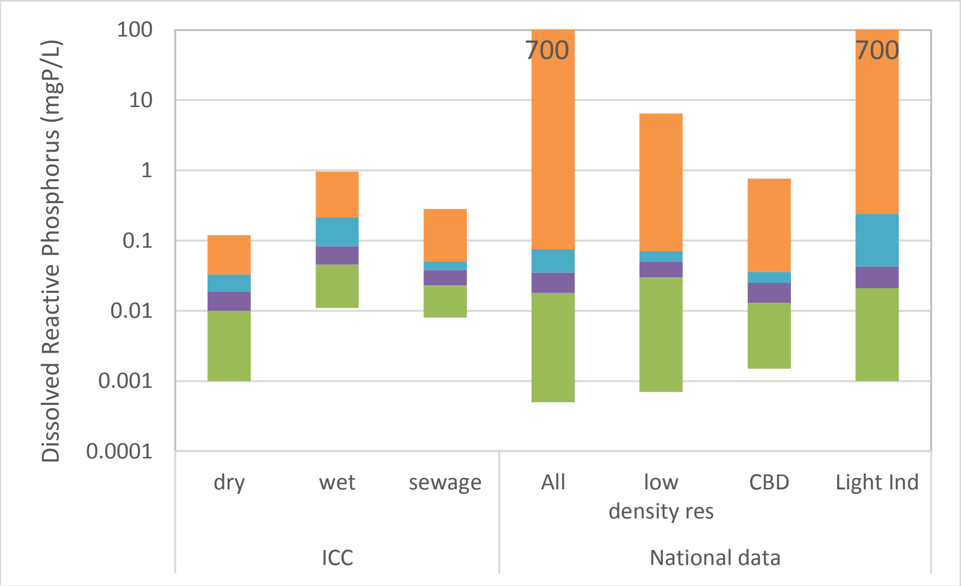


Figure 2-10: Comparison of ICC Dissolved Reactive Phosphorus concentrations to national data

2.4.6 Summary

A summary of this data with respect to the key potential effects and compliance with the relevant guidelines is given in Table 2-2. The shading used in the table is as follows.

1. Red indicates that the discharge may result in impacts on water quality in the receiving environment
2. Orange indicates that some impact may be occurring but only on occasion
3. Yellow, indicates that only minor impacts on few occasion expected
4. Green indicates minimal potential for impact.

The elevated *E.coli* generally reflects sewage contamination as discussed earlier. The nutrient concentrations may be a result of sewage contamination, but may also be sourced from groundwater and rural sources entering the networks. Metal concentrations found in Invercargill stormwater are generally at the low end of that found nationally as reported in the URQIS database.

Table 2-2: Summary of potential effects from discharges

Catchment and number of sites	Presence of sewage	ES Plan WQ Standards	Toxicity (95% protection)			Nutrients	
	E.coli >1,000 in dry weather	Ammonia (<2.2)	Ammonia (<0.9)	Nitrate	Metals[5]	Nitrogen	Phosphorus
Kingswell - 3 sites	Number of sites exceed	Few exceed in dry only	Few exceed in dry only	Most exceed in dry only	Most exceed for Cu and Zn. Few for Cr and Pb	Most exceed	Most exceed
Otepuni - 6 sites	Most exceed	OK	One site in dry only	Four sites in dry only	Most exceed for Cu and Zn. Few for Cr and Pb	Most exceed	Most exceed
Waihopai - 7 sites	Some exceed, half of time	One site few times	One site few times	All sites, most in dry, some in wet	Most exceed for Cu and Zn. Few for Cr and Pb	Most exceed	Most exceed
Waikiwi - 1 site	OK	OK	OK	Exceed few times	Most exceed for Cu and Zn. Half for Cr. Few for Ni and Pb	Most exceed	Most exceed

2.5 Maintenance of Infrastructure

2.5.1 Inspection and Maintenance

The pump stations shown in Appendix A and their mechanical and electrical plant range in age up to 40 years. Pump Stations are inspected several times a week by a pump operator, and are regularly maintained by electricians and fitters.

As at the 2014 Asset Management Plan, approximately 5.3% of the pipe network had been inspected by CCTV, and some visual inspection has been done from manholes and excavations during maintenance work. Parts of the network have no manhole access, and the only visual inspection of these pipe lengths have resulted from maintenance work. The parts of the asset so affected are throughout the older (pre 1950) parts of the inner city, but predominantly in South Invercargill. Approximately 28 km of pipe, or 21% of the whole network has no manhole access.

[5] Analysis is performed for total metals and hence is a conservative assessment of the potential for toxicity effects, given that some of the metals will be bound and hence not bioavailable.

Manhole checks are performed over each summer and consist of a sample of the manholes in the sewer and stormwater systems being lifted to check typically on the condition of the assets. The number of manholes inspected since 2011 are shown in Table 2-3. There are 3475 sewer manholes and 3453 stormwater manholes in the network, so in this 5 year period, ICC have surveyed 33% of sewer manholes and 29% of stormwater manholes. Manholes were selected for survey based on the following:

- areas within the city missing the most data
- location of the manhole being safest for accessing e.g. footpath, out of live traffic lanes etc
- specific areas where future works were planned
- specific locations where data was absent or confusing.

Manholes are surveyed within both the Freshwater and CMA discharge areas and hence the numbers provided are not only for the catchments covered by this consent application.

In the summer of 2015/16, these checks were expanded to include a note of whether any signs of contamination are present in the stormwater manholes. This included specific comment on whether there is any visible sewage debris, slimes, or odour.

Table 2-3: Manhole surveys undertaken

Year surveyed	Stormwater	Foul sewer	Total
2011	167	66	233
2012	158	146	304
2013	429	437	866
2014	223	215	438
2015	169	134	303
Surveyed to Date	1146	998	2144

2.5.2 Sump Cleaning

There are a total of 4966 sump assets recorded with an average age of 41 years. Within kerbed areas, each stormwater structure is inspected either 3 times per year for those on the main arterials and collector/distributor/commercial road, and at least once per year on other roads and walkways and off street car park structures.

The sump box is completely emptied using mechanical vacuum cleaning as required. A record of the number of sumps emptied over the last six years is shown in Table 2-4. No information is available on the amount of material removed. This indicates that not all sumps are emptied each year. Any issues relating to the condition of the structure noted during cleaning is recorded.

Table 2-4: Emptied sumps

Sumps Emptied	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2010							181	114	32	12	11	1	**351**
2011	1	98	23	620	41	493	2393		413	1			**4083**
2012		563	192	56	1	621	1				2	62	**1498**
2013	2		1		2	2	3	933	2	6	256		**1207**
2014				265	27	138	382	180	6	7	27	161	**1193**

Sumps Emptied	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
2015	31	16	13	6	34	36							**709**
Monthly Total	**34**	**677**	**229**	**947**	**105**	**1290**	**2979**	**1229**	**999**	**32**	**296**	**224**	**9041**

2.6 Renewal Programme

The Council initiated a renewal programme in 2009 to replace the aging infrastructure, to ensure that the levels of service are maintained. The stormwater and foul sewer mains that have been renewed since 2009 have been summarised in Table 2-5.

Table 2-5: Length of stormwater mains installed between 2009 and 2015

Year	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015	Total
Stormwater Length (m)	651	1270	1168	3575	1109	1976	**9748**
Foulsewer Length (m)	826	1068	1768	2780	**N/A**	1498	**7940**

As part of the recent LTP consultation, the option to increase the renewal budget to 1% renewal by 2021 was accepted after consultation as discussed in Section 9. This equates to replacement of approximately 1% of the network on an annual basis. At this rate of renewal, the replacement of the ageing earthenware infrastructure could take an estimated 50 to 60 years. The renewal process is an ongoing continuous requirement as the infrastructure of the city ages. Pipes are upgraded based on the following criteria:

- Age
- Material
- Diameter
- Criticality
- Maintenance Tasks
- Under Capacity
- Roading Reseals
- Footpath Renewals
- Removing Mains from within Private Property
- Infiltration.

2.7 Audits of Industrial and Commercial Sites

Site audits are summarised in Table 2-6 which is taken from the 2015 ICC annual report submitted for the current consent. These audits identify if the site has previously had operations or facilities which may produce contaminants. Some sites have been revisited during the period, hence the % audited being over 100% for Otepuni catchment.

The original “properties identified for audit” was based on those identified on hazardous substances registers as having hazardous substances on site. On further examination, a number of these locations were found to not relate to a potential risk of discharge to stormwater, such as gas installations. Also, The ICC has extended the identification of properties for audit beyond those solely on the hazardous substances register, particularly in the Otepuni catchment.

Table 2-6: Audits of Industrial and Commercial Sites within the Catchments

Catchment	Properties identified for Audits	2012	2013	2014/15	2016	Percentage Audited to Date
Waikiwi	2	1	-	-	1	100%
Waihopai	169	30	21	-	5	34%
Otepuni	69	53	38	52	14	228%
Kingswell	4	3	-	-	8	275%
Clifton	2	2	-	-	1	150%
Totals	246	89	59	52	29	

Generally, these audits have shown good on site management of hazardous materials with adequate methods implemented to avoid discharges of material to the municipal stormwater network. Some audits did identify risks to stormwater which were identified at the site.

2.8 Sewage Contamination

As discussed in Section 2.4.2, Condition 6 of the existing consents requires that if an elevated *E.coli* count is found in the monitoring, the ICC was to commence investigations to source and eliminate the sewage contamination. This section relates to the non-engineered sources of sewage resulting from illegal sewer connections to the stormwater network or indirect connections due to the condition of the systems. Sewer overflows due to blockages and storm events are discussed in Section 2.9.

It is noted that the discharge of raw sewage is prohibited under Rule 14 of the Regional Water Plan and hence these discharges are not included in the scope of the application but the programme to detect and reduce these discharges is included.

The investigations undertaken by the ICC involved sampling at various locations in the network generally for *E.coli*. Some locations have been sampled on multiple occasions. The data collected represents a considerable effort on the ICC's part to locate these sewage discharges.

Table 2-7 presents the summary provided by the ICC of the findings of investigations undertaken from 2011 to 2015.

Table 2-7: Summary of findings of Investigations (from the ICC)

Catchment and Outfall	Catchment	Problem	Repaired	Comment
Waihopai				
Talbot Street Outfall	Talbot Street	Sewage reported at outfall	Yes	Testing has not shown evidence of faecal contamination
Queens Drive Outfall True Left Bank Upstream of Bridge	Herbert Street North	High faecal counts, ammonia	Partial	Cross connection in 2 houses in Herbert Street but evidence of other contamination.
	Herbert Street South	High faecal counts, ammonia	No	
	Chelmsford Street	High faecal counts, ammonia	No	
	Layard Street	High faecal counts, ammonia	No	

Catchment and Outfall	Catchment	Problem	Repaired	Comment
	Albert Street	High faecal counts, ammonia	No	
Russel Street Outfall	Grey Street	High faecal counts	Yes	Consistent elevated counts in a small section of Stormwater. Problem disappeared without any work done?
	Albert Street	High faecal counts	No	
	Duke Street	High faecal counts	No	
Prestonville Pump Station Outfall	Preston Street	Commercial carwash to Stormwater	Yes	Carwash diverted to sewer
Otepuni				
Camden Street Outfall	Islington Street	High faecal counts, evidence of laundry waste	No	Some contamination isolated to one property but no evidence of a problem on the property. Other contamination in pipeline also not found.
24 Orwell Cresent True Left Bank	Centre Street	Cross Connection	Yes	House had Stormwater and Sewers plumbed back to front
Kingswell				
Brown Street Outfall True Left Bank Downstream Bridge	Manapouri Street	High faecal counts	Partial	Broken pipes repaired but contamination still evident

The delay from collecting the sample and getting the results for bacterial analysis and the inconsistency in the results obtained has resulted in considerable difficulty in tracking it to its source using this method. The ICC are trialling the use of an in-situ meter for fluorescent whitening agent, which will be present in grey water, as it is in most cleaning products. This will enable real time tracking of sources of contamination and hence may help with tracking sources of contamination.

During the site visits for the Treatment Review reported in Appendix A, the distance between the Council's sewerage and stormwater network was checked. This was to determine if the Council owned assets were laid in the same trench, and hence resulting in potential exchange between the networks. It was noted that generally there was at least 0.5m and generally more than 2m, distance between the manholes for the two systems. Therefore, given this separation and the relatively impermeable nature of soils that the network are placed in, exchange between the Council stormwater and sewage pipes is not considered probable. However, on the privately owned pipes from the house to the street, stormwater and sanitary sewers were observed to be laid in the same trench. Therefore, exchange could be occurring within the private network.

Once identified, issues with detected contamination can be resolved through enforcement under the Building Act if the source is the direct connection of sewage to the stormwater network. However, if the source is a more diffuse source resulting from indirect connections due to the ageing infrastructure, this will require a more long term solution through renewals and probably works on private property.

The ICC have recently employed a drain layer to help with investigations of the stormwater contamination. He has been assigned parts of the stormwater catchments that have suspected contamination and is conducting dye testing and where necessary, remediation of problems encountered.

2.9 Sewer Overflows

Sewage can discharge to the stormwater network from the sewerage network through blockages in the sewer system which cause sewage to overflow to the stormwater system through engineered overflow points. These can occur throughout the network and are hard to predict. CCTV inspection shows the network to be in good condition structurally, and maintenance records show low numbers of system blockages and collapses, confirming the generally good condition of the pipe network.

The ICC have real time telemetry on sewer pump stations which alert them to pump failure and high well levels, which could lead to overflows.

The other way in which discharges of sewage can occur to the stormwater network is through engineered overflows from the sewer system which can occur as a result of storm conditions.

The sewer pipe network is aging with the oldest parts of the network now 100 years of age, which is the assumed economic life of the pipes. A flow monitoring survey of the sewer network has revealed high levels of stormwater infiltration in some areas, which have led to sewage overflows from the sewer network.

The ICC undertook a review of the sewer network and the sewer overflows in 2013, including modelling of the network. The review identified 64 historical overflow locations, 52 within the model study area. The model study area included the freshwater catchments as well as CMA areas. 19 of the 52 recorded overflows were validated in the model as spilling or close to spilling. These were reviewed again in November 2015, and the potential sites of overflows are shown in Figure 2-11.

A monitoring programme was implemented at these 19 locations, to determine if overflows do occur in reality. This monitoring consists of a float which is located on the overflow, which will be dislodged if an overflow occurs. Since 2013, the floats are inspected intermittently, generally at one or 2 month intervals during the winter.

The monitoring has indicated that only two of the potential overflows have definitely discharged. Overflows have occurred at these two locations on at least three occasions each, as indicated by the dislodgement of the float and other evidence of sewage flow down the overflow. It should be noted that the monitoring does not indicate the number of occasions between visits that the overflow occurred, but just that at least one overflow has occurred during the interval from the previous visit. These two locations are shown in red on Figure 2-11; only one of these discharges is to the stormwater network.

At other locations, the floats were dislodged but there was no other evidence of an overflow; these are shown in orange in Figure 2-11, and it is considered unlikely that an overflow occurred at these sites, given the lack of other evidence observed.

The renewal programme is focused on reducing the inflow and infiltration to the network to reduce the frequency and quantity of discharge from these overflows. However, this is a long term solution.

It is noted that given Rule 14 in the current Plan, the discharge of raw sewage is a prohibited activity and hence these discharges from the sewer overflows are excluded from this application. They have been identified to enable an understanding of the various discharges which can impact upon the streams within Invercargill City.

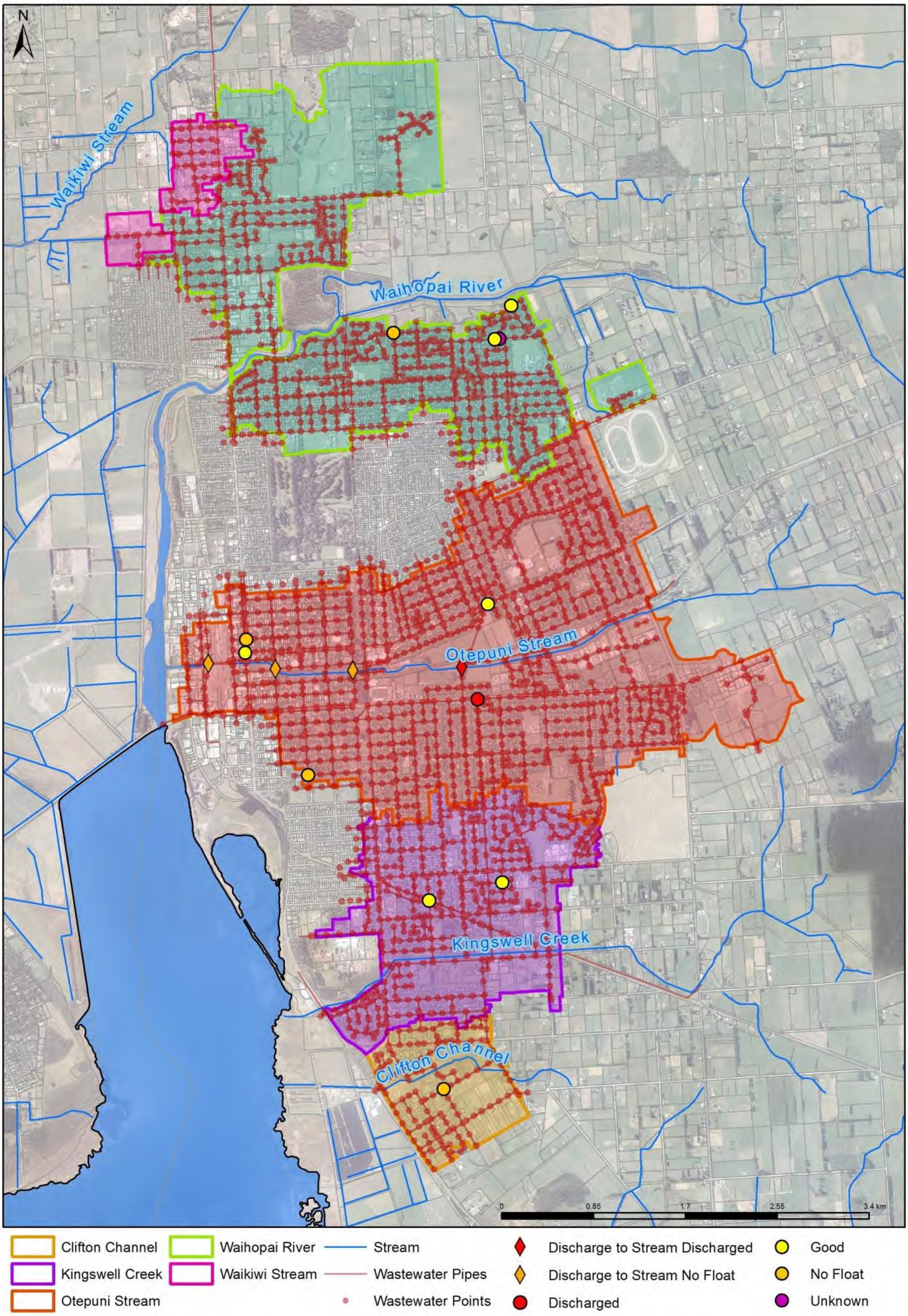


Figure 2-11: Locations at which monitoring for sewer overflows has occurred

3 Description of the Receiving Environment

3.1 Catchments

3.1.1 Size

The stormwater catchments discharge to the following water bodies:

- the Waikiwi Stream, which is a tributary to the Oreti River which discharges to the New River Estuary on the western side
- the Waihopai River and the Otepuni Creek, which discharge to the Waihopai arm of the New River Estuary
- Kingswell Creek and Clifton Channel, which discharge to the eastern side of the New River Estuary.

The extent of the stormwater catchments are shown in Figure 2-3. The extent of the receiving streams catchments and the contributing streams are shown in Figure 3-1. The catchments shown are based on the River Environment Classification (REC) from NIWA, which is a database of catchment spatial attributes, summarised for every segment in New Zealand's network of rivers.

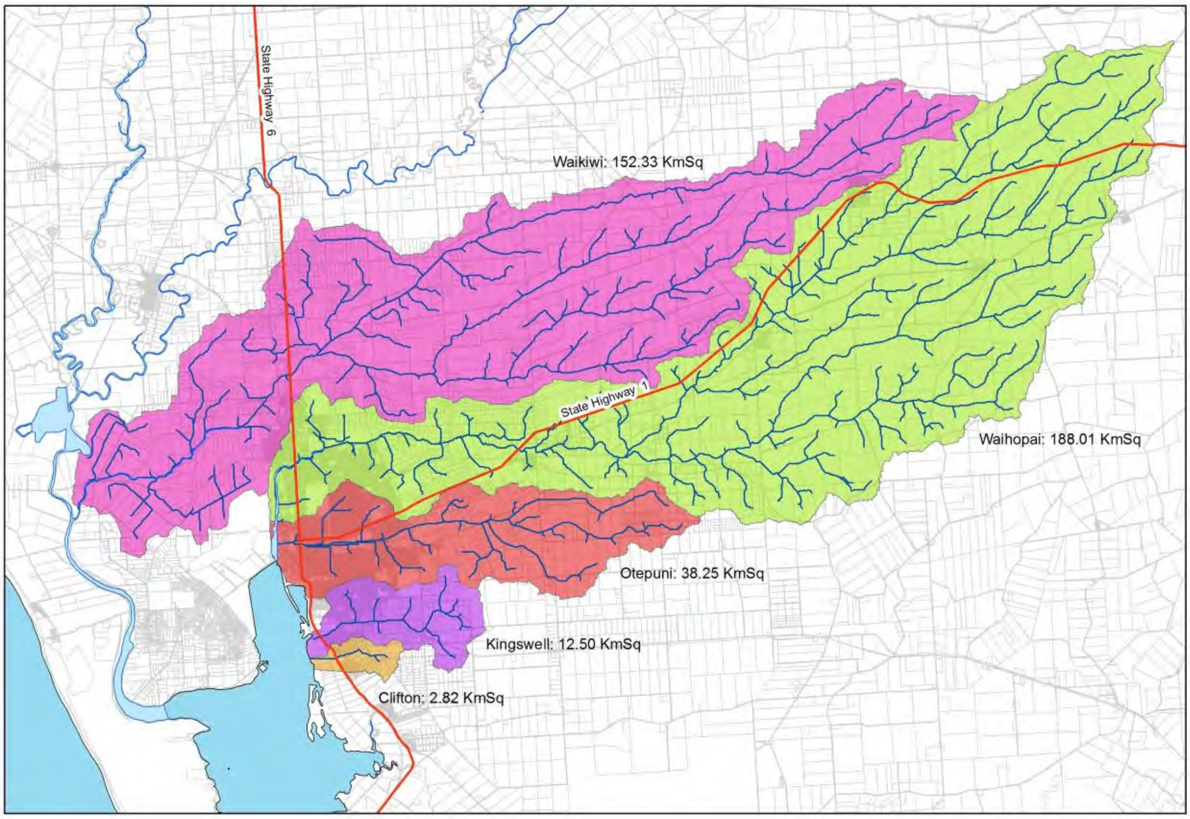


Figure 3-1: Extent of the catchments of the receiving streams

Table 3-1 compares the size of the receiving streams catchment against the contributing ICC stormwater network catchment. Clifton's stormwater network is almost half of the stream catchment. Kingswell and Otepuni represent a significant portion of the receiving stream catchment being between 20% and 30%. The Waihopai stormwater catchment is less than 5% and the Waikiwi stormwater catchment is relatively small, being less than 1% of the total stream catchment.

Table 3-1: Summary of Receiving Streams Catchment Characteristics

Catchment	Receiving Stream Catchment Area (sq-km)	Invercargill Stormwater catchment area (sq-km)	Urban Stormwater catchment as % of Receiving Stream catchment (%)
Clifton	2.82	1.31	46.4
Waihopai	188.01	7.03	3.7
Kingswell	12.54	3.82	30.4
Waikiwi	152.33	0.69	0.5
Otepuni	38.25	10.49	27.4

3.1.2 Nature of Receiving Water Bodies

Photographs of each receiving water body taken in their lower reaches are provided in Figure 3-2. The following is a description of the physical features of each of the water bodies.

Waikiwi Stream

The source of the Waikiwi Stream is flat low-lying farmland to the north of the township of Dacre. Its highest elevation is 80 m down to 10 m where it joins the Oreti River approximately 5 km north west of Invercargill Airport. The catchment has several large branching tributaries that drain a catchment area of 152 km^2 before reaching the Oreti confluence.

The Oreti River has a catchment draining 3,400 km^2, beginning in the Thompson Mountains immediately east of the North Mavora Lake and flows south through Mossburn, Lumsden and Dipton before discharging into the sea via the New River Estuary.

The Waikiwi drains a portion of the Invercargill City reticulated stormwater network. There are four stormwater discharges to a drain along Gloucester Street, which is diverted to the Waikiwi Stream at West Plains Road. The drain is considered part of the receiving environment. Site investigations show that the Waikiwi Stream in the area of the discharge from the drain has a high coverage of weed growth. There is also a stormwater discharge to a ditch at the west end of Renfrew Street, which discharges to the Waikiwi Stream.

Waihopai River

The source of the Waihopai River is low hill country between Edendale and Dacre. Its highest elevation is 100 m where it originates down to 10 m where it exits into the New Estuary harbour. The catchment has several large branching tributaries that drain a catchment area of 188 km^2.

Within Invercargill city, the Waihopai River flows through a combination of rural, residential, commercial and industrial landuses. There are stopbanks along the length of the River within Invercargill city. The first stormwater outfall from the ICC's reticulated stormwater network enters the Waihopai River at the end of Racecourse Road. There are 39 stormwater outlets to the Waihopai River, 4 of which drain into ditches before discharging into the Waihopai and 2 which drain to the Thompson bush reserve tributary.

The river then flows through farmland and open recreational land alongside the Waihopai Embankment Walkway. Here the river has been straightened and diverted from its original course which previously flowed through Thomsons Bush Reserve. The river then flows beneath Queens Drive Bridge where it now follows a more natural meandering course, past the commercial / industrial area to the north of the river and primarily residential to the south before flowing beneath the Dee Street Bridge and out into the New River Estuary.

Otepuni Creek

The Otepuni Creek is a highly modified Creek which flows through the centre of Invercargill City. The catchment above the city is relatively flat farmland, with 40m highest elevation and 10m lowest. The catchment area is 38 km^2. The Creek has been straightened from its original course to allow for drainage and town planning. Stop banks have been created along its length as a flood protection measure and this has enabled the creation of landscaped gardens between Forth and Tyne Streets which provide an area within the central city for seclusion and recreation.

Within Invercargill city, the Otepuni Creek flows through a combination of rural, residential, commercial and heavy industrial landuses. The first stormwater outfall from the ICC's reticulated stormwater network enters the Otepuni Creek beneath the bridge at Rockdale Road. The Creek then flows alongside Otepuni Avenue; through parkland / recreational grounds between Islington and Tweed Streets before flowing through Otepuni Gardens in the centre of the city. The Creek is then culverted beneath the heavy industrial area between Liddel and Mersey Streets; composed predominantly of railway yards and sidings before entering the New River Estuary. There are a total of approximately 67 stormwater outfalls from ICC's reticulated network which enter the Otepuni Creek.

Kingswell Creek
The Kingswell Creek catchment is a very small catchment which primarily takes the ICC reticulated stormwater from a rural residential area; Kingswell and Kew, south of Invercargill City centre. The catchment has a highest elevation of 20m, and lowest 10m. The catchment area is 12.5 km^2.

South of Invercargill City Centre, the Kingswell Creek flows through a combination of larger lifestyle blocks and residential landuses. The first stormwater outfall from the ICC's reticulated stormwater network enters the Kingswell Creek beneath the bridge at Chesney Street. The stream then flows alongside Ball Street; adjacent to larger lifestyle blocks, south of the Invercargill Hospital. The stream is then culverted beneath State Highway 1 before entering the New River Estuary. There are a total of approximately 29 stormwater outfalls from the ICC's reticulated network which enter the Kingswell Creek.

Clifton Creek
The Clifton Channel is a minor waterway to the south of Invercargill City centre, with a catchment elevation of 10m and catchment area of 3km^2. The catchment of the ICC stormwater network is 46% of the total catchment, with the remainder of the catchment being farmland or lifestyle blocks.

The first stormwater outfall from the ICC's reticulated stormwater network enters the Clifton Channel at Bain Street where it is an open ditch in a field. The stream then flows through farmland before flowing beneath Wicklow Street and State Highway 1 before entering the New River Estuary to the north of the Clifton WWTP. There are a total of 6 stormwater outfalls from the ICC's reticulated network which enter the Clifton Channel.

3.1.3 Groundwater

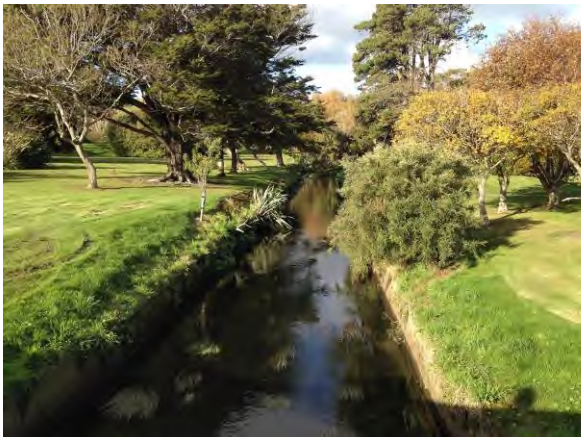
Most of the area is within the Waihopai Groundwater Zone, with the Waikiwi catchment being in the Makarewa Groundwater Zone.

The Environment Southland data sheets for these Groundwater Zones indicate the following:

- *"The subsurface geology of the Waihopai catchment consists of a relatively thin (<30 metre) layer of weathered Quaternary gravels overlying Tertiary sediments of the Eastern Southland group. The subsurface geology of the Makarewa groundwater zone consists of relatively thin Quaternary gravel deposits overlying Tertiary Gore Lignite Measure sediments.*
- *The gravel deposits consist of poorly sorted quartz sand and gravel in a highly weathered clay matrix. These gravels form a low-yielding unconfined aquifer system that extends across much of the Waihopai and Makarewa groundwater zone.*
- *Groundwater quality is generally good in both groundwater zones, although it does vary according to the source aquifer and location. Groundwater in the gravel deposits can be susceptible to nutrient enrichment, although does generally remain within the acceptable limits set by the drinking water standards.*
- *Groundwater that is sourced from the Tertiary aquifers can contain high iron concentrations, which is characteristic of the mudstone and lignite geology.*
- *Recharge to both zones is exclusively from rainfall recharge. The extensive land drainage by mole, tile and artificial drainage channels may have a significant influence on the actual rate of groundwater recharge in many parts of the groundwater zones. A majority of groundwater is discharged by local infiltration into drainage channels and first and second order streams."*

Waikiwi Stream by West Plains Road

Waihopai River in Thompson Bush Park



Otepuni Stream in Otepuni Gardens

Kingswell Creek near Kew Hospital

Clifton Channel near the Clifton Wastewater Treatment Plant

Figure 3-2: Photographs of the lower reaches of the receiving streams

3.2 Rainfall and Temperature

Two temperature stations were identified from Environment Southland and showed a seasonal temperature variations as shown in Figure 3-4 below. The Pomona Street station showed less variation over the year with marginally warmer winter temperatures and cooler summers. The Pomona Street station also showed a shift in the minimum temperature being in July compare to Glengarry Street which is in June.

Two rainfall stations were identified within the catchments draining the five freshwater zones. These were both at dams, on the Waihopai River and Kingswell Creek. The rainfall profile showed average daily rainfall is fairly consistent over the year with slightly lower rainfall present in July and August. There appears to be no major trends between the two stations.

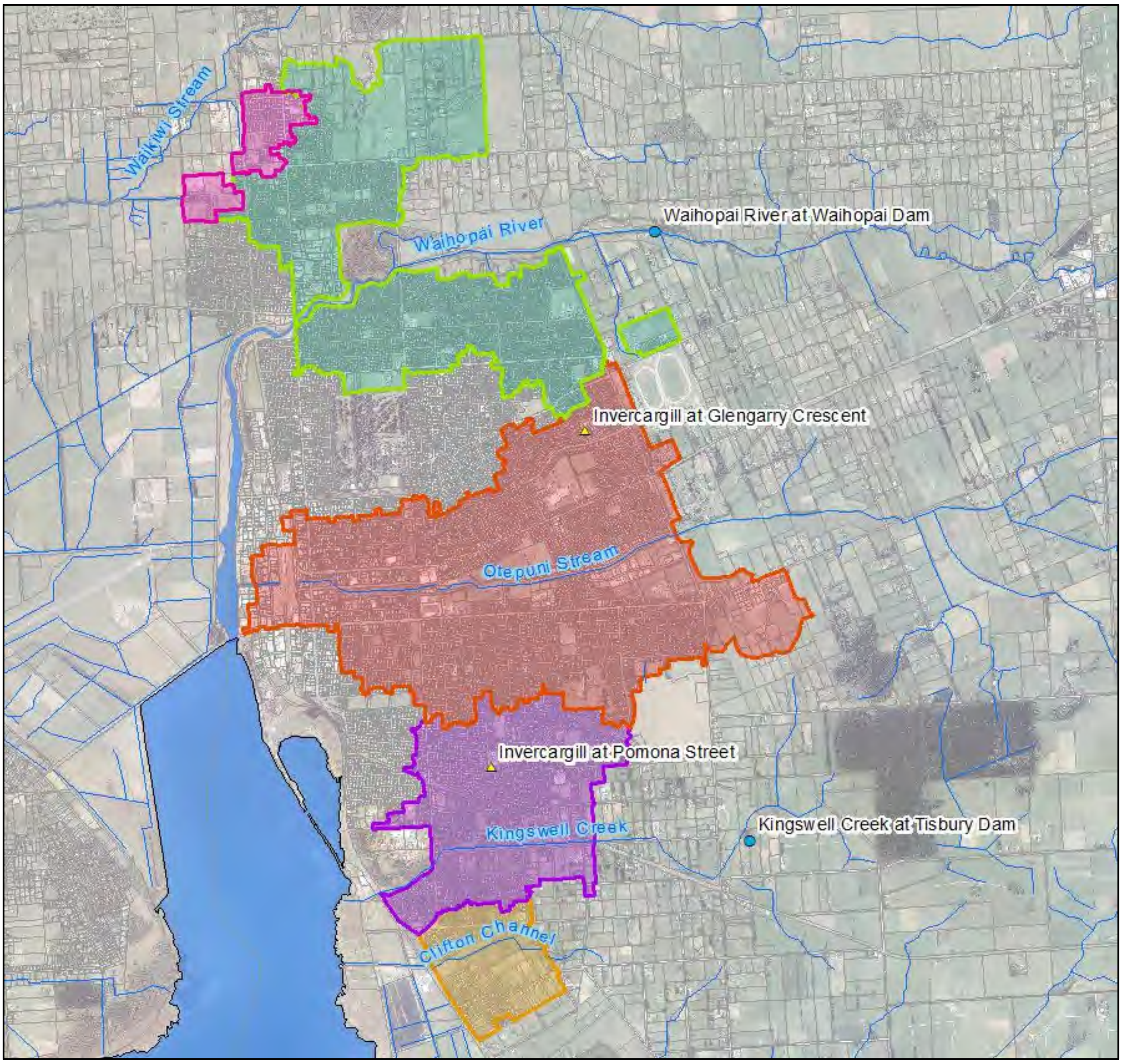


Figure 3-3: Location of Environment Southland Rainfall and Temperature gauging stations

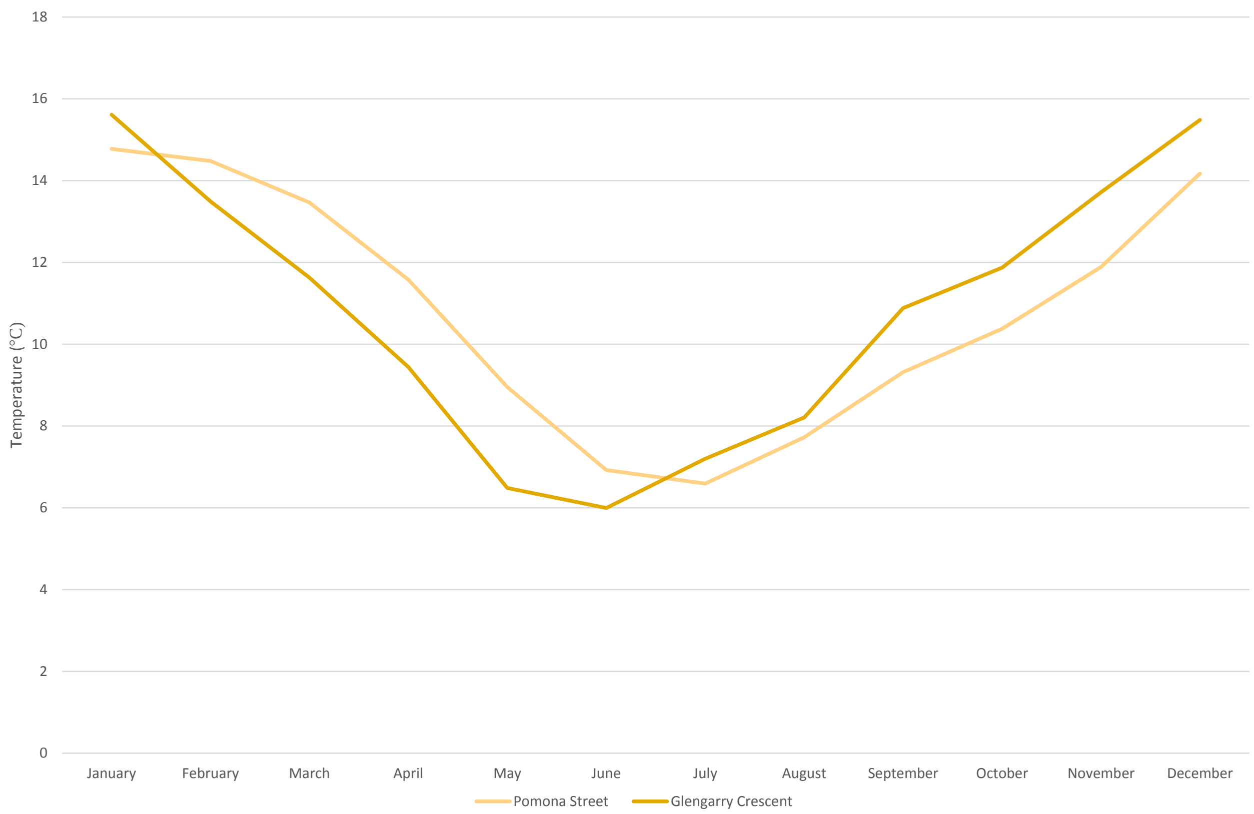


Figure 3-4 Average daily temperature for Pomona and Glengarry street stations

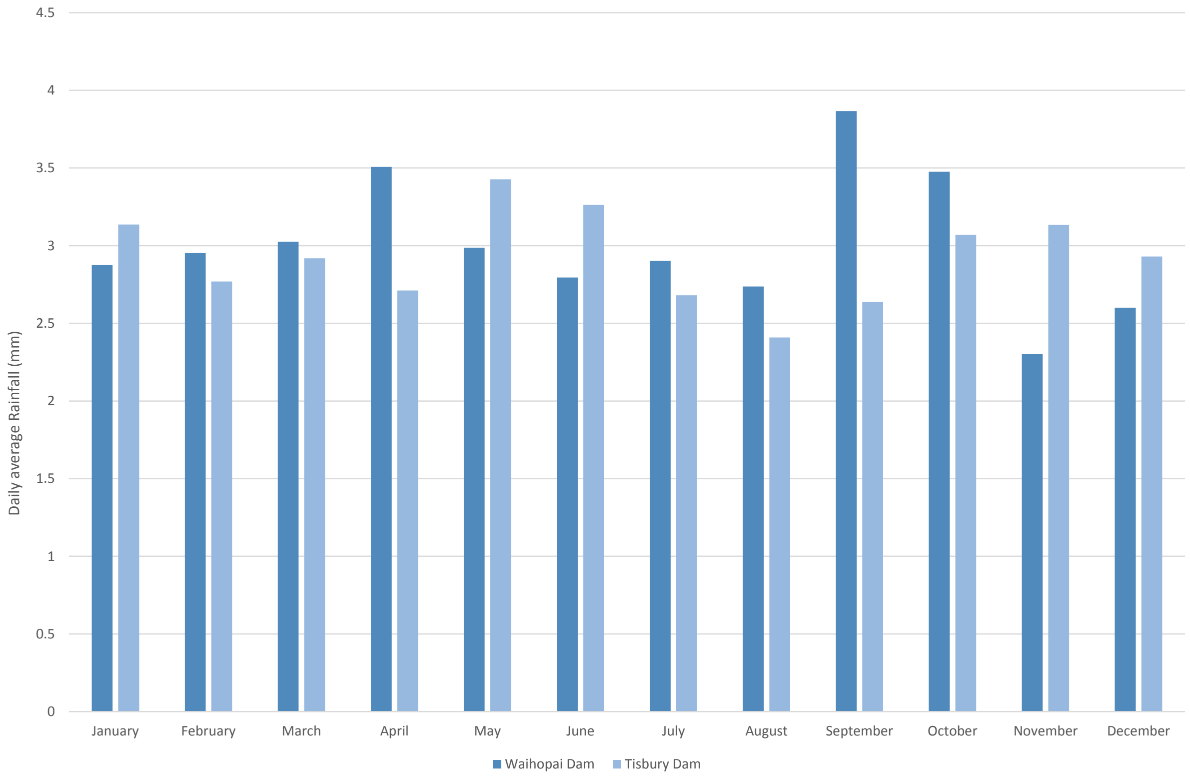


Figure 3-5 Average daily rainfall for Waihopai and Tisbury Dam Stations

Figure 3-6 presents the number of days where there has been less than 0.5mm of rain in the previous 72 hours (taken as the definition of “no rain”). This is grouped by each month of the year and each individual bar is the value for each year from 1992 to 2015. This shows that there is minimal monthly variation in the number of “dry” days per month, although there is slightly less during the winter months.

There is generally less than 5 "dry" days per month and there is often only a single day in a month. This illustrates the difficulty in scheduling sampling during "dry" days. Also, it shows that in Invercargill there is generally not prolonged periods when contaminants can build up on surfaces before being washed off by rainfall. This could be the reason for the generally low concentrations on contaminants in the ICC stormwater discharges as compared to national data as discussed in Section 2.4.

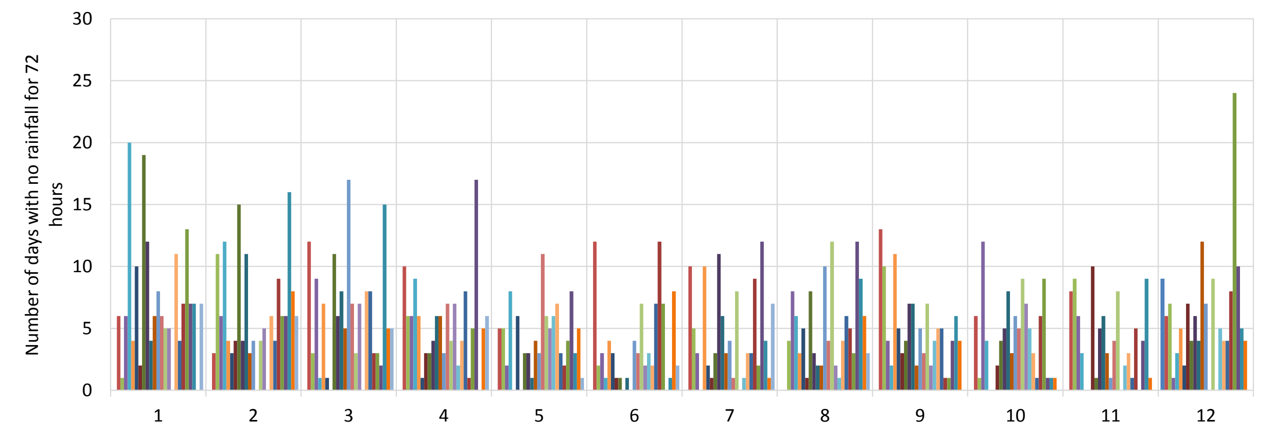


Figure 3-6 Number of days with no rainfall for 72 hours from Waihopai Dam Station (1991 to 2015)

3.3 Water Quality

3.3.1 Introduction

The consents required monitoring of the quality of the water bodies. The sampling locations are identified in Figure 3-7 as pink dots. Sampling was targeted to specific rainfall periods. From 2012 to 2016, between 13 and 19 sampling events (dependent upon location) were collected at each location in dry weather conditions and 5 or 6 in wet weather conditions.

The full record of the receiving water monitoring data undertaken by ICC is provided in Appendix B. The data has been formatted to show the variation for each parameter between the various sites, with the highest measurement being red and the lowest being green.

The data from the State of the Environment monitoring conducted by Environment Southland in the area has been provided. The relevant monitoring locations for the Invercargill discharges were:

- Otepuni Creek at Nith Street, which in the lower reaches of the stream within the city
- Waihopai River u/s Queens Drive, which is upstream of the discharges from the Invercargill stormwater network
- Waikiwi Stream at North Road, which is upstream of the discharges from the Invercargill stormwater network.

Data has been provided from 1995 where available and is generally collected every month. Monitoring includes a variety of parameters, which provide the general context for the discharges and constitutes a long term record of the water quality at these sites. This data has not been formally reported but is summarised in the Environment Southland Beacon data from July 2009 to June 2014.

Environment Southland have also provided the data from their Living Stream programme which includes monitoring of water quality at a number of locations from 2001 to 2014, including a number of locations in the Invercargill urban area, which appear to have been monitored from 2007. This also provides useful background on general conditions.

A number of reports have also been reviewed mainly from Environment Southland and relevant information summarised in this application.

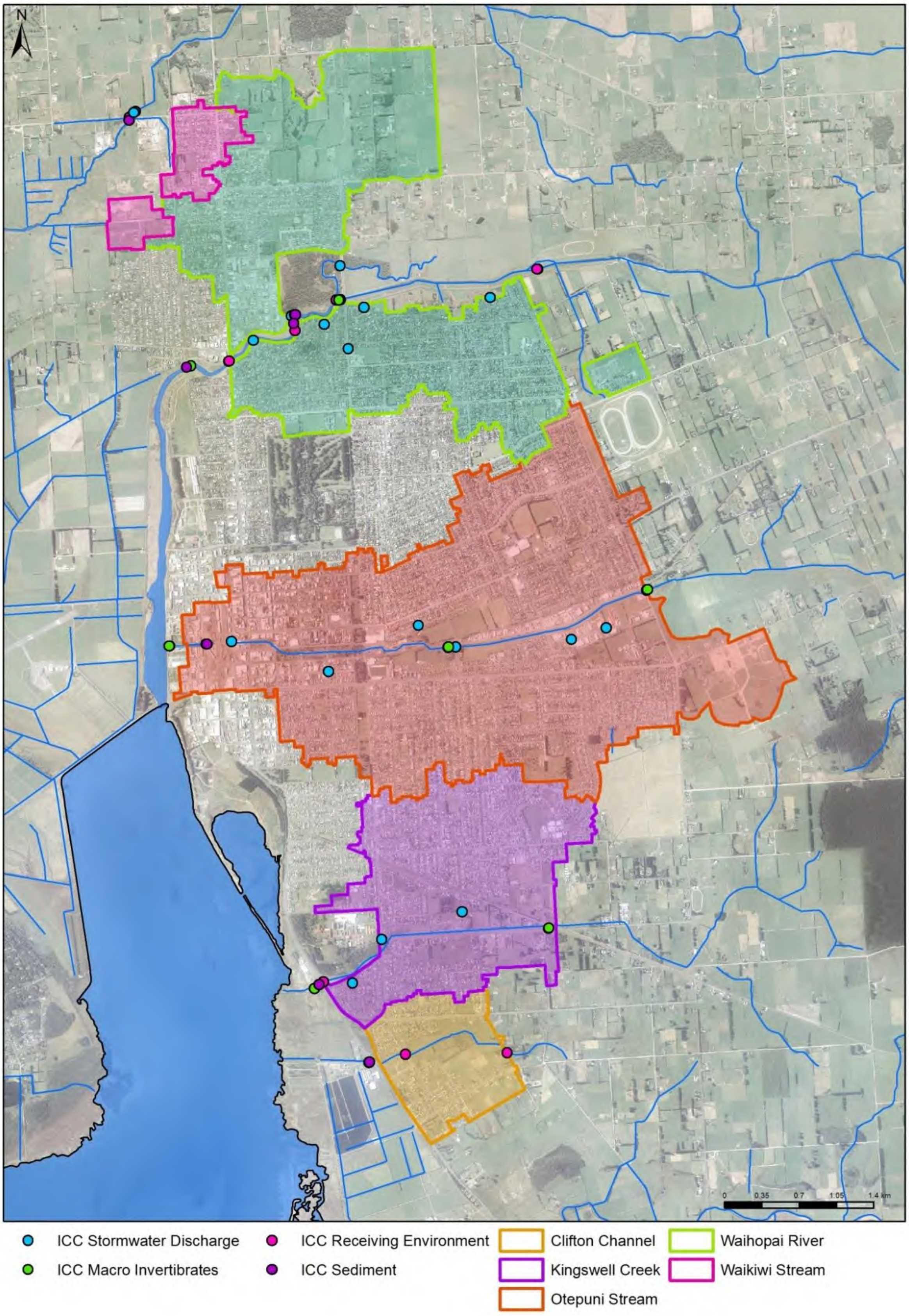


Figure 3-7: Location of ICC monitoring points

3.3.2 Public Health (Bacteria)

Figure 3-8 presents a summary of the data from both the ICC monitoring and the ES State of the Environment (SOE) monitoring, which is for a much longer period, and includes significantly more data points. The data is grouped by catchment, with 1 being the most upstream location, then progressing down the stream in order.

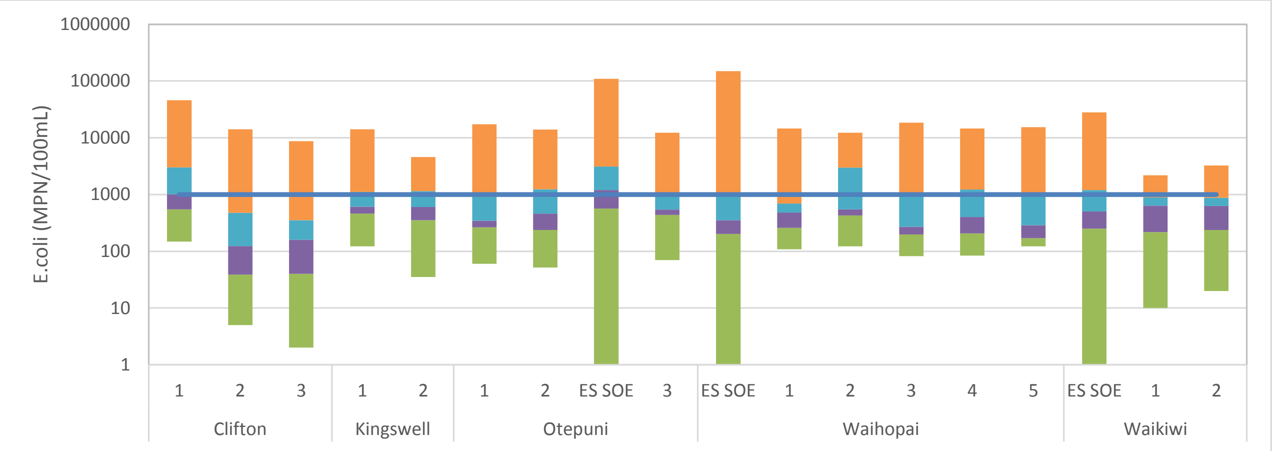


Figure 3-8: Range of *E.coli* from ICC and ES SOE monitoring[6]

This shows that the *E.coli* concentrations in all of the streams often exceeds 1,000 MPN/100mL, on more than 25% of the sampling occasions. For the ICC monitoring where rainfall was noted, the wet weather samples generally had higher concentrations than the dry weather.

Given that *E.coli* is a subset of faecal coliforms, this indicates that the Regional Plan standard for these water bodies is not complied with for between a quarter and half of the time. The standard is exceeded upstream as well as through the catchment of the stormwater network, and there is minimal change through the locations of the discharges, except in Otepuni Creek, as indicated by the ES SOE data and in Clifton Creek where the upstream location had much higher concentrations than the downstream samples.

Therefore, these results coupled with the monitoring of the discharges themselves indicates that the stormwater discharges are contributing to elevated bacteria concentrations in the water bodies, particularly during wet weather, but is not the sole source of bacteria to the water bodies, and potentially not the most significant.

While a number of the wet weather stormwater discharges were elevated above 1,000 MPN/100mL as shown in Figure 2-4, the highly elevated bacteria concentrations in the discharges are understood to be associated with connections of sewage to the stormwater system, which is not included in the scope of this application and a programme for the removal of these discharges from the network is provided in Section 5.

It is expected that any sewage in the discharges would significantly contribute to exceedences of the Plan standard in the receiving water, however the discharge of sewage is not included in the scope of this consent.

Normal stormwater in wet weather events has elevated bacteria. The discharge monitoring indicated dry and wet samples (without sewage influence) would be similar for bacteria. For the streams, where the stormwater system is a significant part of the overall catchment, it is likely that in wet weather events, the discharges will contribute to exceedences of the standard. For the larger water bodies, the effect of the normal wet weather stormwater discharges would be less due to the greater dilution available.

[6] Each quartile of the data sets are shown in a different colour, ie the lowest 25% of each data set is in the green band. The interface between the blue and purple band is the median and the orange band is the top 25% of the data.

In dry weather, the stormwater discharges is expected to be relatively low flow and hence it is expected that they would not significantly impact on compliance with the standard.

Therefore, the discharges for which this consent is sought are anticipated to contribute to the observed non-compliance with the Regional Plan faecal coliforms standard, generally during wet weather in the smaller receiving water catchments.

3.3.3 Dissolved Oxygen

Figure 3-9 presents the historical record of dissolved oxygen monitoring from the ES SOE monitoring. In 2007, the method was changed from a lab based method after fixing of the sample to a field based method. The data appears reasonably consistent between the periods, although the later monitoring appears to be slightly higher. The limits in the NPS-FM for Dissolved Oxygen are included as lines on the graph.

This data is not directly comparable to the NPS-FM as the ES SOE data is from single samples collected during the day rather than from a continuous record which will include the worst case daily minimum record which is generally around dawn. However the data indicates that at all three SOE sites, the dissolved oxygen would typically exceed the Grade A limit, but there were occasional readings that did not comply with the Grade B. All results complied with the National Bottom Line limit. This includes the two upstream SOE sites.

Comparison with the NPS-FM limits for the ICC monitoring has similar limitations as the ES SOE data. Figure 3-10 shows that generally the ICC monitoring indicates dissolved oxygen which complies with Grade A limit, but Clifton and Kingswell included a number of data points which did not comply with the Grade C limit. This was generally in dry weather samples, when flow in the streams would be low. Whilst the stormwater discharges may be contributing to this reduced dissolved oxygen concentrations, the physical nature of streams will be influencing this, as the straightened stream allow minimal opportunity for natural re-aeration.

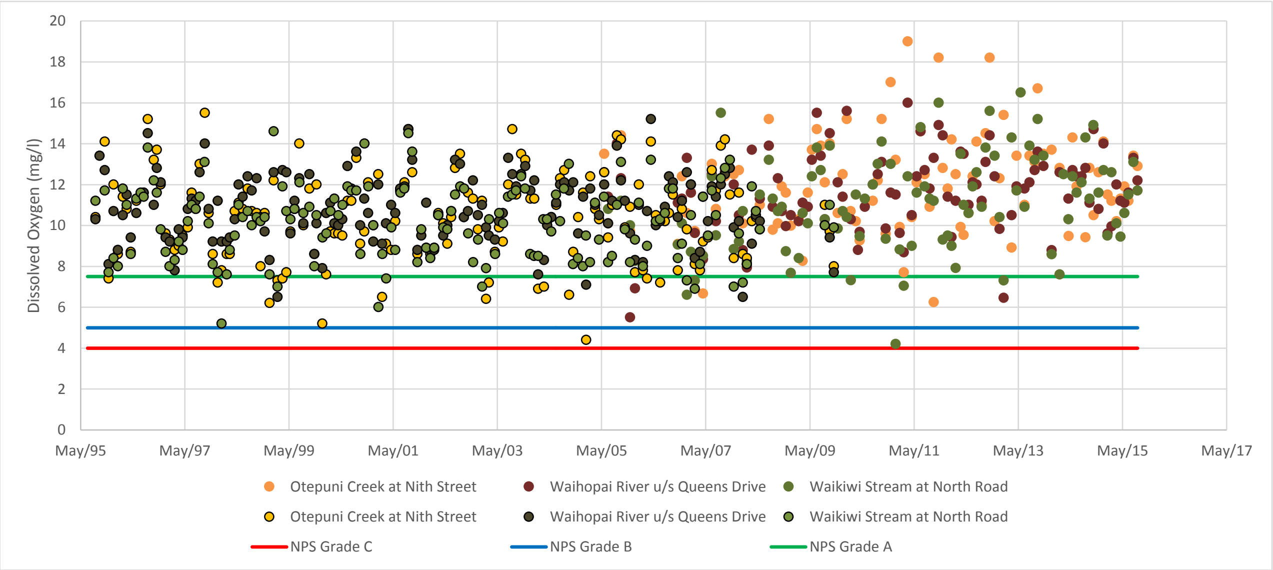


Figure 3-9: ES SOE monitoring of Dissolved Oxygen

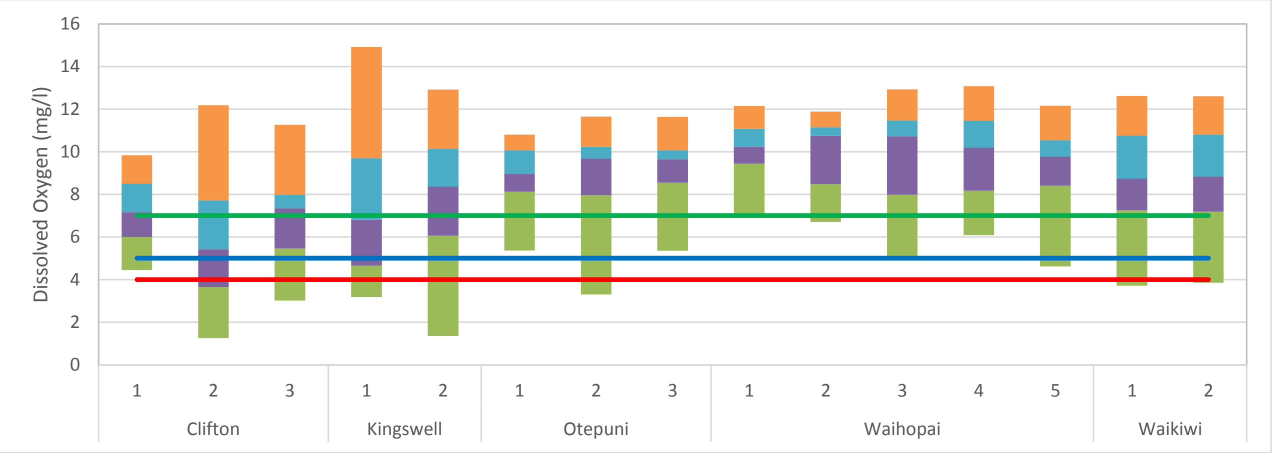


Figure 3-10: Range of dissolved oxygen from ICC monitoring

3.3.4 Toxicity (ammonia, and metals)

Figure 3-11 summarises the range of ammoniacal nitrogen concentrations recorded in the ICC and ES SOE monitoring programmes as described in Section 3.3.1. These indicates that ammoniacal nitrogen has generally been less than the 95% Trigger Value to protect against toxicity, and there is minimal spatial variation in concentration, except for Clifton which had significant concentrations upstream of the ICC network, which have generally reduced by the lower reaches.

The total concentrations of zinc and copper recorded in the ICC monitoring are given in Figure 3-12 and Figure 3-13. Metal concentrations were not typically recorded in the ES SOE monitoring. The concentrations increase downstream in all catchments for zinc, although most significantly in Clifton and Otepuni. Copper concentrations only increase downstream in Otepuni, for the other catchments there is minimal spatial change.

For zinc and copper, most of the data exceeded the 95% trigger value for toxicity, but largely complied with the 80% trigger value, which is shown in darker blue in the graphs.

Therefore, it is considered that the stormwater discharges are contributing to metal concentrations in the water column which are elevated above the 95% toxicity trigger values primarily in the Otepuni catchment, although typically the less stringent toxicity trigger is not exceeded.

However, it is noted that these recorded concentrations are for total metals, rather than dissolved metals and hence represent a worst case assessment of potential toxicity, and it is unlikely that there has been sufficient bioavailable (dissolved) metal to exert a significant toxic effect.

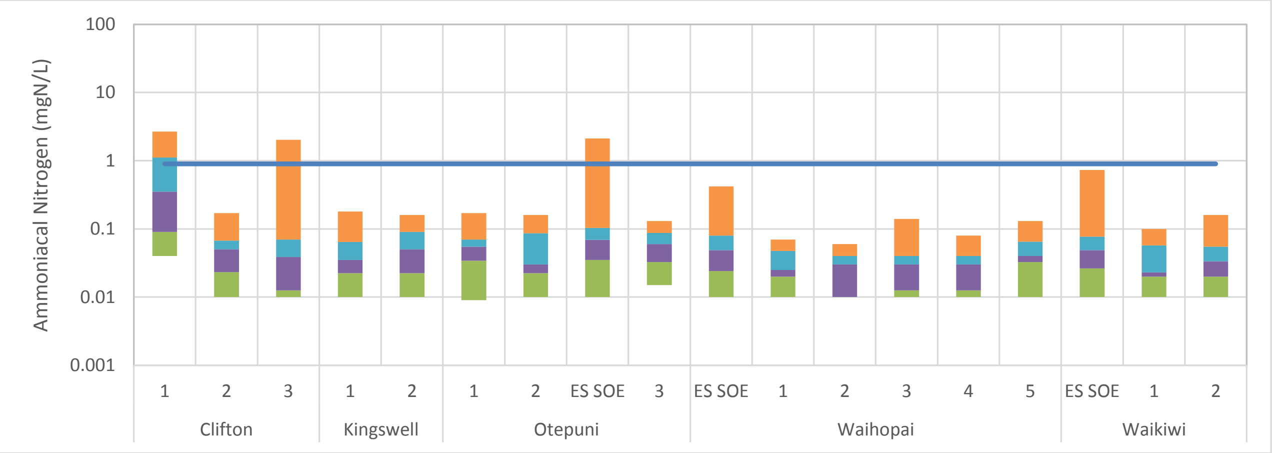


Figure 3-11: Range of Ammoniacal Nitrogen from ICC and ES SOE monitoring

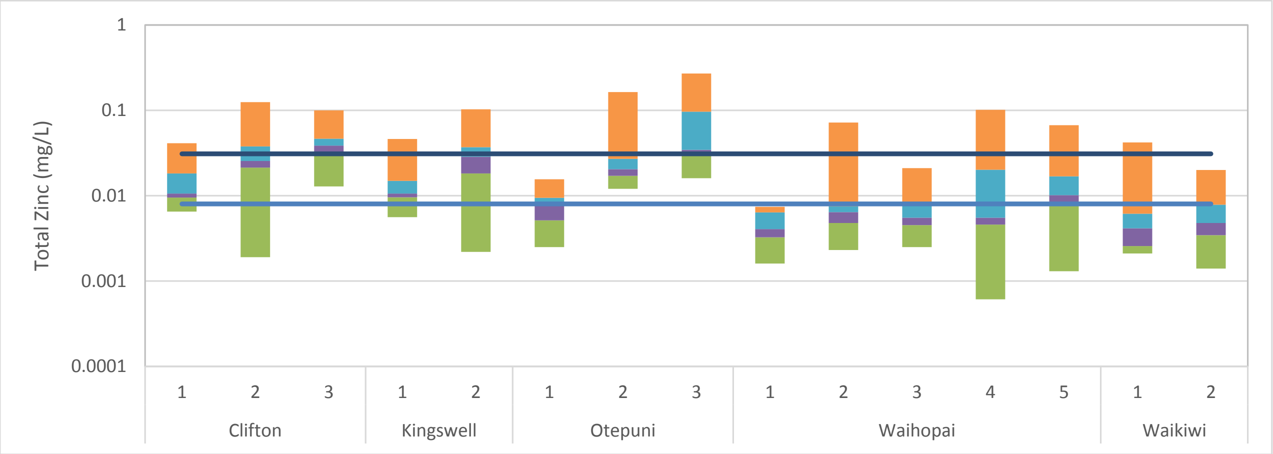


Figure 3-12: Range of total zinc from ICC monitoring

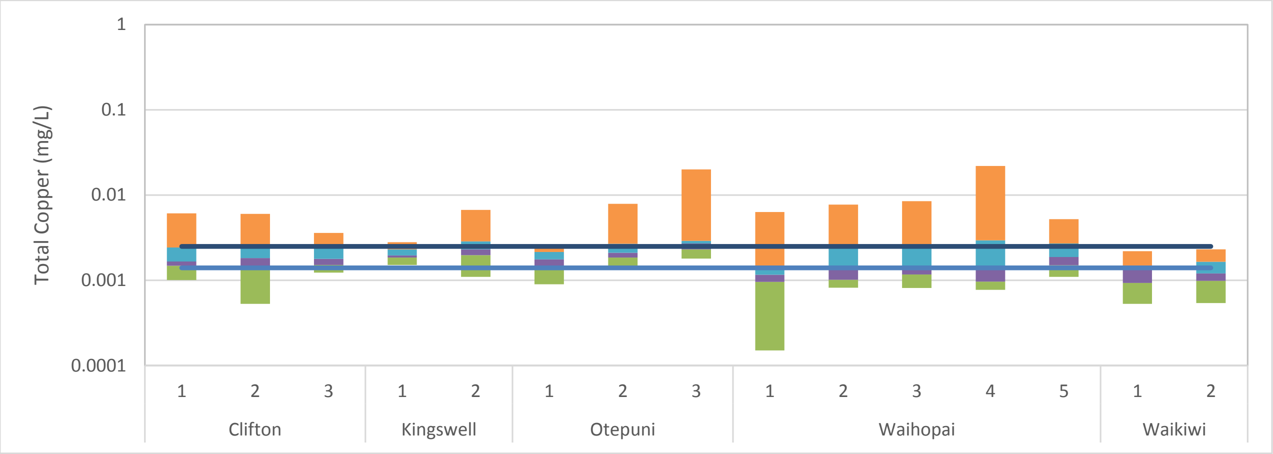


Figure 3-13: Range of total copper from ICC monitoring

3.3.5 Nutrients

Figure 3-14 and Figure 3-15 present the range of data from the ICC and ES SOE monitoring programmes for nitrate nitrogen and dissolved reactive phosphorus respectively. The nutrient based trigger value for each parameter is shown as the blue line and the median limit of Grade B in the NPS-FM for toxicity for nitrate is the red line. The National Bottom Line for toxicity is an annual median of 6.9 mgN/L, which was not exceeded in any of the sampling.

Generally the upstream sites have recorded higher nutrient concentrations than those in the lower reaches of the streams, except for Otepuni Stream. The nutrient trigger values are generally exceeded at all locations, indicating that there is potential for nutrient effects to be found in all streams, this is consistent with the observations of weed growth at most sites. The toxicity trigger for nitrate was occasionally exceeded in Clifton Creek, Waihopai River and Waikiwi Stream, and was highest upstream.

Given the spatial pattern, it is considered that while the stormwater discharges will be contributing nutrients to the streams, they are not as significant as those upstream, except possibly for Otepuni Stream.

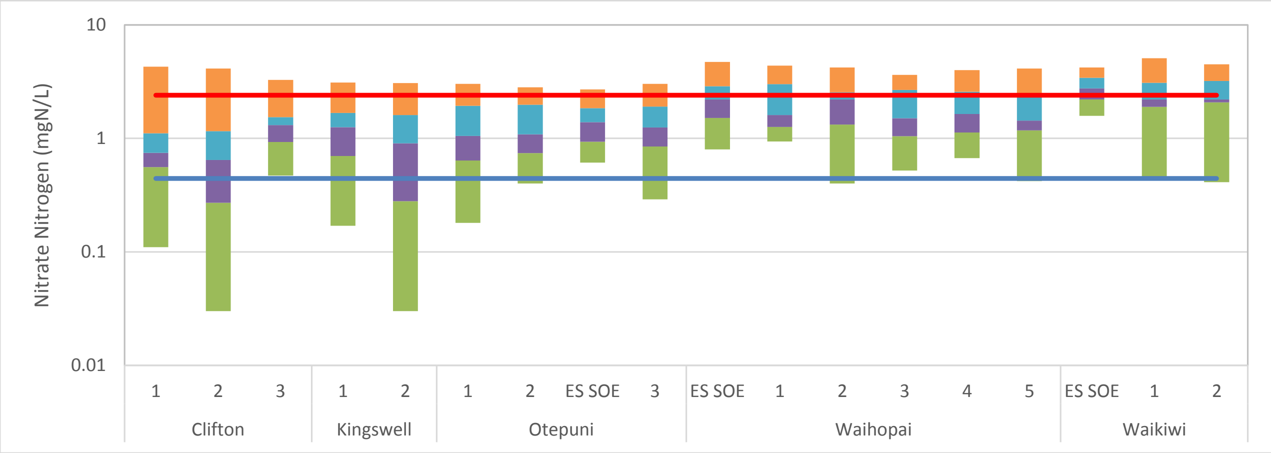


Figure 3-14: Range of nitrate nitrogen from ICC and ES SOE monitoring

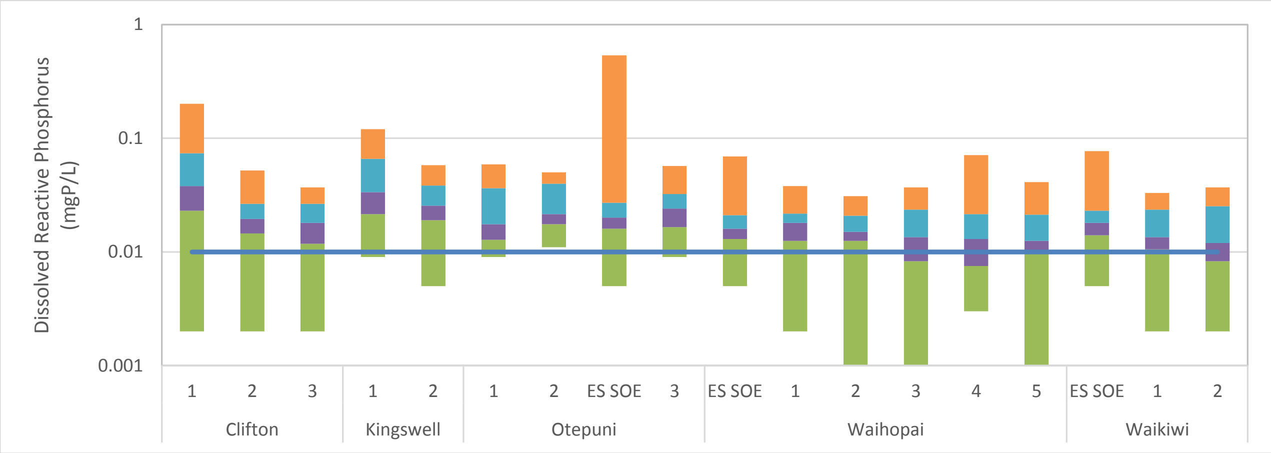


Figure 3-15: Range of dissolved reactive phosphorus from ICC and ES SOE monitoring

3.3.6 Summary

A summary of this data with respect to the key potential effects and compliance with the relevant guidelines is given in Table 2-2. The shading used in the table is as follows:

- red indicates that the stormwater discharges could be the cause of the impacts on water quality in the receiving environment
- orange indicates that some impact may be occurring from the stormwater discharges but only on occasion
- yellow, indicates that only minor impacts on few occasions recorded or that the impacts observed are unlikely to be the result of the stormwater discharges
- green indicates minimal impact.

For most parameters, concentrations increased during wet conditions as would be expected given mobilisation of contaminants by wet weather, except for nitrate that was higher in dry weather conditions. The spatial patterns vary between catchments. For ammonia and *E.coli*, the upstream sites generally had higher concentrations than the downstream sites.

Table 3-2: Summary of ICC Receiving Water Monitoring

Catchment and Number of Sites	ES Plan WQ Standards	NPS-FM (National Bottom Line)			Toxicity (95% protection)			Nutrients	
	Ammonia (<2.2)	Dissolved Oxygen	E.coli <1,000	Nitrate (<9.8)	Ammonia (<0.9)	Nitrate (<2.4)	Metals[7]	Nitrogen	Phosphorus
Clifton - U/S site - mid site - D/S site	Occasional U/S only exceed	Some in dry weather	Some exceed in wet, U/S only in dry	OK	Some but U/S worse	Some in dry, all sites	All sites, most of time for Cu, Cr, Zn	All sites, most of time	All sites, most of time
Kingswell - U/S site - D/S site	OK	Few in wet and dry	Both sites, most times in wet, few and U/S only in dry	OK	OK	Few in dry both sites	Both sites most of time for Cu, Cr and Zn	Both sites, most of time	Both sites, most of time
Otepuni - U/S site - mid site - D/S site	OK	One site on one occasion in dry	Most exceed in wet, only one site once in dry	OK	OK	Some at all sites in dry only	All sites, most of time for Cu, Zn Cr, Pb and Ni only some in wet	All sites, most of time	All sites, most of time
Waihopai - U/S site - 3 mid sites - D/S site	OK	OK	Most exceed in wet, some in dry	OK	OK	Some at all sites in dry only	All sites, half of time for Cu Some sites half of time for Zn Few sites occasion for Cr	All sites, all of time	All sites, half of time
Waikiwi - U/S site - D/S site	OK	Both sites on one occasion in dry	Both sites, half of time in wet and dry	OK	OK	Both sites, most of time	Both sites, half of time for Cu and Zn Few times D/s only in wet for Cr	All sites, all of time	All sites, half of time

[7] Analysis is performed for total metals and hence is a conservative assessment of the potential for toxicity effects, given that some of the metals will be bound and hence not bioavailable.

3.4 Sediment

3.4.1 Available Monitoring

The Consent required monitoring of Sediment quality within the various water bodies. Monitoring has been undertaken at the following locations, on an annual basis between 2012 to 2016:

- Clifton
    - Clifton Channel at Lake Street
- Kingswell
    - Kingswell Creek 150m West of Bluff Road at Walking Track Bridge
- Otepuni
    - Otepuni Downstream of Lindisfarne Bridge
    - Otepuni Outfall to Waihopai River
    - Otepuni Upstream of Mersey Street Bridge
    - Otepuni Upstream of Rockdale Road
- Waihopai
    - Waihopai 20 metres above Railway Bridge
    - Waihopai Downstream of North Road
    - Waihopai Downstream of Prestonville
    - Waihopai Downstream Queens Drive Bridge
    - Waihopai Upstream of Prestonville
    - Waihopai Upstream of Racecourse Road
- Waikiwi
    - Waikiwi West Plains Road Bridge.

The locations of sampling are provided in Figure 3-7 as pink dots. Samples were collected as composite samples with a single sample for analysis at each location once per year and analysed for TOC, metals and a range of organics.

The full record of the monitoring data received for sediment samples is provided in Appendix B. This has been formatted to show the variation for each parameter against the International Sediment Quality Guidelines (ISQG) as specified by the consent and samples that exceed the ISQG low guidelines are highlighted in red fill and those exceeding the ISQG High guideline is highlighted in pink fill. Most of the samples which exceed the ISQG are in the Otepuni Stream and lower Waihopai River.

Environment Southland undertakes monitoring of sediment quality as part of their Estuarine State of the Environment monitoring at seven sites in the New River Estuary. Data has been provided for the samples which have been collected from 2001 to 2014. Monitoring has been intermittent during this time across all sites. This data has not been formally reported, but the data was provided for this application.

Environment Southland also undertook a specific survey of sediment contamination in the Waihopai River in 2011 as part of the Living Streams programme, and the report has been provided of this Study[8] which undertook sampling over 7 locations in the Waihopai River, testing for:

- Particle Size Distribution
- Total Organic Carbon (TOC)
- Total Nitrogen and Total Recoverable Phosphorus
- Heavy Metals, Total Recoverable:
    - Arsenic (As)
    - Cadmium (Cd)
    - Chromium (Cr)
    - Copper (Cu)
    - Mercury (Hg)
    - Nickel (Ni)
    - Lead (Pb)
    - Zinc (Zn)

[8] Environment Southland: "Living Streams Lower Waihopai River Sediment Quality Assessment", November 2011.

- 16 USEPA priority Polycyclic Aromatic Hydrocarbons (PAH)
- Organochlorine Pesticides (OCPs), including DDT, Lindane and Dieldrin.

Landcare Research and Environment Southland also undertook in 2013, the '*contaminants in estuarine and riverine sediments and biota in southland*', which examined sediment and flesh contaminant concentrations including some sites around New River Estuary. The data for this survey has been provided and has been formally reported[9].

3.4.2 Metals

Figure 3-16, Figure 3-17 and Figure 3-18 summarise the data from the ICC monitoring of the sediment concentrations. The average of the 4 sample events is presented and is compared to the ISQG Low and High Sediment Guidelines. The Regional Plan standards are the same as the ISQG low guidelines.

The average sediment concentrations in the lower reaches of the Clifton Creek, Kingswell Creek and Waikiwi River near the stormwater discharge are less than the ISQG Low guidelines, however three of the four samples exceeded the ISQG Low Guideline for zinc in Clifton Creek.

In the Waihopai River, only the lowest sampling location on the River exceeded the ISQG low guideline for nickel only. On the Otepuni Creek, the two downstream locations exceeded the ISQG low guideline for zinc, nickel and lead. The upstream locations on the Otepuni had lower metal concentrations which met the guidelines.

The ISQG high guidelines are not exceeded for any average metal concentration at any location, and only one single sample exceeded the high guidelines for zinc at a downstream Otepuni site.

There were minimal temporal trends in the sediment concentrations. This could be due to the contamination being from a historical source which is not changing, or that the metal input to the sediment from incoming sediment being deposited is similar to that being removed from the area. It is considered that the second explanation is the most likely, and hence if the inputs of metals to the sediment in the Waihopai River and Otepuni Creek are reduced, the concentrations in the sediment would be expected to reduce over time.

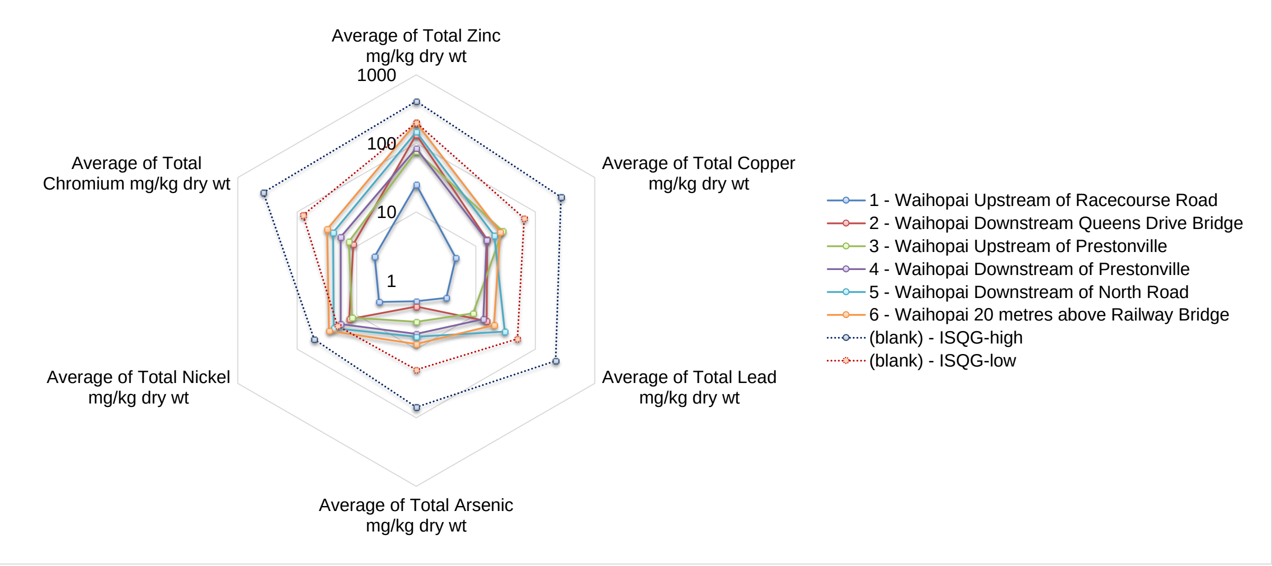


Figure 3-16: Average of metal concentrations in sediment in Waihopai River from ICC monitoring

9 http://www.es.govt.nz/media/37499/contaminants_in_estuarine_and_riverine_sediments_and_biota_in_southland_2014.pdf

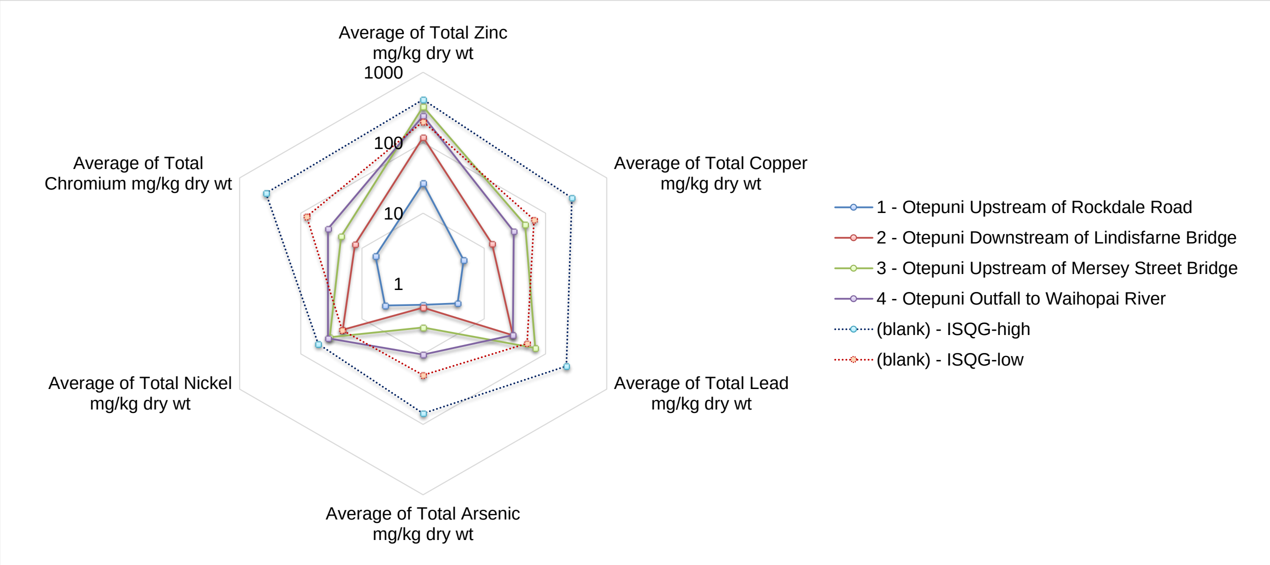


Figure 3-17: Average of metal concentrations in sediment in Otepuni Creek from ICC monitoring

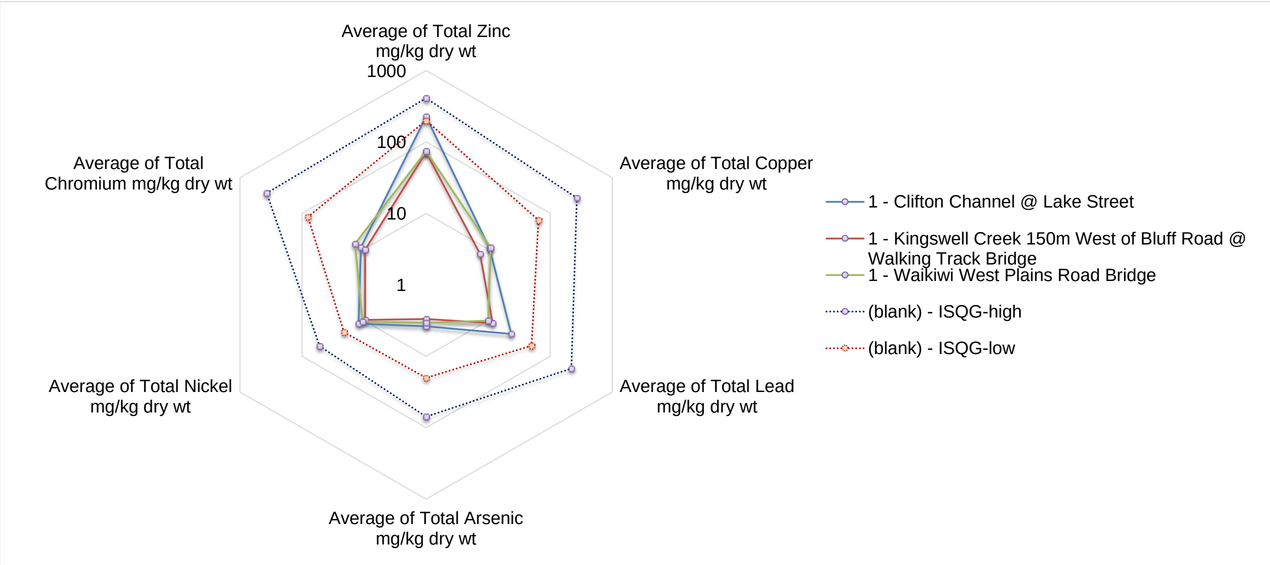


Figure 3-18: Average of metal concentrations in sediment in Clifton Creek, Kingswell Creek and Waikiwi Stream from ICC monitoring

These results are consistent with those found in the 2013 Landcare Research project for Environment Southland: 'C*ontaminants in estuarine and riverine sediments and biota in southland*', which examined sediment and flesh contaminant concentrations including some sites around New River Estuary. Principle results and conclusions from that project with respect to sediment were:

> *"Similar to previous studies, we found that several sites within New River Estuary and surrounding rivers were highly enriched with phosphorus and also contained elevated organic carbon. Levels of contamination from metals (including arsenic) in both estuaries were generally low and concentrations rarely exceeded the Australian and New Zealand Environment Conservation Council (ANZECC) ISQG-low guidelines. An exception was nickel in the upper arms of the New River Estuary, which exceeded the IQGS guideline at two locations that had a high proportion of fine sediment.*
>
> *Sediments collected from New River Estuary appeared to be well-mixed with contaminant loads (and organic carbon and phosphorus) and the contaminants were highly correlated with the amount of fine sediment present at the sites. …*

Elevated contaminant concentrations were found in sediments collected from rivers and streams draining into the New River Estuary, and unsurprisingly those passing through Invercargill (Otepuni, Waihopai and Kingswell catchments) had higher metal concentrations than those rivers and streams draining more agricultural catchments (Oreti and Waikiwi). Nickel and zinc showed the greatest exceedance of sediment quality standards. ΣDDT concentration was also greater in sediments from the urban catchment compared with agricultural catchments. In contrast, cadmium was found at higher concentrations in some sediment samples from agricultural catchments (Waikiwi River). The presence of cadmium in the sediment, and its high correlation with phosphorus, likely suggests an input of agricultural soils to the drainage systems. "

Environment Southland's Estuarine State of the Environment monitoring indicated similar results to the 2013 study, with sediment complying with the ISQG-low except for Nickel at the north-eastern site.

The survey of sediment contamination in the Waihopai River undertaken by Environment Southland in 2011 as part of the Living Streams programme concluded that concentrations of nickel and zinc were more than ISQG-low but less than ISQG-high in the sites between North Road Bridge and Beatrice Street. The concentrations of all other metals, PAHs, and OCP were below the ISQG-low. The sites used in the Living Streams investigation were closer to the mouth of the Waihopai than the most downstream site in the ICC monitoring, but the results are consistent with that observed in the ICC monitoring.

3.4.3 Organics

As shown in Appendix B, the concentrations of a number of the polyaromatic hydrocarbons (PAH) in the sediment exceeded the ISQG Low Guidelines at a number of locations on the Otepuni Creek and Waihopai River and to a lesser extent in the Clifton Channel.

The concentrations in the upstream locations on the Waihopai River and Otepuni Creek, and the downstream location on the Waihopai River, Waikiwi Stream and Kingswell Creek were less than the guideline and often less than the detection limit.

This indicates that the stormwater discharges are contributing to the PAH contamination in the sediments. It should be noted that there may be other sources of contamination upstream of the city, which are dropping down into the sediments at the mouths of the streams.

3.5 Aquatic Ecology

3.5.1 Benthic Macroinvertebrates

Ryder Consulting Limited (RCL) have undertaken benthic macroinvertebrate surveys in 2012 and 2016 on behalf of the ICC. The 2012 survey covered the three largest catchments; Kingswell, Otepuni and Waihopai and the 2016 survey was extended to include the Waikiwi catchment. The 2016 report is included as Appendix D.

The locations of upstream and downstream sampling sites in each catchment are provided in Figure 3-7 as green dots.

Macroinvertebrate community health was determined by RCL using the metrics number of taxa present, number of *Ephemeroptera*, *Plecoptera* and *Trichoptera* (EPT) taxa, percentage of EPT taxa, macroinvertebrate community index (MCI) and semi-quantitative MCI (SQMCI).

The surveys by RCL showed that the communities at the sampled sites were numerically dominated by molluscs (snails), oligochaetes (works) and crustaceans (amphipods and ostracods) while EPT taxa, particularly stoneflies and mayflies were absent or rare.

The bed substrates recorded by RCL at the sampling sites ranged from fine sediment and muds at the Waikiwi Stream sites to mixed cobbles, gravels and some fine sediment at the Otepuni Stream sites.

In comparing the 2012 and 2016 surveys, RCL noted that the results were largely similar, except that the upstream Waihopai sampling site had improved. Overall, RCL note that the MCI and SQMCI scores at all sampling sites indicate poor habitat quality and the possibility of degraded water quality and habitat throughout the Invercargill Stormwater Catchment, including the upstream sites. Therefore, whilst there is some evidence of habitat degradation downstream, but there is no conclusive evidence that the stormwater discharges are adversely affecting the benthic communities in the receiving water bodies.

A potential cause of the reduced scores in the lower reaches is the influence of salt water, given that the MCI is for freshwater environments. The results for the sites in the lower reaches were compared to the data from the Environment Southland monitoring of infauna in cores as part of their Estuarine State of the Environment monitoring at seven sites in the New River Estuary. Data has been provided for the samples which have been collected from 2001 to 2014. Monitoring has been intermittent during this time across all sites. The data in the RCL survey was similar to that in the ES SOE surveys. RCL note that the abundance and diversity of the macroinvertebrates was much as expected for modified estuarine environments in Southern New Zealand.

Environment Southland monitor ecosystem health of these watercourses as part of their “Living Streams” study and as part of their regional state of the environment (SOE) monitoring programme. The programme includes monitoring of macroinvertebrates and periphyton to assess the health of aquatic communities. An indication of the health of the Otepuni Stream, Waihopai River and Waikiwi Stream is provided from the SOE surveys with respect to the matrices taxa abundance and richness, MCI, number of EPT Taxa and percentage EPT. A summary of this information is provided in Table 3-3.

Table 3-3: Summary of Macro-invertebrate sampling data (averages)

Location	Abundance	Richness	MCI	No. EPT Taxa	% EPT
Otepuni Creek at Nith Street	19547	14	69	2	13
Waihopai River at Waihopai Dam	3780	17	82	6	35
Waihopai River u/s Queens Drive	4507	15	79	4	26
Waikiwi Stream at North Road	6994	18	80	3	19

The recorded MCI scores at the sampling sites is less than the relevant Regional Water Plan Standard of 90 indicating poor habitat quality. This is consistent with the RCL surveys.

3.5.2 Fish

The New Zealand Freshwater Fish Database indicate that Waikiwi Stream and the Waihopai River support reasonable populations of native fish including Longfin eels, giant and banded kokopu, common galaxias, common bully, redfin bully and inanga. Reaches of the Waihopai River upstream of Kennington support brown trout populations.

Little information however exists on fish populations in Otepuni Creek and Clifton Channel. It is probable that modification of the channels of these watercourses through channelisation and removal of riparian vegetation has led to a significant loss of habitat and decline in habitat quality for native fish.

3.5.3 Contamination in Biota

Landcare Research report that fish and eel samples collected by Environment Southland[10] and analysed by Hill Laboratories in 2013 show an accumulation of mercury and DDTs with contaminant concentrations typically higher in the organs than in the flesh. Landcare Research noted some species specific differences in contaminant accumulation with arsenic detected in eel flesh while cadmium and zinc were typically present at lower concentrations in fish flesh compared to eel flesh.

Regardless of the contaminant concentrations Landcare Research considered there to be a negligible health risk associated with consumption of eel and fish even under a high consumption scenario.

[10] Collected by fyke net at selected riverine locations beyond the Jacobs River and New River Estuaries.

4 Assessment of Effects on the Receiving Environments

4.1 Positive Effects

The reticulation stormwater system assists in reducing public health risk and protecting properties that could be exposed to flooding especially those located in lower lying areas and/or where poorly drained soils occur. Reticulated systems are also beneficial in enabling use of public amenities such as roads and parks following wet weather. Issuing the resource consent sought will enable the discharge of stormwater and contaminants from this existing network to lawfully continue, thereby helping to safeguard the community from public health and environmental risks associated with stormwater and flooding, and the related adverse social, cultural and economic effects.

4.2 Surface Water Quality

4.2.1 Waikiwi Stream

The ICC and Environment Southland's State of the Environment (SoE) monitoring results as summarised in Figures 3-9 and 3-10 indicate that the dissolved oxygen concentrations were generally being maintained in the upstream and downstream monitoring sites above the NPS A grade limit and the concentrations of ammonia were generally less than the 95% toxicity trigger value.

Whilst the Waikiwi Stream does not comply with the faecal coliforms standard in the Regional Plan on a consistent basis, the monitoring of the discharge and the stream indicate that this is due to the upstream sources rather than the stormwater discharges.

The ICC monitoring results show that total concentrations of zinc and copper increase between the upstream and downstream sites. The total concentrations of these metals exceeded the 95% toxicity trigger values on about half of the sampling occasions at both monitoring sites. Nutrient concentrations while generally exceeded on most occasions tended to be more elevated at the upstream site.

These results indicate that the stormwater discharges (excluding sewage) is currently having a minor impact on the water quality of Waikiwi Stream, as indicated in Table 3-2. Given that this application is for resource consent to continue with the current discharges of stormwater and contaminants, and to improve the quality of the stormwater over time, it is not expected that the effect of continuing the discharges on water quality would result in any significant negative change in water quality.

4.2.2 Waihopai River

The ICC and SOE monitoring results for the Waihopai River also indicate that the dissolved oxygen concentrations were generally being maintained at the upstream, mid reach and downstream monitoring sites above the NPS A grade limit and the concentrations of ammonia were generally less than the 95% toxicity trigger value.

The Waihopai River does not comply with the faecal coliforms standard in the Regional Plan on a consistent basis. There are a number of monitored stormwater discharges that appear to contain sewage and this is contributing the non-compliance, although there are significant upstream sources apparent. The stormwater catchment is only 4% of the total catchment of the River indicating that there is significant available dilution for the stormwater discharges.

The ICC monitoring results show that total concentrations of copper and zinc increase between the upstream and downstream sites. The concentration of copper and zinc exceeded the 95% toxicity trigger values at some or all the monitoring sites (in the case of copper) on about half of the sampling occasions. Concentrations of chromium occasionally exceeded the 95% toxicity trigger values at some of the sites. Nutrient concentrations while generally exceeded on most occasions tended to be more elevated at the upstream site.

These results indicate that the stormwater discharges (excluding sewage) is currently having a minor impact on the water quality of the Waihopai River. Granting the discharge permit sought would not increase the degree of adverse effects currently identified.

4.2.3 Otepuni Creek

The ICC and SOE monitoring results for Otepuni Creek similarly indicate that the dissolved oxygen concentrations were generally being maintained in the upstream, mid site and downstream monitoring sites above the NPS A grade limit and the concentrations of ammonia were generally less than the 95% trigger value.

The Otepuni Creek does not comply with the faecal coliforms standard in the Regional Plan on a consistent basis. There are a number of monitored stormwater discharges that appear to contain sewage and this is contributing to the non-compliance, although there are significant upstream sources apparent. The monitored wet weather discharges within the Otepuni Creek that did not appear to contain sewage had relatively high faecal coliforms concentrations, possibly due to the built up nature of the catchment. The stormwater catchment is only 27% of the total catchment of the Creek, and hence there is less available dilution for the stormwater discharges.

The ICC monitoring results show that total concentrations of zinc and copper increase between the upstream and downstream sites and on most sampling occasions exceeded the 95% toxicity trigger values at all of the sites while concentrations of chromium, lead and nickel were elevated following some wet weather events. Conversely nutrient concentrations were higher at the downstream site compared to the other water bodies.

These results indicate that the stormwater discharges (excluding sewage) is currently having a moderate impact on the water quality of the Otepuni Stream. This effect would not increase as a result of granting the discharge permit now sought.

4.2.4 Kingswell Creek

The ICC and SOE monitoring results for Kingswell Creek indicate that the dissolved oxygen concentrations were generally being maintained in the upstream and downstream monitoring sites above the NPS A grade limit and the concentrations of ammonia were generally less than the 95% toxicity trigger value.

The Kingswell Creek does not comply with the faecal coliforms standard in the Regional Plan on a consistent basis. There are monitored stormwater discharges that appear to contain sewage and this is contributing to the non-compliance, although there are significant upstream sources apparent. The stormwater catchment is 30% of the total catchment of the River indicating that there is less available dilution for the stormwater discharges.

The ICC monitoring results show that total concentrations of zinc, copper and chromium increase between the upstream and downstream sites and on most sampling occasions exceeded the 95% toxicity trigger values at both sites. Nutrient concentrations while generally exceeded on most occasions tended to also be more elevated at the upstream site.

These results indicate that the stormwater discharges (excluding sewage) is currently having a minor impact on the water quality of Kingswell Creek. This effect would not increase as a result of granting the discharge permit now sought.

4.2.5 Clifton Channel

The ICC and SOE monitoring results indicate that the dissolved oxygen concentrations were generally being maintained in the upstream, mid site and downstream monitoring sites above the NPS A grade limit and the concentrations of ammonia were above the 95% toxicity trigger value but were more elevated at the upstream site. Nitrate levels were also elevated above the toxicity trigger value at all the monitoring sites including during dry weather.

The Clifton Channel does not comply with the faecal coliforms standard in the Regional Plan on a consistent basis. No stormwater discharges were monitored in the catchment. There are significant upstream sources apparent. The stormwater catchment is 48% of the total catchment of the river indicating that there is less available dilution for the stormwater discharges.

The ICC monitoring results show that total concentrations of zinc, copper and chromium were elevated above the 95% toxicity trigger values at all the sites on most sampling occasions. Nutrient concentrations while generally exceeded on most occasions tended to also be more elevated at the upstream site.

These results indicate that the stormwater discharges (excluding sewage) is currently having a moderate impact on the water quality of the Clifton Channel. This effect would not increase as a result of granting the discharge permit now sought.

4.2.6 Assessment of Plan Standards

The Water Quality Standards in Appendix G of the Regional Water Plan apply following reasonable mixing with the receiving waters. These standards remain unchanged in the proposed Southland Water and Land Plan.

Table 4-1 provides an assessment of the impact of the discharges on compliance with the relevant water quality standards. The Waikiwi Stream, Waihopai River and Clifton Creek are Lowland Hard Bed and the Otepuni and Kingswell Creeks are Lowland Soft Bed, with each type subject to different standards.

There are a number of Plan standards which are not complied with in the receiving water bodies. Whilst the stormwater discharges may impact on these effects regulated by the standards, they are not considered to be a primary cause of non-compliance, except for the faecal coliforms standard.

The discharges for which consent is sought through this application (ie the discharges from the stormwater network, excluding sewage) are anticipated to contribute to the observed non-compliance with the Regional Plan faecal coliforms standard, during wet weather and primarily in Otepuni Creek.

Table 4-1: Lowland Hard Bed and Lowland Soft Bed Standards

Standard	Comment	Compliance
Water temperature shall not exceed 23°C		✓
Daily maximum temperature shall not increase by: • more than 3°C when the natural water temperature is 16°C or less • more than 1°C when the natural water temperature is more than 16°C (It is understood there are no trout spawning areas in the potentially affected water bodies.)	The temperature in the water bodies has exceeded 16°C. Waikiwi : no change in temperature Difference between most upstream and downstream sites along other streams was often more than 1°C and was more than 3°C on some occasions, in the summer months. This is considered to be due to the lack of shading along the streams, rather than the discharges	× (but probably not due to the discharges)
pH shall be within the range of 6.5 – 9		✓
The concentration of dissolved oxygen shall exceed 80% saturation	ICC monitoring recorded as mg/L rather than % saturation, but indicates that standard not complied with at all times. ES SOE monitoring indicates all three sites, occasionally do not comply, includes 2 upstream sites. Discharges may contribute to lowered DO but physical characteristics and upstream sources probably dominant cause of non-compliance	× (but probably not due to the discharges)
There shall be no bacterial or fungal slime growths visible to the naked eye as obvious plumose growths or mats.	None noted during site visits	✓

Standard	Comment	Compliance
When the flow is below the median flow, the visual clarity of the water shall not be less than 1.6m, except where the water is naturally low in clarity as a result of high concentrations of tannins, in which case the natural colour and clarity shall not be altered.	Lowland Hard Bed only: Not monitored in ICC programme ES SOE monitoring indicates that clarity less than 1.6m upper and mid-catchment most of the time. Whilst the discharge probably contribute to effect, they are probably not the primary cause.	× (but probably not due to the discharges)
When the flow is below the median flow, the visual clarity of the water shall not be less than 1.3 metres.	Lowland soft Bed only: As above for lowland hard bed.	× (but probably not due to the discharges)
The concentration of ammonia shall not exceed the values specified in Table 1 of Appendix of Plan	Ammoniacal nitrogen is generally less than 0.9 mgN/L, which is the limit for the highest recorded pH of 8.	✓
The concentration of faecal coliforms shall not exceed 1,000 per 100 millilitres (There are no "Popular Bathing Sites" designated in Appendix G of the Plan within the affected area.)	Both ICC and ES SOE monitoring indicates that standard exceeded on 25% to 50% of the sampling occasions at all locations. Any sewage in the discharges would significantly contribute to exceedences of the Plan standard in the receiving water, but the discharge of sewage is not included in the scope of this consent. Normal stormwater in wet weather events has elevated bacteria. For the streams, where the stormwater system is a significant part of the overall catchment, it is likely that in wet weather events, the discharges will contribute to exceedences of the standard. For the larger water bodies, the effect of the wet weather stormwater discharges would be less due to the greater dilution available. In dry weather, the stormwater discharges are expected to be of relatively low flow and hence it is expected that they would not significantly impact on compliance with the standard. Therefore, the discharges for which this consent is sought are anticipated to contribute to the observed non-compliance with the Regional Plan faecal coliforms standard, generally during wet weather in the water bodies with smaller catchments.	× (stormwater discharges expected to contribute to exceedences particularly in wet weather in the smaller catchments)
For the period 1 November through to 30 April, filamentous algae of greater than 2cm long shall not cover more than 30% of the visible stream bed. Growths of diatoms and cyanobacteria greater than 0.3cm thick shall not cover more than 60% of the visible stream bed. Biomass shall not exceed 35g/m^2 for either filamentous algae or diatoms and cyanobacteria. Chlorophyll *a* shall not exceed 120mg/m^2 for diatoms and cyanobacteria.	Lowland Hard Bed only. Applies to Waikiwi Stream, Waihopai River and Clifton Creek only. Not specifically addressed by monitoring programmes. Stormwater discharges include nutrients which could contribute to growth, but nutrient sources from upstream are expected to be more significant, as shown by the ICC and ES monitoring.	?

Standard	Comment	Compliance
The Macroinvertebrate Community Index (MCI) shall exceed a score of 90 and the Semi-Quantative Macroinvertebrate Community Index (SQMCI) shall exceed a score of 4.5	Lowland Hard Bed only: Applies to Waikiwi Stream, Waihopai River and Clifton Creek. Not assessed for Clifton Creek Neither the upstream or downstream sites achieve the required scores in both ICC and ES surveys. The Ryder report indicates that this is due to the habitat and possibly degraded water quality	× (but probably not due to the discharges)
The MCI shall exceed 80 and the SQMCI shall exceed 3.5.	Lowland Soft Bed only: Applies to Otepuni Creek and Kingswell Creek. The 2016 Ryder report indicates the MCI is not achieved at any location, but the SQMCI standard is achieved at both sites in both Otepuni Creek sites and at the downstream Kingswell Creek site. The report states that the low MCI scores reflect poor habitat and possibly degraded water quality.	× (but probably not due to the discharges)
Fish shall not be rendered unsuitable for human consumption by the presence of contaminants	The industrial audits indicated that the risks of hazardous chemicals from industrial and commercial entering the stormwater are minimised. The Landcare Research report indicated that contaminant concentrations in eels and fish in the New River Estuary have a negligible health risk even under high consumption scenarios.	✓

4.3 Sediment

The ICC monitoring of sediment in Kingswell Creek, Waikiwi Stream and Clifton Channel complied with the ISQG Low guidelines which are the Regional Water Plan standards, except for zinc in the lower reaches of Clifton Creek.

The lower reaches of Otepuni Creek exceeded the ISQG Low guidelines for zinc, nickel and lead and the lower reaches of Waihopai River exceeded the nickel guideline only. These streams also had elevated polyaromatic hydrocarbons (PAHs) which exceeded the ISQG Low guidelines.

Whilst not being the sole contributors to these metal and PAH loads in the sediment, the stormwater discharges are considered to contribute towards these elevated concentrations.

4.4 Aquatic Ecosystems

4.4.1 Waikiwi Stream

Analysis of the macroinvertebrate matrices by RCL in 2016 revealed low MCI and SQMCI scores for communities collected at both sites, indicating poor habitat quality. Statistical tests revealed a significant difference in MCI scores between the sites but no difference in SQMCI scores.

RCL conclude that the significant difference in MCI scores does not provide conclusive evidence that stormwater discharge is adversely affecting the benthic communities. RCL note that SQMCI calculation is more informative than MCI as it takes account of the abundance of each taxon.

4.4.2 Waihopai River

RCL recorded eleven pollution sensitive EPT taxa at the upstream sites in relatively high abundance compared to low EPT abundance and EPT taxa diversity at the downstream site. ANOVA tests revealed statistical differences in the number of EPT taxa and MCI scores between the sites. However RCL recorded low SQMCI scores for the macroinvertebrate communities collected at all the sampling sites with no statistical difference in SQMCI scores between the sites.

RCL attribute the difference in number of EPT taxa and MCI scores between the sites to the influence of saltwater intrusion at the downstream site. The results were consistent with the ES SOE fauna monitoring undertaken in the New River Estuary and are as expected for a modified estuarine environment.

4.4.3 Otepuni Stream

RCL recorded low MCI and SQMCI scores for the macroinvertebrate communities collected from both sampling sites with no statistical differences in the scores between the sites. EPT taxa were recorded at both sites with a greater abundance and diversity recorded at the upstream site. ANOVA tests revealed a statistical difference in number of taxa between the sites. Despite the statistical difference in EPT taxa RCL conclude that this is not considered conclusive evidence that the stormwater discharge is adversely affecting benthic communities in the Otepuni Stream.

4.4.4 Kingswell Creek

RCL similarly recorded low MCI and SQMCI scores for the macroinvertebrate communities collected from both sampling sites. However the average scores for both metrics were higher at the downstream site with ANOVA tests revealing a statistical difference in MCI and SQMCI scores between the sites. The diversity and abundance of EPT was low at both sites.

RCL notes the change in macroinvertebrate community structure with distance downstream indicates improved rather than degraded habitat quality compared to the upper end of the stormwater catchment.

4.4.5 Trends in Macroinvertebrate Community Health Index Scores

In comparing the survey results RCL noted that the communities sampled in 2012 are similar to the communities sampled in 2016. In their comparative analysis RCL state:

"The macroinvertebrate communities of the three surveyed sites in 2012 were assessed as being of "poor" quality, as indicated by low MCI and SQMCI community health index scores. MCI and SQMCI scores calculated from the 2016 macroinvertebrate surveys were similar, also indicating "poor" quality, excepting the upstream Waihopai sites, whose MCI scores indicates "fair quality". Again this is an indication of an improvement in habitat quality upstream of the stormwater discharge in the Waihopai River. Despite subtle differences in the communities found in each survey, which are likely a reflection of changes in habitat factors such as the abundance and diversity of macrophyte beds in the stream, river flow, etc. the similar community health index scores at the two monitoring sites indicate that the stormwater discharge has not had an adverse effect on macroinvertebrate communities over time."

4.5 Surface Water Quantity

The discharge of stormwater to surface water bodies has the potential to increase flooding of areas downstream of the outfalls, unless stormwater runoff is attenuated.

Localised flooding problems experienced in Invercargill tended to be related to the capacity of the reticulation rather than the water bodies downstream of the outfalls.

Discharges of stormwater during either the construction phase of a subdivision or after the development is completed have the potential to cause scour and erosion. This can cause instability to the banks and bed of a receiving (minor) watercourse in the vicinity of the outfalls if the discharges are uncontrolled or high flow rates are concentrated over an area susceptible to erosion.

The ICC proposes that a condition be included on any discharge permit that will require ICC to ensure that stormwater discharges do not result in scour and erosion of the bed or banks of any of the receiving water bodies.

4.6 Groundwater Quantity and Quality

Contaminants entrained in stormwater from urban sources can contaminate groundwater and effects are particularly significant when this water is used for human consumption. We note that no groundwater that could be affected by the ICC stormwater network is used for human consumption as there is a reticulated water supply network.

Nutrients, such as nitrogen dissolve readily in water, move rapidly through soil and can cause illness when ingested, however concentrations in the Invercargill stormwater discharges were well below the NZ drinking water standards. A number of pathogenic micro-organisms present in pets and other animals can cause disease in humans, while contaminants such as hydrocarbons make drinking water unpalatable, even at low concentrations.

Increasing urban development results in an increase in impermeable surfaces and reduces the potential for rainfall to re-charge groundwater, especially where stormwater is directly reticulated to a surface waterway as is the case in Invercargill.

Given the nature of the underlying aquifers and their relative impermeability, while it is probable that groundwater will enter the stormwater system, it is considered less likely for stormwater to enter the groundwater system in a quantity sufficient to significantly affect its quantity.

4.7 Visual and Amenity Effects

Visual and amenity values can be affected in both a positive and negative way from stormwater discharges. Stormwater treatment/impoundment systems can often enhance an area and provide for more recreational amenity opportunities within urban areas. However, there can be visual impacts from these discharges, especially as a result of rubbish accumulation and entrainment at outfalls and discolouration of the receiving waters due to the discharge of sediment during wet weather. These effects are more than minor in a local context and require regular maintenance to prevent unsightly accumulation of rubbish at outfalls.

4.8 Effects on Cultural Values

Te Tangi a Tauira, the Iwi Management Plan for Ngai Tahu ki Murihiku outlines the values, issues and policies that tangata whenua have adopted with respect to the Southland environment. With respect to water, it is noted that:

> *'Water is a taonga, or treasure of the people. It is the kaitiaki responsibility of tangata whenua to ensure that this taonga is available for future generations in as good as, if not better quality.'*

Maintenance of water quality and quantity, protection of the mauri and wairua of rivers, lakes and wetlands, enhancing waterways and direct and indirect discharges to water are all issues of relevance to ICC's stormwater discharges.

Waikiwi Stream is a tributary of the Oreti River which is the subject of a statutory acknowledgement pursuant to the Ngai Tahu Claims Settlement Act 1998, which outlines Ngai Tahu ki Murihiku's historical and ongoing association with the river. The Oreti River is an important mahinga kai resource and there were a number of important settlement sites at the mouth of the Oreti River in the New River estuary.

In considering any actual or potential adverse effects on cultural values, particular regard must be placed on the importance of the Oreti River and tributaries such as Waikiwi Stream to Ngai Tahu and the mahinga kai and other taonga that it supports

The effects of the stormwater discharges on cultural values are minor when considered in the context of the current degraded state of the receiving watercourses due to agricultural runoff in the catchments upstream of Invercargill and modification due to loss of riparian cover and channelisation.

5 Existing and Proposed Mitigation Measures

5.1 Introduction

There are a number of existing mitigation measures in the form of general management and maintenance activities which the ICC are undertaking to ensure that the stormwater network works appropriately and minimises contamination into the network. The primary elements of these which will be continued during the consent term are identified in Section 5.2.

Sections 2 and 3 identified the following issues which need to be addressed to reduce the impacts from the stormwater discharges:

- Discharges of sewage into the stormwater network as a result of illegal connections and cross contamination from the sewer network and sewer overflows.
- Discharges of metals from the stormwater network, particularly into the Waihopai River, Otepuni Creek and Clifton Creek, which are resulting in elevated concentrations in the water column (copper and zinc) and in the sediment at the lower reaches of these water bodies (zinc, nickel and lead).

This section identifies the monitoring that is proposed to identify and characterise the discharges primarily contributing to these effects during the consent term and the management techniques that will be employed to reduce the load on an ongoing basis throughout the consent term. The way in which this reduction will be verified during the consent term is also specified.

5.2 General Management and Maintenance Activities

Section 2.5 described the existing inspection and maintenance procedures which will be continued during the consent term. This will include:

- the manhole checks, which will continue to inspect a percentage of the network assets each summer. This will specifically check for signs of sewage in the stormwater assets. Any evidence of sewage contamination will be investigated in a similar manner to that found through the monitoring discussed in Section 5.3
- sump cleaning. This will be performed as descried to ensure that the hydraulic capacity of the network is maintained. It is noted that not all sumps are cleaned each year under the current system. A representative survey will be undertaken in the first year of the consent to determine the depth of material in sumps. This will be assessed to determine if improvements can be made to improve the contaminant removal from the stormwater using the existing sump network.

As described in Section 2.6, the budgets for the renewal programme for both the stormwater and sewer networks will be increased to 1% by 2021. The renewal programme will target the parts of the network with the most significant problems to maximise the improvements that will result. This programme will over time reduce the exchange between the two systems thus reducing cross contamination and sewer overflows.

Audits of industrial and commercial sites as described in Section 2.7 will continue to ensure all sites with the increased risk of discharge of contaminants to stormwater are visited at least once every 5 years. The purpose of these visits will be to ensure that adequate controls and management protocols are in place to reduce the risk of discharge of contaminants to the stormwater network.

With regard to new developments, the ICC require developers to use low impact design in the establishment of stormwater systems that connect into the municipal system. This is specified by the ICC bylaw governing new sub-division.

5.3 Reduction in Sewage Contamination

5.3.1 Introduction

The review of the 18 monitored stormwater discharges and their contributing catchments identified the critical contamination to be due to sewage discharges into the stormwater system. The Treatment

Review (in Appendix A) noted that the contamination is likely to be from direct cross-connections or in flows, or to be from seepages between damaged sewers and stormwater laterals in the same trenches particularly on private property. Of the monitored catchments, four show contamination likely to be associated with sewage, with two more potentially indicating sewage contamination.

The review indicated that there is no practicable method to treat sewage contamination once it is transferred to the stormwater system. Therefore, the focus needs to be on identifying and removing discharges of sewage into the system.

5.3.2 Detection of Sewage Contamination

The existing monitoring programmes performed by ICC during the previous consent period and also the Environment Southland State of the Environment programme have identified a number of issues in definitively identifying sewage contamination in the receiving water and also in the stormwater discharges themselves.

As identified in Section 2.8, the use of *E.coli* as a sole indicator of sewage contamination makes the finding of the actual sources difficult due to the delay between sampling and obtaining the results a few days later, the sporadic nature of this type of contamination and the inherent variability in bacterial concentrations.

Investigations for sewage contamination should be undertaken in dry weather as wet weather discharges will mask the presence of the sewage with contamination from catchment surfaces.

Figure 5-1 shows the results for *E.coli* plotted against the ammonia concentrations from the ICC receiving water monitoring including data collected in dry weather only. This is to determine if there is a relationship between the two parameters. The left hand plot includes all monitoring locations and the right plot excludes the stream locations upstream of the ICC stormwater outfalls on each of the water bodies.

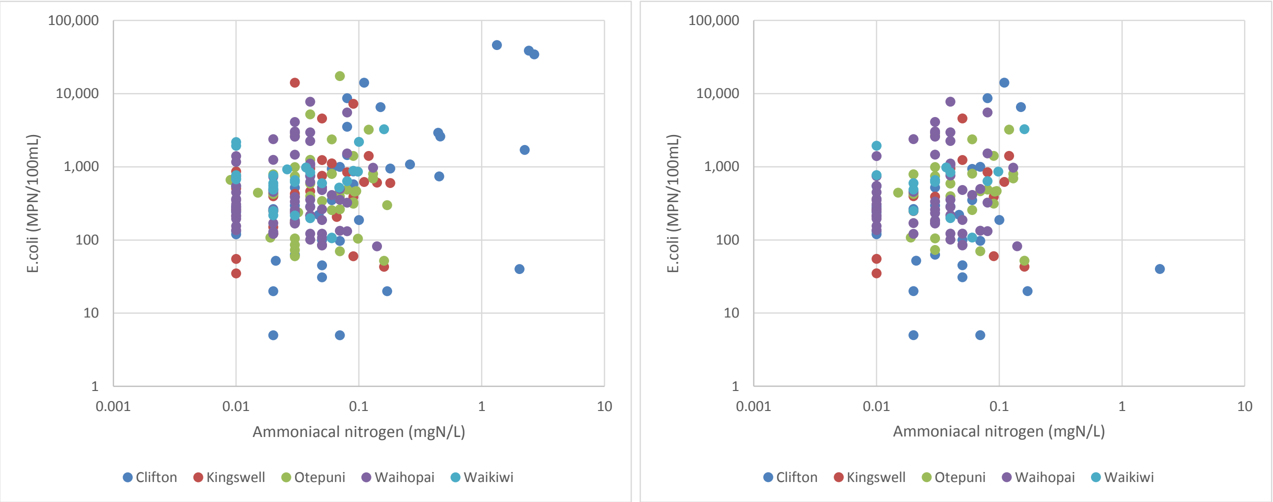


Figure 5-1: *E.coli* versus ammoniacal nitrogen concentrations in receiving water from ICC monitoring

These plots show that upstream locations have elevated *E.coli* and ammonia which are not due to sewage contamination in the stormwater network. The influence of contamination from upstream sources will continue to impact on water quality through the area impacted by the stormwater discharges. This indicates the problem with absolute use of indicators as the determinant of sewage contamination.

The ES SOE monitoring includes two locations upstream of the urban area (Waihopai and Waikiwi) and one in middle of urban catchment (Otepuni). There is no differentiation of wet and dry conditions in the monitoring results hence Figure 5-2 includes monitoring from all conditions collected monthly from 1995 to 2015.

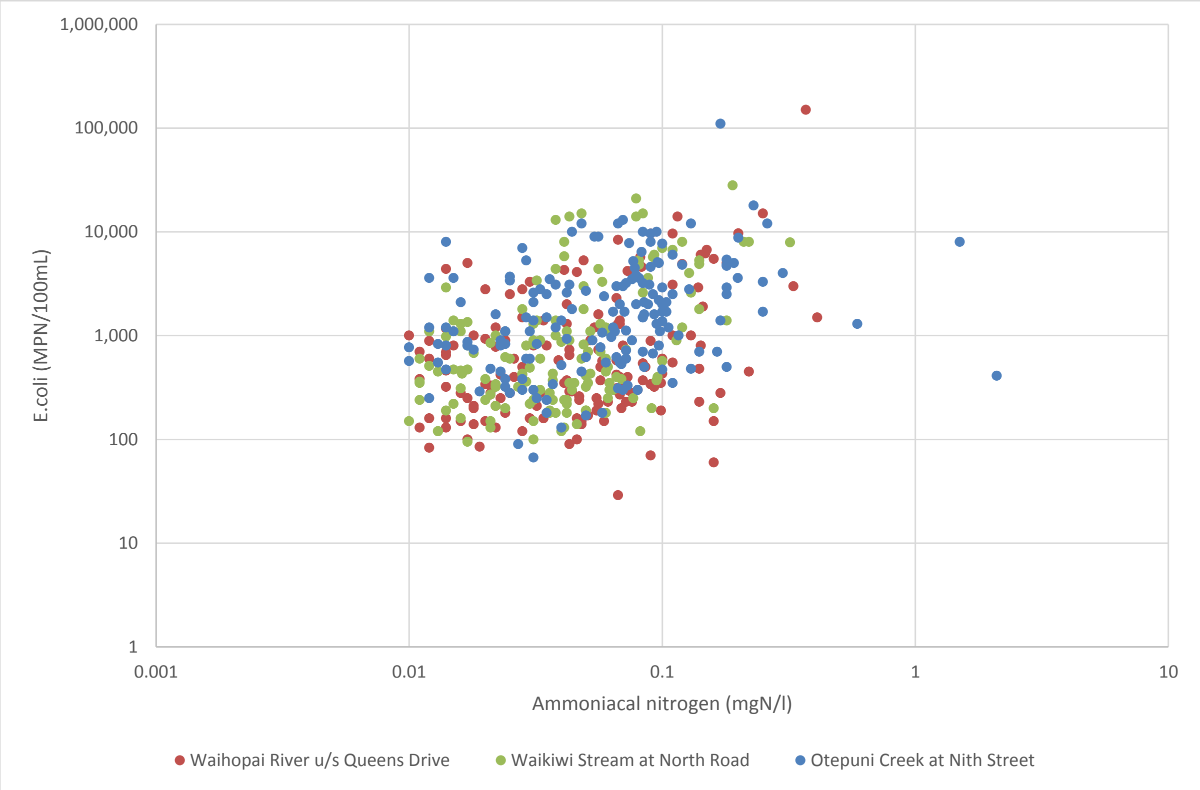


Figure 5-2: *E.coli* versus ammoniacal nitrogen concentrations in receiving water from ES SOE monitoring

Figure 5-2 further shows that *E.coli* and ammonia are not definitive indicators of sewage contamination in the receiving water. This is because they are present in significant concentrations in the discharges from rural areas, potentially from malfunctioning septic tanks and especially from stock contamination. However, they could be used as a trigger for further investigation. It is considered that these triggers could be set in receiving waters at *E.coli* greater than 1,000 MPN/100mL or ammoniacal nitrogen greater than 0.1 mg/l. These should only be applied to monitoring in dry weather conditions.

Figure 5-3 plots the *E.coli* against ammoniacal nitrogen recorded in the discharge monitoring performed by ICC in dry weather only. It is noted that there are a number of discharges with *E.coli* over 1,000 MPN/100mL which was the trigger used in the previous consent, which had minimal ammoniacal nitrogen concentrations which would be expected if the bacteria was from sewage.

Figure 5-4 shows the relationship between *E.coli* and fluorescent whitening agent (FWA) which is present in discharges from laundry. Hence dependent upon the nature of the cross connection, FWA may not be present at all times if only the toilet is cross connected. However, there are a number of other potential sources that can elevate the FWA concentration and it is not recommended that this be used as a trigger, but it does represent a potentially useful tool in the real time tracking of sewage contamination through the stormwater network to its source. Analysis for FWA as part of this investigation programme will provide an indication of whether it can be reliably used in the tracking of any indicated sewage contamination.

The following triggers are proposed for dry weather discharges to instigate investigation for sewage contamination: *E.coli* over 10,000 MPN/100mL or ammoniacal nitrogen over 1 mg/l.

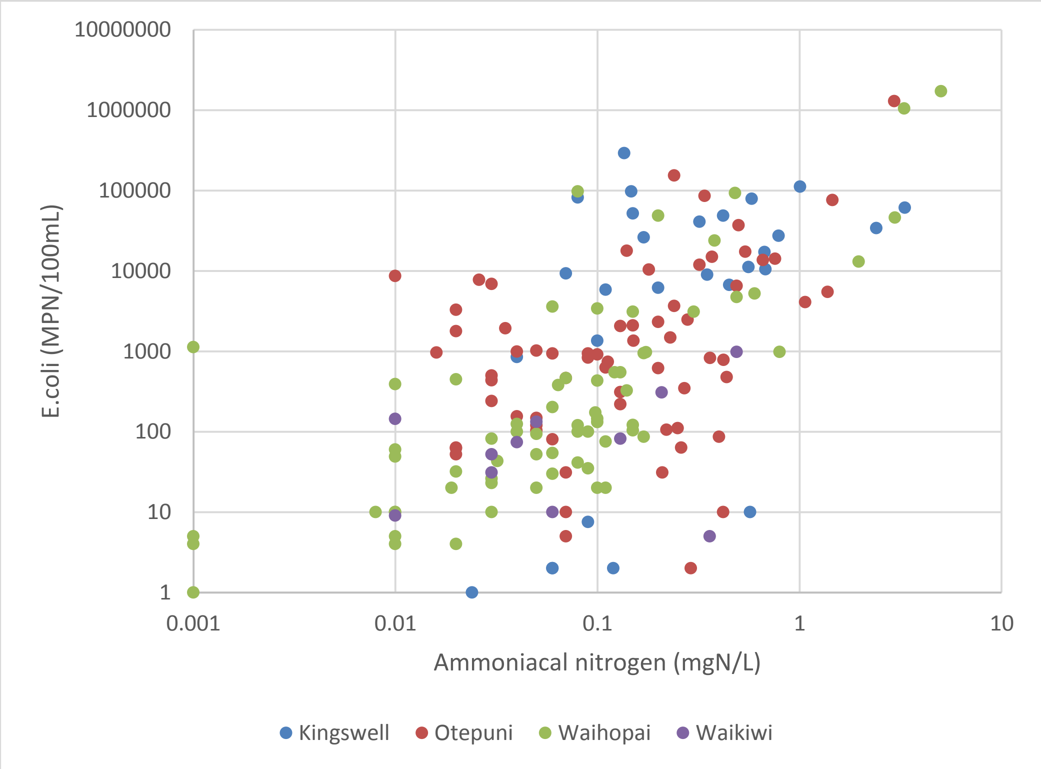


Figure 5-3: *E.coli* versus ammoniacal nitrogen concentrations in dry weather discharges from ICC monitoring

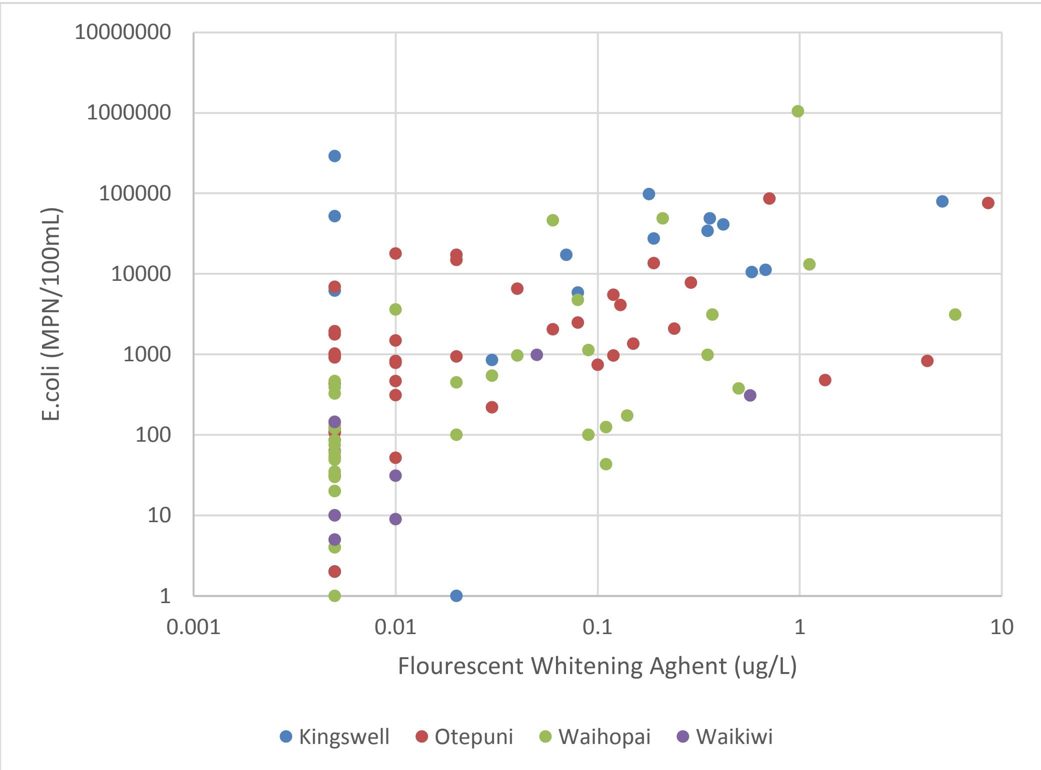


Figure 5-4: *E.coli* versus fluorescent whitening agent concentrations in dry weather discharges from ICC monitoring

5.3.3 Proposed Programme

The purpose of this monitoring programme is to identify sources of sewage contamination into the stormwater network. It includes:

- a surveillance programme in the receiving water to indicate whether contamination may be present, and which validates that the source has been removed.
- an indicator programme of the potentially contaminated discharges to locate the discharge within whose catchment the sewage source is probably located. This monitoring is undertaken when triggered by elevated concentrations recorded in the receiving water and includes all discharges between the receiving water monitoring locations;
- an investigation within the catchment of the discharge to locate the source of the contamination. This investigation is triggered by elevated concentrations being recorded in the stormwater discharge.

For the six discharges which were identified as contaminated with *E.coli* in the ICC monitoring programme during the previous consent (Discharges 2, 3, 6, 7, 8, and 14 and discharges in lower part of Clifton Creek), the indicator programme will be initiated in the first six months of the consent to confirm if sewage is still present in these discharges.

Surveillance Programme
The surveillance programme will include sampling at locations along each of the receiving water bodies, such that there is a maximum of 500m or a maximum of 10 discharges discharging into the receiving water between monitoring locations. This will result in approximately the following number of sample locations: Waikiwi (3), Waihopai (6), Otepuni (10), Kingswell (7) and Clifton (4). This is a total of 30 sites across the network discharging outside the Coastal Marine Area.

The actual number and location of these sites will be established to ensure that adequate access can be gained to the sites. It is proposed that the number and location of sites be reviewed after the first three years of data has been collected, as some refinement of the programme may be appropriate at that stage.

Sampling is to be undertaken in dry weather conditions every two months. Samples will be analysed for *E.coli*, and ammoniacal nitrogen.

If the concentrations at any location exceeds the following triggers on more than one occasion in any rolling set of five samples, then the indicator programme will be triggered:

- *E.coli* greater than 1,000 MPN/100mL or
- ammoniacal nitrogen greater than 0.1 mg/l.

It is envisaged that this surveillance programme in its current or reduced form will continue throughout the consent term to detect any sewage contamination into the stormwater network.

Indicator Programme
Once triggered by the surveillance programme, sampling will be undertaken of all discharges between the location at which the triggers were exceeded and the next upstream site.

Sampling will be undertaken in dry weather conditions only, and samples will be collected monthly for six months. Samples will be analysed for *E.coli*, ammoniacal nitrogen and fluorescent whitening agent.

If the concentrations recorded at any discharge exceed the following triggers on more than one occasion in the set of six samples, then an investigation of the catchment of that discharge will be triggered:

- *E.coli* greater than 10,000 MPN/100mL or
- ammoniacal nitrogen greater than 1 mg/l.

Once the investigation is complete and any identified remediation measures have been undertaken, then this indicator monitoring will be repeated for that discharge to confirm that the source has been addressed. If the triggers continue to be exceeded, this will either trigger further investigations within the catchment or the potential alternative sources of the contamination will be investigated and discussed with Environment Southland.

Investigation
If triggered by the indicator programme, an investigation will be undertaken to determine if any sources of sewage can be detected in the catchment. It should be recognised that dependent upon the nature of the catchment and the source, this could be difficult.

The investigation will include two phases:

- tracking the sewage through the network to the area in which the source is likely to be present. Dependent upon the size of the catchment, this may represent a significant task. If the monitoring of the discharge indicated that elevated FWA concentrations were also present, the mobile meter could be used to track the source in real time, or visual inspections for signs of sewage may be used with sampling for *E.coli* and ammonia as previously undertaken. The source may be intermittent and hence attempts to track the source may need to be repeated.
- Locating the source. Once the source has been tracked to a specific area of the network, there are a number of options for locating the actual source. These include smoke testing, dye testing, CCTV surveys and individual house inspections.

Once complete, the reporting of the investigation will include the methodology adopted for the investigation, maps which show the locations at which samples, inspections or other activities were undertaken and the result of the investigation including any mitigation measure that is required or has been undertaken.

The outcome of the investigation will be verified by repeating the indicator programme for the outlet of the discharge as described above.

5.3.4 Overflow Monitoring

Section 2.9 discussed the sewer overflows and the previous monitoring that has been undertaken to determine when the identified engineered overflow locations discharge. Whilst these discharges are outside of the scope of this application, it is proposed that the following monitoring be undertaken to enable a better understanding of these discharges.

The current monitoring mechanism for determining if an overflow has discharged as previously described is continued, with each site being visited at least quarterly and if the single daily rainfall exceeds 30mm. This rainfall was exceeded 48 times in the 24 years of monitoring at the Waihopai River at Waihopai Dam rainfall gauge and hence represents an intense rainfall event which may lead to an overflow.

5.4 Reduction in Metal Loads

5.4.1 Introduction

Section 3 identified that the metals of concern in the receiving environment are primarily zinc in both the water column and the sediment, and also nickel and lead in the sediment and copper in the water column only. Lead was only a concern in the Otepuni catchment.

Typically removal of metals from stormwater discharges is undertaken by reducing the suspended solids in the discharge which includes the particulate fraction of the metal. There are treatment methods for reducing dissolved metals which are designed for small catchments which have a high load.

The Treatment Review involved field surveys which revealed only a few locations where it may be practical to install treatment systems in the existing reticulation at the outfalls. The surveys showed that at most outfalls there is no head (gradient fall) or insufficient area for treatment systems. The review noted that any retrofitting of treatment at or near outfalls would require major works such as pumping stormwater to generate head and/or stream realignment and would be expensive.

Additionally the engineers note that in-catchment treatment such as in line filtration at the base of the catchment is only possible at very few locations and catchments. These locations were not those with the highest risk of contaminants as identified in the monitoring programme and would be difficult to implement.

Further, the Treatment Review (included in Appendix A) identified the requirements of the various treatment methods that can be used to reduce contaminants in stormwater. Generally these systems are used for smaller catchments than those which the ICC discharges serve. Therefore, treatment is generally only feasible for smaller sub-catchments within the larger catchments, where sufficient land is available.

These sub-catchments will need to be targeted at the specific areas of the catchment which act as principle sources of the metals of concern.

The proposed approach to managing metal contamination from the stormwater consists of the following elements:

- monitoring to track trends in metal concentrations during the consent term.
- estimating the load from the individual sources and mapping those sources within the catchment.
- undertake targeted monitoring of the areas identified as contributing significant loads to characterise the discharge and identify priority areas to consider implementing potential treatment/management options
- identify and implement the most appropriate treatment or management method for reducing the load from the area.

5.4.2 Monitoring

The principle concerns identified in the review of the available monitoring were:

- zinc concentrations in the water column in the Otepuni Creek,
- zinc, copper, and nickel in the sediments of the Waihopai River, Otepuni Creek and Clifton Channel, and
- lead was also a concern in the sediments of the Otepuni Creek.

Given the variability in receiving water concentrations, it is proposed that the sediment concentrations are used as an indicator of reduction of loads and hence monitoring of the water column is not proposed.

Sediment samples will be collected on an annual basis from the locations that have been undertaken in the previous monitoring period in the Waihopai River, Otepuni Creek and Clifton Creek. Samples will be analysed for total organic carbon, zinc, copper, nickel and lead.

5.4.3 Estimating and Mapping Loads

Copper and Zinc

The copper and zinc loads can be estimated using the Auckland Council Contaminant Load Model. The model produced will be referenced back to the ICC GIS network so that the locations of the identified main sources can be determined.

The estimated copper and zinc loads will be prepared for each of the three receiving water catchments within the first two years of the consent.

Nickel and Lead

The Auckland Council model does not cover nickel or lead. There is currently no documented and calibrated method in NZ that can be used to estimate the loads of these metals. In the ICC monitoring of the stormwater discharges, elevated concentrations of nickel were recorded in two of the discharges whose catchments included the industry. It is further noted that lead may be present from residual contamination resulting from the presence of lead in petrol which is not a continuing current source.

The potential sources of these metals from industrial and other activities can be identified. The Hazardous Activities and Industries list which is included as Appendix B of “Contaminated Land Management Guidelines No. 3: Risk Screening System” identifies the various contaminants that can be associated with various activities or industries. Again, it should be noted that these can be from historic as well as current practices. The activities associated with these two metals are identified as:

- Nickel:
  - Battery manufacture or recycling – assembling, disassembling, manufacturing or recycling batteries (other than storing batteries for retail sale)
  - Foundry operations – commercial production of metal products by injecting or pouring molten metal into moulds and associated activities
  - Gun, pistol or rifle ranges
  - Iron and steel works
- Lead:
  - Agrichemical spray contractor’s premises used for filling and washing out tanks for commercial agrichemical application
  - Battery manufacture or recycling – assembling, disassembling, manufacturing or recycling batteries (other than storing batteries for retail sale)
  - Cemeteries
  - Defence works and defence establishments, including ordinance storage and training areas where live firing is carried out
  - Electrical transformers – manufacturing, repairing or disposing of electrical transformers or other heavy electrical equipment
  - Explosive production or bulk storage
  - Foundry operations – commercial production of metal products by injecting or pouring molten metal into moulds and associated activities
  - Gasworks – manufacture of town gas from coal or oil feedstocks
  - Gun, pistol or rifle ranges
  - Market gardens, orchards, glass houses or other areas where the use of persistent agricultural chemicals occurred
  - Metal treatment or coating – including polishing, anodising, galvanising, pickling, electroplating, heat treatment using cyanide compounds and finishing; curing works or commercially finishing leather
  - Pesticide manufacture (including animal poisons, insecticides, fungicides and herbicides) – commercially manufacturing, blending, mixing or formulating pesticides
  - Petroleum or petrochemical industries or storage, including oil production and operating a petroleum depot, terminal, blending plant or refinery, retail or commercial refuelling facility, and facilities for recovery, reprocessing or recycling petroleum-based materials and bulk storage above and below ground
  - Port activities – including dry docks and ship and boat maintenance facilities
  - Service stations.

A review of the five catchments will be undertaken within the first year of the consent to identify and map to the GIS network any sites which are identified in either of the lists above.

The Site Audits identified in Section 5.2 will be targeted such that all of these sites will be visited within the first three years. The audit should include a specific review of the presence, use, storage and discharge of nickel and lead at these properties to identify if they may be contributing to the stormwater.

It should be noted the list indicates activities which may result in nickel and lead contamination and that not all of such activities will be significant contributors.

5.4.4 Targeted Monitoring

Once the specific areas or sub-catchments have been identified through the actions described in Section 5.4.3, targeted monitoring will be undertake to characterise the sub-catchment to confirm the estimated loads or presence of significant concentrations of metals and to provide information for the design of the treatment or management method to be employed.

Flow monitoring will typically not be possible in the network and hence the collection of flow proportional composite samples will generally not be possible, but a series of grab samples will be collected across a number of storm events and some dry weather samples collected as well. Consideration should also be given to analysis of a "control" area to determine if the area selected does have elevated loads of metals.

Analysis will be performed for the dissolved and total forms of the specific metal to be targeted and will include other parameters as required to guide design of the reduction measure. This could include total solids, suspended solids, particle size distribution, and other parameters if the dissolved component will be targeted.

Targeted monitoring of at least two areas or sub-catchments will be undertaken in each year of the first five years of the consent.

5.4.5 Identification and Implementation of Treatment / Management Method

Based on the results of the targeted monitoring, the most appropriate treatment or management method for reducing the load from the area shall be identified. This may include installing a treatment device, implementation of a management regime to reduce the risk of loads entering the system or methods to reduce the production of the contaminant, such as painting of roofs.

Each year the ICC will prepare a report which summarises the results of the investigations undertaken so far which identifies the process and timeframe for implementing the identified solution will be identified. It is noted that this may not be the construction of a treatment device. It may require the consultation with the wider community, particularly if the most appropriate reduction method involves work funded by private landowners.

6 Activity Status

The status of the activities including stormwater discharges that affect surface water quality are specified in the rule finder under Chapter 2 of the Regional Water Plan (the RWP). Rules that are relevant to stormwater discharges are Rules 1, 2 and 11.

The water bodies receiving discharges from the ICC reticulated network are classified as lowland hard bed and lowland soft bed in Appendix G of the Plan. The assessment of stormwater discharges in relation to the RWP water quality standards as provided in Section 4.2.6 indicate that a number of the standards are not complied with in the receiving surface water bodies. Whilst the cause of the non-compliance with most of the RWP standards are considered to not relate specifically to the discharges for which consent is sought, they could impact upon compliance with the faecal coliforms standard, particularly in wet weather conditions.

With respect to Rule 1 of the RWP this applies to discharges that do not reduce the water quality below any standards set for the relevant water body after reasonable mixing. These discharges are classified as a discretionary activity in accordance with Rule 1.

Rule 11 of the RWP applies to stormwater discharges that, amongst other conditions, are not from a reticulated system. The discharges authorised by this consent would not comply with either of these two rules.

Accordingly the stormwater discharges are a **non-complying** activity in terms of Rule 2 which concerns discharges to surface water bodies that do not meet receiving water quality standards.

7 Statutory Assessment

7.1 Introduction

In considering an application for a resource consent pursuant to Section 104 of the RMA, Council must, subject to Part 2 of the RMA 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*
>
> *(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application".*

Sections 7.1 and 7.2 identify the objectives and policies of the NPS and regional planning instruments of relevance to the application and Section 7.3 provides a commentary on the consistency or otherwise of the stormwater discharges in light of these provisions.

7.2 National Policy Statement (NPS) for Freshwater Management 2014

The National Policy Statement for Freshwater Management (NPS – FM) took effect on 1 August 2014 and provides overarching objectives and policies for managing the quality and quantity of freshwater resources in New Zealand. "Ecosystem health" and "human health for recreation" are compulsory national values and must be provided for everywhere. The NPS includes nationally-set minimum acceptable states for these two values which are called national bottom lines. The NPS-FM also includes a specific statement at the outset of the document about the national significance of fresh water and Te Mana o te Wai (the mana of the water). This recognises that there is a range of community and tāngata whenua values associated with fresh water.

Relevant Objectives are:

Objective A1 of the NPS states:

"*To safeguard:*

> *(a) the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water, and*
> *(b) The health of people and communities, at least by secondary contact with fresh water; in sustainably managing the use and development of land, and of discharges of contaminants.*

Objective C1 of the NPS states:

"*To improve integrated management of fresh water and the use and development of land in whole catchment, including the interactions between fresh water, land, associated ecosystems and the coastal environment*."

Objective D of the NPS states:

"To provide for the involvement of iwi and hapu, and to ensure that tangata whenua values and interests are identified and reflected in the management of fresh water including associated ecosystems, and decision-making regarding freshwater planning, including on how all other objectives of this national policy statement are given effect to."

Objective A1(a) is relevant to the stormwater discharges as it requires the life supporting capacity, ecosystems and indigenous species and their associated ecosystems of the receiving environments to be safeguarded through sustainably managing the use and development of land, and of discharges of contaminants in the stormwater.

Objective C1 is relevant as the proposed management of stormwater includes a programme of investigations targeted as reducing cross connections to reduce sewage contamination and promotion of low impact design stormwater systems for new land developments.

Objective D is relevant as tanagata whenua values and interests have been identified through initial consultation with Te Ao Marama on this project and through proposed management measures that seek to reduce sewage contamination in line with Objective A1(a).

7.3 Relevant Planning Instruments

7.3.1 Southland Regional Policy Statement 1997

The purpose of the Southland Regional Policy Statement (RPS) is to integrate the management of the natural and physical resources of the region by providing an overview of the issues, policies and methods relevant to the whole region. All regional and district plans must give effect to the RPS.

The RPS establishes sustainable resource management policies relating to tangata whenua; biodiversity; water quality, quantity and water bodies; landscape and soils; transport and the built environment; the air, coast, energy and solid waste; and natural hazards, and hazardous substances. The RPS became operative in December 1997.

Relevant objectives and policies are contained in Section 5.1 – Takata whenua, Section 5.5 – Water quality and Section 5.10 – Built Environment.

The relevant objectives in Section 5.1 (Objectives 1.1, 1.2, 1.4) require the recognition of the importance of wahi tapu, wahi taoka, mahika kai and the customary use of water to Kai Tahu, to incorporate Maori cultural and traditional spiritual values where appropriate into resource management decision making processes and have particular regard to the concept of kaitiakitanga.

The relevant objectives in Section 5.5 (Objectives 5.1, 5.2, 5.3) require sustainable management of the Region's water resources so as to meet the needs of a range of uses and the reasonably foreseeable needs of future generations and to safeguard the life-supporting capacity of water and related ecosystems and to ensure that the discharge of contaminants does not compromise water quality standards established for the region. Relevant policies 5.2 and 5.8 require all point source discharges, after reasonable mixing, to comply with water quality standards while recognising and providing for the values that Maori place on water.

The relevant objectives and policies in Section 5.10 (Objectives 10.1, 10.5, Policies 10.2) require sustainable management of the built environment and avoiding, remedying or mitigating adverse effects of the built environment and associated network utilities on natural and physical resources.

7.3.2 Proposed Southland Regional Policy Statement 2012

The Proposed Southland Regional Policy Statement 2012 (Proposed RPS) was publicly notified on Saturday 19 May 2012 and provides a high level policy framework for the Southland region.

Relevant objectives and policies are contained in Chapter 3 – Tangata whenua, Chapter 4 – Water quality, and Chapter 16 – Infrastructure/Transport.

Objective TW.3 requires Tangata whenua spiritual values and customary resources Mauri and wairua to be sustained or improved where degraded, and that mahinga kai and customary resources are healthy, abundant and accessible to tangata whenua.

Objective WQUAL.1 requires that the life-supporting capacity of water and related ecosystems is safeguarded, that water quality is maintained where it is good or enhanced where it is degraded and that it meets the needs of a range of uses, including the reasonably foreseeable needs of future generations.

Policy WQUAL.1 requires the identification of values of surface and groundwater that should be maintained, and management of discharges and land use activities to maintain or enhance water quality to provide for those values.

Policy WQUAL.2 requires the maintenance and enhancement of the water quality of surface water and groundwater by managing activities to reduce the levels of nitrogen and phosphorus; sediment and microbiological contaminants.

Objective INF.1 requires that Southland's regional, national and critical infrastructure is secure, operates efficiently, and is integrated with land use and the environment.

Policy INF.2 requires avoidance, remediation or mitigation of the adverse effects of infrastructure on the environment.

7.3.3 Southland Regional Water Plan

The purpose of this plan is to promote the sustainable management of Southland's rivers, lakes, groundwater, surface water, and wetland resources. The plan is aimed at enabling the use and development of fresh water where this can be undertaken in a sustainable way, providing a framework for activities, such as discharges to water, taking and using water, and structures and bed disturbance activities in river beds.

The Southland Regional Water Plan (RWP) provides a legislative framework that aims to address these issues. This includes setting of water quality standards according to classifications reflecting the different characteristics of the region's water bodies. Waikiwi Stream, Waihopai River and Clifton Channel are classified as a "lowland hard bed" while Otepuni Stream and Kingwell Creek are classified as "lowland soft bed" in the RWP.

Objectives and policies of relevance to this application are:

Objective 2 requires the management of water quality so that there is no reduction in the quality of the water in any surface water body, beyond the zone of reasonable mixing for discharges, beyond the date this RWP became operative (January 2010).

Objective 3 requires the maintenance and enhancement of surface water bodies outside of natural state waters so that values (bathing, presence of trout, stock drinking water, cultural values and natural character) are protected where water quality is already suitable for them, and where water quality is currently not suitable, measurable progress is achieved towards making it suitable for them.

Policy 3 specifies that no discharges to surface water bodies that will result in a reduction of water quality beyond the zone of reasonable mixing should occur unless it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the RMA.

Policy 4 states that point source and non-point sources discharges to surface water bodies outside Natural State Waters shall meet or exceed the water quality standards referred to in Rule 1 and specified in Appendix G "Water Quality Standards", unless it is consistent with the promotion of the sustainable management of natural and physical resources as set out in Part 2 of the RMA and so avoid levels of contaminants in water and sediments that could harm the health of humans, domestic animals including stock and/or aquatic life.

Rule 2 of the RWP is of relevance as it relates to discharges to surface water bodies that do not meet water quality standards. Rule 2 states:

"(a) Except as provided for elsewhere in this Plan or in any other Southland Regional Council regional plan, the discharge of any:
(i) contaminant or water into a surface water body; or
(ii) contaminant onto or into land in circumstances where it may enter a surface water body

that cannot meet the conditions in Rule 1 is a non-complying activity."

The relevant water quality standards are set out in Appendix G of the RWP which concern lowland hard bed and lowland soft bed waterways such as those referred to in this application.

The RWP standards for lowland hard bed water bodies are:

- The temperature of the water
  - shall not exceed 23°C
  - shall not exceed 11°C in trout spawning areas during May to September inclusive
  - the daily maximum ambient water temperature shall not be increased by more than 3°C when the natural or existing water temperature is 16°C or less, as a result of any discharge. If the natural or existing water temperature is above 16°C, the natural or existing water temperature shall not be exceeded by more than 1°C as a result of any discharge.
- The pH of the water shall be within the range 6.5 to 9, and there shall be no pH change in water due to a discharge that results in a loss of biological diversity or a change in community composition.
- The concentration of dissolved oxygen in water shall exceed 80% of saturation concentration.
- There shall be no bacterial or fungal slime growths visible to the naked eye as obvious plumose growths or mats. Note that this standard also applies to within the zone of reasonable mixing for a discharge.
- When the flow is below the median flow, the visual clarity of the water shall not be less than 1.6 metres.
- The concentration of total ammonia shall not exceed the values specified in Table 1 "Ammonia standards for Lowland and Hill surface water bodies".
- The concentration of faecal coliforms shall not exceed 1,000 coliforms per 100 millilitres, except for popular bathing sites, defined in Appendix K "Popular Bathing Sites" and within 1 km immediately upstream of these sites, where the concentration of *Escherichia coli* shall not exceed 130 *E. coli* per 100 millilitres.
- For the period 1 November to 30 April filamentous algae of greater than 2 cm long shall not cover more than 30% of the visible stream bed. Growths of diatoms and cyanobacteria greater than 0.3cm thick shall not cover more than 60% of the visible stream bed.
- Biomass shall not exceed 35 grams per square metre for filamentous algae.
- Chlorophyll *a* shall not exceed 120 milligrams per square metre for filamentous algae and 200 milligrams per square metre for diatoms and cyanobacteria.
- The Macroinvertebrate Community Index shall exceed a score of 90 and the Semi-Quantitative Macroinvertebrate Community Index shall exceed a score of 4.5.
- Fish shall not be rendered unsuitable for human consumption by the presence of contaminants.

The RWP standards for lowland soft bed water bodies are:

- The temperature of the water
  - shall not exceed 23°C
  - shall not exceed 11°C in trout spawning areas during May to September inclusive
  - the daily maximum ambient water temperature shall not be increased by more than 3°C when the natural or existing water temperature is 16°C or less, as a result of any discharge. If the natural or existing water temperature is above 16°C, the natural or existing water temperature shall not be exceeded by more than 1°C as a result of any discharge.
- The pH of the water shall be within the range 6.5 to 9, and there shall be no pH change in water due to a discharge that results in a loss of biological diversity or a change in community composition.
- The concentration of dissolved oxygen in water shall exceed 80% of saturation concentration.
- There shall be no bacterial or fungal slime growths visible to the naked eye as obvious plumose growths or mats. Note that this standard also applies to within the zone of reasonable mixing for a discharge.
- When the flow is below the median flow, the visual clarity of the water shall not be less than 1.3 metres.

- The concentration of total ammonia shall not exceed the values specified in Table 1 "Ammonia standards for Lowland and Hill surface water bodies".
- The concentration of faecal coliforms shall not exceed 1,000 coliforms per 100 millilitres, except for popular bathing sites, defined in Appendix K "Popular Bathing Sites" and within 1 km immediately upstream of these sites, where the concentration of *Escherichia coli* shall not exceed 130 *E. coli* per 100 millilitres.
- The Macroinvertebrate Community Index shall exceed a score of 80 and the Semi-Quantitative Macroinvertebrate Community Index shall exceed a score of 3.5.
- Fish shall not be rendered unsuitable for human consumption by the presence of contaminants.

7.3.4 Proposed Southland Water and Land Plan

The Proposed Southland Regional Water and Land Plan (WLP) was notified on 3 June 2016 and is intended to provide direction and guidance regarding the sustainable use, development and protection of water and land resources in the Southland region.

The WLP recognises the national significance of Te Mana o te Wai, which puts the mauri (inherent health) of the waterbody and its ability to provide for te hauora o te tangata (the health of the people), te hauora o te taiao (health of the environment) and te hauora o te wai (the health of the waterbody) to the forefront of freshwater management.

The WLP gives effect to the NPS-FM, which includes a requirement to define the waterbodies to be managed, and set outcomes, limits, targets and other measures to achieve those outcomes. In accordance with this framework, the Southland region has been divided into five catchments, which stretch from the mountains to the estuaries and sea at the bottom of these catchments. These are the Freshwater Management Units (FMU) for the purposes of the NPS-FM.

The WLP outlines objectives, policies and rules that apply to the whole of the region. Through the FMU limit setting process, objectives, policies and rules will be developed for each FMU. These will be tailored to respond to the pressures faced within each particular catchment. As the FMU limit setting process proceeds, the region-wide objectives, policies and rules in the WLP may be added to or replaced by the objectives, policies and rules specific to each FMU. Environment Southland intends to complete its FMU limit setting programme by December 2025.

The relevant region wide objectives and policies with the latter specific to Ngai Tahu, water quality and consideration of resource consent applications are set out below.

Objective 1 - Land and water and associated ecosystems are managed as integrated natural resources, recognising the connectivity between surface water and groundwater, and between freshwater, land and the coast.

Objective 3 - The mauri (inherent health) of waterbodies provide for te hauora o te tangata (health of the people), te hauora o te taiao (health of the environment) and te hauora o te wai (health of the waterbody).

Objective 4 - Tāngata whenua values and interests are identified and reflected in the management of freshwater and associated ecosystems.

Objective 6 - There is no reduction in the quality of freshwater, or water in estuaries and coastal lagoons, by:

- maintaining the quality of water in waterbodies, estuaries and coastal lagoons, where the water quality is not degraded; and
- improving the quality of water in waterbodies, estuaries and coastal lagoons, that have been degraded by human activities.

Policy 1 – Enable papatipu rūnanga to participate
Enable papatipu rūnanga to effectively undertake their kaitiaki responsibilities in freshwater and land management through Environment Southland:

1. providing copies of all applications that may affect a Statutory Acknowledgement area, tōpuni, nohoanga, mātaitai or taiāpure to Te Rūnanga o Ngāi Tahu and the relevant papatipu

rūnanga;
2. identifying Ngāi Tahu interests in freshwater and associated ecosystems in Southland/Murihiku;
3. reflect Ngāi Tahu values and interests in the management of and decision-making on freshwater and freshwater ecosystems in Southland/Murihiku, consistent with the Charter of Understanding.

Policy 2 – Take into account iwi management plans
Any assessment of an activity covered by this plan must:

1. take into account any relevant iwi management plan; and
2. assess water quality and quantity based on Ngāi Tahu indicators of health.

Policy 13 – Management of land use activities and discharges
Manage land use activities and discharges (point source and non-point source) to land and water so that water quality and the health of humans, domestic animals and aquatic life, is protected.

Policy 15 – Maintaining and improving water quality
Maintain and improve water quality by:

1. despite any other policy or objective in this Plan, avoiding new discharges to surface waterbodies that will reduce water quality beyond the zone of reasonable mixing;
2. avoiding point source and non-point source discharges to land that will reduce surface or groundwater quality, unless the adverse effects of the discharge can be avoided, remedied or mitigated;
3. avoiding land use activities that will reduce surface or groundwater quality, unless the adverse effects can be avoided, remedied or mitigated; and
4. avoiding discharges to artificial watercourses that will reduce water quality in a river, lake or modified watercourse beyond the zone of reasonable mixing;

so that:

1. water quality is maintained where it is better than the water quality standards specified in Appendix E "Water Quality Standards"; or
2. water quality is improved where it does not meet the water quality standards specified in Appendix E "Water Quality Standards"; and
3. water quality meets the Drinking-Water Standards for New Zealand 2005 (revised 2008); and
4. ANZECC sediment guidelines (as shown in Appendix C of this Plan) are met.

Policy 39A – Integrated Management
To improve integrated management of freshwater and the use and development of land in whole catchments, including the interactions between freshwater, land and associated ecosystems (including estuaries).

Policy 40 – Determining the term of resource consents
When determining the term of a resource consent consideration will be given, but not limited, to:

1. granting a shorter duration when there is uncertainty regarding the nature, scale, duration and frequency of adverse effects from the activity or the capacity of the resource;
2. relevant tangata whenua values and Ngāi Tahu indicators of health;
3. the duration sought by the applicant, plus material to support the duration sought;
4. the permanence and economic life of any capital investment;
5. the desirability of applying a common expiry date for water permits that allocate water from the same resource or land use and discharges that may affect the quality of the same resource;
6. the applicant's compliance with the conditions of any previous resource consent; and
7. the timing of development of FMU sections of this Plan, and whether granting a shorter or longer duration will better enable implementation of the any revised frameworks established in those sections.

Policy 41 – Matching monitoring to risk
Consider the magnitude of environmental effects and risk when determining requirements for auditing and supply of monitoring information on resource consents.

7.4 Assessment of NPS, RPS and Regional Plan Provisions

Table 7-1: NPS-FW Assessment Table

Chapter/Section	Statutory Planning Provision
National Policy Statement of Freshwater Management 2014	
Section A Water Quality	*Objectives* Objective A1(a) Objective C1 Objective D
Assessment The 2012 and 2016 macroinvertebrate surveys conducted by RCL for the ICC indicate that the stormwater discharges are not adversely affecting the macroinvertebrate communities and the life supporting capacity of the receiving water bodies. The discharges are not inconsistent with Objective A1(a). In line with Objective C1, the ICC will undertake a review of potentially suitable stormwater treatment including source control measures in certain catchments, and removal of sewage from the stormwater network. With regard to Objective D, Te Ao Marama has initially been consulted and will continue to be consulted to ensure the values and interests of the Runanga they represent are taken into account during the preparation of the application and in particular around the proposed management of the stormwater system and formulation of the proposed consent conditions.	
Regional Policy Statement 1997	
Section 5.1- Takata whenua	Objectives 1.1, 1.2, 1.4.
Section 5.5 – Water Quality	Objectives 5.1, 5.2, 5.2. Policies 5.2, 5.8
Section 5.10 – Built Environment	Objectives 10.1, 10.5 Policy 10.2
Assessment Consultation being undertaken with Te Ao Marama by the ICC is consistent with the requirements of objectives 1.1, 1.2 and 1.4 and policies 5.2 and 5.8 which require due recognition in the application of the importance of wahi tapu, wahi taoka and mahika kai in the receiving water bodies. Objectives 5.1, 5.2 and 5.3 are relevant as the ICC seeks to improve water quality in the receiving water bodies through measures that reduce the concentration of contaminants entering the stormwater reticulation system. In regard to objectives 10.1 and 10.5 and policy 10.2 the ICC will require new developments to utilise low impact design to better manage contaminant loads in the stormwater. Through its own investigations and renewal programmes the ICC is seeking to reduce the impacts of the urban environment on stormwater quality and water quality in the receiving environments.	

Chapter/Section	Statutory Planning Provision
Proposed Regional Policy Statement 2012	
Chapter 3 - Tangata whenua	Objectives TW.3
Chapter 4 – Water Quality Chapter 16 – Infrastructure/Transport	Objectives WQUAL.1. Policies WQAUL.1, WQUAL.2 Objective INF.1 Policy INF.2
Assessment The ICC is seeking to align Objective TW.3 through a programmed management of improvements to stormwater management as previously outlined. The ICC is seeking to improve water quality in the receiving water bodies in accordance with objective WQUAL.1 and policies WQUAL1 through management of contaminants such as sediment, heavy metals and microbiological contaminants. The ICC has a renewal programme for replacement of aging infrastructure to ensure levels of services are maintained which is consistent with objective INF.1 and policy INF.2.	
Regional Water Plan	
Part L/Section 5	Objectives 2, 3 Policies 3, 4
Assessment The ICC is seeking to align with these objectives and policies through implementation of on-site in-catchment measures to reduce sewage contamination and metal loads in the discharges in order to improve water quality in the receiving water bodies (see Part 5 of this document). These measures will be supported to the ICC's intention to continue to audit the industrial and commercial properties to reduce the risk of contaminants entering the stormwater network from these locations.	
Proposed Southland Water and Land Plan	
	Objectives 1, 3, 4, 6 Policies 1, 2, 13, 15, 39A, 40, 41.
Assessment With respect to objectives 1 and 6 and policies 13, 15 and 39A ICC recognise the importance of an integrated approach to stormwater management on a catchment wide basis in order to be effective in bringing about improvements in water quality in the receiving water bodies. The consultation being undertaken with Te Ao Marama and remedial measures the ICC is investigating is consistent with the requirements of objectives 3 and 4 and policies 1 and 2. A term of 35 sought in this application aligns with Policy 40 in terms of the permanence and economic life of the capital investment by the ICC which is significant.	

Chapter/Section	Statutory Planning Provision
The discharge and receiving environment monitoring that forms part of the proposed consent conditions set out in Section 9 aligns with policy 41. The information derived from monitoring will inform Council of the magnitude of any effects of the discharges on the receiving water bodies.	

7.5 Other Matters

7.5.1 Te Tangi a Tauira

The purpose of this Iwi Management Plan (IWP) is to consolidate Ngai Tahu ki Murihiku values, knowledge and perspectives on natural resource and environmental management issues within the Southland environment. It is an expression of kaitiakitanga. While the plan is first and foremost a planning document to assist Ngai Tahu ki Murihiku in carrying out kaitiaki roles and responsibilities, it also recognises the role of communities in achieving good environmental outcomes and healthy environments, and thus is designed to assist others in understanding tangata whenua values and policy.

The IWP includes specific sections on Te Ra a Takitimu (Southland Plains).

Te Tangi a Tauira identifies values, objectives, policies and outcomes sought by the tangata whenua of Murihiku.

Nga Kaupapa (Policies) of relevance to this application concern subdivision and development and water quality are set out below.

- *The role of Ngai Tahi ki Muihiku as tangata whenua and kaitiaki of water must be recognised and provided for in all water quality management*
- *Strive for the highest possible standard of water quality that is characteristic of a particular place/waterway, recognising principles of achievability.*
- *Require cumulative effects assessments for any activity that may have adverse effects on water quality.*
- *Avoid adverse effects on the natural environment as a consequence of increased demands placed upon land, water and community infrastructure resulting from the granting of new subdivision consents for residential or commercial development.*
- *Require that the disposal of stormwater occurs in a manner that avoids inundation of land within or adjoining the subdivision, and does not adversely affect the quality of surface and groundwater.*
- *Require robust monitoring of discharge permits to detect non-compliance with consent conditions. Non-compliance must result in appropriate enforcement action to discourage further non-compliance.*

An initial summary of the available information for the application was provided to Te Ao Marama and representatives from Te Ao Marama attended the consultation meeting on 14 March 2015 in line with the IWP's consultation policy.

7.6 Resource Management Act

7.6.1 Section 104D of the Resource Management Act 1991

Section 104D of the Act concerns particular restrictions for non-complying activities. A consent authority may grant a resource consent for a non-complying activity only if it satisfied that either:

(a) The adverse effects of the activity on the environment will be minor; or

(b) The application is for an activity that will not be contrary to the objectives and policies of the relevant plan and relevant proposed plan.

The assessment of effects on the receiving environments in Section 4 indicates that the stormwater discharges, excluding sewage are having a minor to moderate effect on water quality, a minor effect on aquatic ecosystems, a minor effect on groundwater quality and a moderate effect on the visual and amenity values. Sewage contamination in the stormwater network is however having more than a minor effect on water quality in the receiving environments, but sewage is excluded from the scope of this consent.

On the basis of the Section 4 assessment the first gateway test is not met.

In terms of the second gateway test, the stormwater discharges are not contrary to the objectives and policies of the Regional Water Plan and Proposed Southland Water and Land Plan when the provisions of both plans are considered together. While Objective 2 and Policies 3 of the Regional Water Plan require no reduction in water quality beyond the zone of reasonable mixing and to avoid levels of contaminants in water and sediment that could harm the health of humans and aquatic life, Objective 3 of the Plan seeks measurable progress towards improving water quality for a range of values. This objective is complemented by Objectives 1 and 6 and Policies 13 and 15 of the proposed Southland Water and Land Plan which place weight on integrated management of land and water and associated ecosystems and improvement of water quality degraded by human activities and measures that avoid, remedy or mitigate adverse effects of the discharges.

The Council's maintenance and renewal programmes, programmed industrial and commercial site audits and proposed measures to reduce sewage contamination and metal loads as discussed in Section 5 seek to improve the quality of the degraded receiving environments and are therefore consistent with the overall intent of the objectives and policies of both plans.

It is noted that these programmed improvements to the reticulation network and general management measures align with the objectives and policies contained in the built environment chapter of the Operative RPS and in the Infrastructure/Transport chapter in the Proposed RPS. These provisions require secure and efficient operation of infrastructure which is integrated with land use while avoiding, remedying and mitigating adverse effects on the environment.

7.6.2 Section 105 of the Resource Management Act 1991

Section 105 RMA sets out additional matters which the consent authority must have regard to when determining an application for a discharge permit that contravenes section 15 or 15B of the RMA.

The nature of the discharge and its sensitivity to the discharges (s105(1)(a)) are described in some detail in Parts 2 – 4 of this application, including the constituents as determined through the ICC's monitoring regime.

The ICC's reasons for the discharges (s105(1)(b)) are set out in Parts 1-2 of this document, and includes the need to continue the discharges in order to manage stormwater for the Invercargill community in a way that maintains public health and well-being.

In Part 8 of this application the applicant considered alternatives to treating and discharging stormwater (s105(1)(c)). The potential to discharge to alternative receiving environments was limited to devices such as soakage trenches and rain gardens etc., but no feasible alternatives to discharging stormwater through the existing outfalls were identified, given the logistics and prohibitive costs of making substantial changes to the ICC's established stormwater network. The most likely alternative to continuing the discharges would be source control, where stormwater is discharged to land close to where it originates, but the opportunities to do so effectively within the Invercargill catchment is limited by the climate, topography and the drainage characteristics of underlying soils. Regardless, the logistics and cost of retrofitting such devices on the scale necessary to effectively manage stormwater would be prohibitive.

7.6.3 Section 107 of the Resource Management Act 1991

Section 107 RMA prevents the consent authority from granting a discharge permit where the discharge of water and contaminants will give rise to a defined range of adverse effects on amenity values or significant adverse effects on aquatic life after reasonable mixing (s107(1)(c) – (g)).

The assessment of effects set out in Part 4 of this application document demonstrates that no such adverse effects will result after reasonable mixing at each discharge point, and hence s107 RMA does not prevent the application from being granted.

7.6.4 Part 2- Purpose and Principles of the Resource Management Act 1991

7.6.4.1 Purpose of RMA – Section 5

The proposed programme of staged remediation of contamination in the stormwater network and promotion of treatment devices that reduce contaminant concentrations accords with section 5 which is the promotion of the sustainable management of natural and physical resources. The purpose of the remedial measures is to protect public health and reduce input of further contaminants including sediment and heavy metals in order to maintain the life supporting capacity of the water bodies in Invercargill's stormwater catchments. Ongoing renewal programme and upgrades involves a physical resource and protection of public health through programmed reduction in sources of contamination provides for the social and economic wellbeing and health and safety of the local and wider communities.

In terms of Section 5(2)(b) the monitoring data compiled to date indicates that the life supporting capacity of the aquatic ecosystems in the stormwater catchments are being safeguarded.

In terms of Section 5(2)(c) the mitigation measures proposed in this application including in catchment treatment measures to reduce sewage contamination and metal loads will avoid, remedy and mitigate the adverse effects of the stormwater discharges on the environment.

7.6.5 Matters of National Importance and Other Matters – Sections 6 and 7

Section 6 and section 7 matters of relevance to the application are recognising and providing for the relationship of Kai Tahu and their culture and traditions with their ancestral lands, water, waahi tapu, and other taoka (section 6(e)) and the role of Kai Tahu as kaitiaki (section 7 (a)) and the ethic of stewardship (section 7(aa)). The special significance of wairua, mauri, taoka and mahika kai to Kai Tahu is reflected in the proposed mitigation measures, which seek to maintain or improve stormwater quality and water quality in the receiving environments.

Under section 7 decision makers are required to have particular regard to a range of matters, the most relevant to this application being the maintenance and enhancement of amenity values (s7(c)), the intrinsic values of ecosystems (s7(d)) and the maintenance and enhancement of the quality of the environment (s7(f)).

The continuation of the proposed stormwater discharges will not result in adverse effects in the receiving environment beyond those already identified in Part 4 of this document. The opportunity to enhance amenity values and the quality of the receiving environment however, lies in the commitment by the applicant to mitigating the actual and potential adverse effects of the discharges through proposed mitigation activities including identifying and addressing sewage contamination, and reducing metals in wastewater. Be doing so, the intrinsic values of ecosystems in the receiving waterbodies are better provided for.

7.6.6 Treaty of Waitangi – Section 8

Section 8 require the principles of the Treaty of Waitangi to be taken into account and in doing so recognising Kai Tahu's role as kaitiaki and their relationship with the waterbodies in the Invercargill urban area. The proposed remedial measures seek to minimise adverse effects of the stormwater discharges on waahi tapu, taoka and mahika kai through proposed mitigation measures that address contaminant concentrations in the discharges.

7.7 Other Relevant Legislation

7.7.1 Health Act 1956

This legislation requires the ICC to ensure safe sanitation through the improvement, promotion and protection of public health within its district. The Health Act also requires the ICC to inspect its district to ascertain if conditions exist which are likely to be injurious to health. If such conditions do exist, the ICC is required to take reasonable steps to ensure that they are abated or removed.

8 Assessment of Treatment Alternatives

A preliminary desktop assessment of potentially suitable stormwater treatment devices was undertaken by MWH as part of Phase 1 of the treatment review referred to in Section 1.1. This assessment was based on catchment and contaminant characteristics of the 18 Invercargill stormwater discharges that are currently monitored to determine whether there were any areas where treatment could be implemented for these discharges.

Potentially suitable treatment devices assessed that re typically used around the country were:

- Ponds and wetlands
- Structural Filters
- Rain Gardens
- Infiltration basin, trenches and porous pavement
- Swales
- Filter Strips
- Vegetation/revegetation measures
- Oil and Water Separators and
- Cross Pollutant Traps.

Information on these measures and devices and treatment capability is provided in Table 4-3 of the review report (refer to Appendix A).

In determining the potential effectiveness of different stormwater treatment devices at specific sites, Phase 1 of the review considered the following factors:

- Catchment area draining to the treatment device
- The targeted contaminants at the stormwater discharge locations
- Soils in the location of the intended stormwater management device
- Slopes
- General constraints: space availability, maximum sediment inputs, slope stability (if known), high groundwater table (if known), etc.
- Maintenance opportunities and constraints.

The Phase 1 assessment indicated that there is only limited potential for effective treatment of stormwater flows in-line or at the discharge point and concluded that source control is likely to have the greatest potential for improvement of the quality of stormwater discharges.

These findings were confirmed during the Phase 2 site walkovers which showed that there were few locations where it was practical to install treatment systems in the existing reticulation or at the outfalls. The key factors constraining installation were a general lack of driving head and a lack of sufficiently large area of land to accommodate low-head systems.

The review concluded that any retrofitting of treatment systems at or near outfalls would require major works such as pumping stormwater to generate head and/or stream realignment to accommodate low head systems, both of which would be expensive to implement. The review further concluded that base of catchment treatment such as inline filtration would only be possible at a few locations which do not necessary correspond with locations where water quality monitoring indicate there is a need for treatment.

9 Consultation Undertaken

Consultation undertaken to date has involved the preparation of a comprehensive consultation information document which was circulated to Environment Southland and key stakeholders including Te Ao Marama, the Department of Conservation, Fish and Game Council and Public Health South. The consultation document contained some of the information that has been developed into Sections 1 to 4 of this Application.

A meeting with representatives from these organisations was held on 14 March 2016 and engendered a good level of discussion on the scope of the application and key issues such as the nature of the discharges and the stormwater network, monitoring of the discharges, sewage overflows and management and treatment measures. Minutes to the meeting are provided in Appendix E.

During the consultation undertaken for the 2015-2025 Long Term Plan, the options for the renewal expenditure for the sewerage and stormwater infrastructure was specifically consulted on. In both cases, ratepayers were offered three options for rate of renewals of this infrastructure, and were advised of the resulting impact on rates.

Options were:

1. Retain Current expenditure (with CPI increases). With this level of expenditure the age of the asset would continue to increase, so level of service would drop over time due to increased failure of pipes.

2. Increase expenditure to 1 % of asset value by 2021, to match the economic life of the pipe assets. As the oldest pipes would be replaced first, this option would provide an increase in the service levels over time, and would reduce contamination of Stormwater and sewerage.

3. Increase expenditure to 1.5 % of asset value by 2021 to improve at a faster rate than option 2.

Figure 9-1 shows the responses, which strongly favoured the adopted option of increasing the expenditure to 1% by 2021.

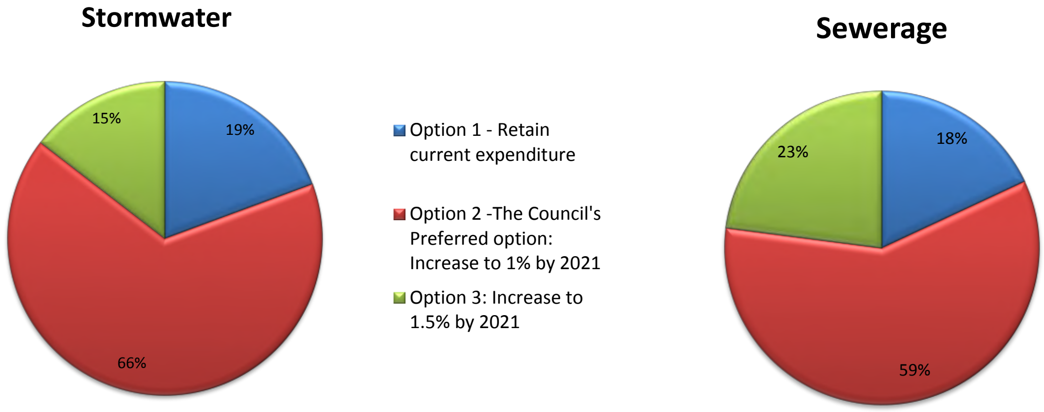


Figure 9-1: Results of consultation on renewal expenditure from 2015-2025 LTP

STORMWATER DISCHARGES –
APPLICATION DOCUMENT – APPENDICES

Prepared for the Invercargill City Council

Appendix A Invercargill Stormwater Consent Treatment Review - Phase 1 and Phase 2

MWH. now part of Stantec

INVERCARGILL STORMWATER CONSENT TREATMENT REVIEW - PHASE 1 AND PHASE 2

Prepared for Invercargill City Council

September 2016

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			Prepared by	Checked by	Reviewed by	Approved by
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Executive Summary

Invercargill City Council (ICC) has resource consents authorising the discharges from reticulated stormwater networks owned and operated by the ICC into the Waihopai River, Waikiwi Stream, Otepuni Stream, Kingswell Creek and Clifton Channel. The existing consents expire on 15 December 2016, and a new consent is intended to be lodged by ICC.

An assessment of the potential for treatment to be added to the existing network is required for the discharge consent application. MWH, now part of Stantec, was engaged by ICC to undertake a desk top review of the Invercargill stormwater discharges that are currently monitored (18 in number) a pilot study, determine whether there are any areas where stormwater treatment could be implemented and develop a preliminary assessment of suitability of stormwater treatment devices for each of the locations reinforced by a field survey.

Desktop assessment of catchment and contaminant characteristics of the 18 monitored discharges indicates that there is only limited potential for effective treatment of stormwater flows in-line or at the discharge point. The outcomes of the desktop preliminary assessment was confirmed by the field survey.

Overall, this assessment indicates that treatment systems could only be retrofitted at a small number of locations that are not related to areas of high contamination, and would therefore be ineffective for improving the quality of stormwater discharge.

The key contamination (indicator E Coli) is likely to be from sewage inflow and cross-connection. There is not a practicable method to treat this contaminant within the stormwater system. Therefore removal at source is recommended. This could be achieved by a programme of screening monitoring and investigation to identify source areas, and subsequently specific investigations and house-to-house testing in areas shown to be the potential source of contamination.

Invercargill City Council

Invercargill Stormwater Treatment Review – Phase 1 and Phase 2

CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1 Introduction

Invercargill City Council (ICC) has resource consents authorising the discharges from reticulated stormwater networks owned and operated by the ICC into the Waihopai River, Waikiwi Stream, Otepuni Stream, Kingswell Creek and Clifton Channel.

The existing consents authorise discharges of stormwater from the ICC reticulated network to water. There are no discharges to land from the stormwater network.

The existing consents were granted as non-complying activities under Rule 2 of the Water Plan on the basis that they could not comply with Rules 11 (given that the discharges are from reticulated stormwater systems) or 1 (given that the discharges may reduce water quality to less than the relevant Water Quality Standards).

The existing consents expire on 15 December 2016, and hence an application to replace these consents is intended to be lodged in July 2016. It is intended to apply for a single consent which will cover all five catchments, rather than individual consents for each catchment, as currently exists.

2 Scope of Work

An engineering assessment of the potential for treatment to be added to the existing network is required for the discharge consent application. This assessment has been undertaken in two phases, being Phase 1 and Phase 2. These phased assessments form the scope of this report.

Phase 1 of the Invercargill Stormwater Consent project consists of undertaking a desk top review of the Invercargill stormwater discharges that are currently monitored (18 in number). The purpose of this phase is to identify potential treatment methods as a pilot study based on a summary of stormwater treatment devices that are typically used around the country.

Phase 2 of the Invercargill Stormwater Consent project consists of undertaking a field survey of the monitored discharges to confirm if the treatment devices identified during Phase 1 could be incorporated into the Invercargill network (either at the point of discharge or within the network) taking into account the specific constraints at each site.

3 Reference Source

The following documents references and information sources were used.

- NZTA Stormwater Treatment Standard for State Highway Infrastructure (NZTA, May 2010).
- TP10 Design guideline manual stormwater treatment devices (Auckland Council, 2003).
- On-site Stormwater Management Guideline (NZWERF, 2004).
- Product Overview Stormwater360.
- Invercargill City Council GIS information.
- Stormwater Consents: Consultation Information (MWH, March 2016).

4 Stormwater Treatment Devices

In order to establish if the available treatment devices that are typically used around New Zealand are suitable to Invercargill situation, a study of the existing guidelines in the New Zealand have been carried and summarized in the following Table 4-1, Table 4-2 and Table 4-3.

The purpose of this study is to provide a summary of available treatment mechanisms, their opportunities, constraints and efficacy. This will then be used to consider and determine appropriate treatment systems for Invercargill considering specific design and issues. The summary in Tables 4-1, 4-2 and 4-3 needs to be read in conjunction with the detail included in the reference source.

Table 4-1: Summary of Stormwater Treatment Devices Site constraints

Stormwater Treatment Device		Description (NZWERF on site management)	Surrounding soil type	Slope	Contributed catchment area: Approximate contributed cathment area (ha)	Contributed catchment area: Controlling factor for use	High Groundwater table and potential mounding	Close to bedrock	Slope stability	Space consumption limitation	Maximum depth limitation	High sediment inputs	Thermal impact	Specific constraints	Estimation of area required based on previous MWH projects examples throughout the country (% of contributed catchment)	Depth or Driving head required (based on TP10 Auckland Region)
PONDS		Include ponds dug or created by a dam and used for flow detention and treatment	Clay loam Silty Clay loam Sandy Clay Silty Clay Clay	Not recommended on slopes > 10%	6 - 40	Catchment area to maintain normal pool of water	Generally not a restriction	Can be overcome with careful site design	Can be overcome with careful site design	Require large sites	Negative effect	Forebay will require more frequent maintenance	Negative effect		Minimum 2% of contributed catchment for the pond wet pool area (access and maintenance not included). If detention is to be included the minimum required area will increase considerably	Average 1 m depth (2 m maximum depth recommended for safety). Forebay depth 1200 mm minimum
WETLANDS		Constructed shallow pond with intensive plantings. It provides multi-purpose quality and peak flow reduction.	Clay loam Silty Clay loam Sandy Clay Silty Clay Clay	Not recommended on slopes > 10%	4 - 40	Catchment area to maintain hydric soil	Generally not a restriction	Can be overcome with careful site design	Negative effect	Require large sites	Negative effect	Forebay will require more frequent maintenance	Slightly negative effect		Minimum 4% of contributed catchment for the wetland wet pool area (access and maintenance not included). If detention is to be provided the minimum required area will increase considerably	Dead storage at 0-0.5 depth will contain 60% of the wetland wet pool area. Dead storage banded bathymetry at 0.5-1 m will have the 40% wetland pool area. Forebay maximum depth 2.00 m
STRUCTURAL FILTERS	For example: Sand filters Cartridge filters Membrane filters	Device to store and treat stormwater by filtration through the media Well suited for industrial and other sites with contaminants attached to the particulates	Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam Silty Clay loam Sandy Clay Silty Clay Clay	Open systems -->Not recommended on slopes > 10% Prefabricated --> slope is not critical (live storage in the unit)	0 - 6	Volume of runoff Driving head (specially for retrofit)	Can be overcome with careful site design	Generally not a restriction	Generally not a restriction	Generally not a restriction	Generally not a restriction	Performance fairly rapid decline	Generally not a restriction	Diversion of higher flows around the filter Maintenance		Driving head required from 740-450 mm depending of the type of filter
RAIN GARDENS		Bio retention systems. Device constructed within in-situ soil where treatment is achieved by flow through a sand/soil medium It can be incorporated within domestic or commercial landscape areas	Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam Silty Clay loam Sandy Clay Silty Clay Clay	Not recommended on slopes > 10% (live storage to be contained will be a problem in steeper slopes. The surface of the rain gardens has to be level to ensure an even flow through the media)	0 - 4	Volume of runoff	Can sometimes be overcome with careful site design	Generally not a restriction	Generally not a restriction	Can be overcome with careful site design	Generally not a restriction	Performance fairly rapid decline	Generally not a restriction	40% of the WQV should be provided as live storage	Minimum 8% of contributed catchment	Normal depth is 1 m
INFILTRATION	Infiltration basin		Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam	Not recommended on slopes or in fill areas (stability can be a problem)	0 - 20	Soils, slope, stability,etc	Negative effect	Negative effect	Negative effect	Require large sites	Negative effect	Performance fairly rapid decline	Generally not a restriction		Minimum 8% of contributed catchment	
INFILTRATION	Infiltration trench	Bio filtration system. Gravelled-filled trench that can be constructed underneath a swale Well suited for commercial, some industrial and other sites	Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam	Not recommended on slopes or in fill areas (stability can be a problem)	0 - 4	Soils, slope, stability,etc	Negative effect	Negative effect	Negative effect	Can be overcome with careful site design	Negative effect	Performance fairly rapid decline	Generally not a restriction	Require pre-treatment to reduce sediment loads and avoid blockage		
INFILTRATION	Porous Pavement	Pavement that is specially designed to facilitate and maximise infiltration of rainfall through the pavement for stormwater benefit	Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam	Not recommended on slopes or in fill areas (stability can be a problem)	0 - 6	Soils, slope, stability,etc	Negative effect	Negative effect	Negative effect	Can be overcome with careful site design	Negative effect	Performance fairly rapid decline	Generally not a restriction	Particular care is need in the design of pavement foundations with respect to effects of infiltration, traffic loads, the nature of the subgrade and pavement durability		

Stormwater Treatment Device		Description (NZWERF on site management)	Surrounding soil type	Slope	Contributed catchment area		High Groundwater table and potential mounding	Close to bedrock	Slope stability	Space consumption limitation	Maximum depth limitation	High sediment inputs	Thermal impact	Specific constraints	Estimation of area required based on previous MWH projects examples throughout the country (% of contributed catchment)	Depth or Driving head required (based on TP10 Auckland Region)
					Approximate contributed cathment area (ha)	Controlling factor for use										
SWALES		Device where treatment is achieved via shallow surface flow channels achieving treatment by surface flow It can be incorporated within car parks or within road median strips	Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam Silty Clay loam Sandy Clay Silty Clay Clay	Not recommended on slopes > 5% (<2% --> perforated underdrain shall be provided >5% --> check dams shall be provided with a maximum slope of 8%)	0 - 4	Rate of runoff and slope Retention time	Can be overcome with careful site design	Can be overcome with careful site design	Can sometimes be overcome with careful site design	Can be overcome with careful site design	Can be overcome with careful site design	Performance fairly rapid decline	Generally not a restriction	Minimum length 30 m Maximum bottom width 2 m Minimum hydraulic residence time 9 minutes		Maximum water depth from 150-250 mm
FILTER STRIPS		Device where treatment is achieved via shallow surface flow channels achieving treatment by surface flow It can be incorporated within car parks or within road median strips	Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam Silty Clay loam Sandy Clay Silty Clay Clay	Slopes between 2-5 % (<2% --> not recommended unless the are designed for infiltration of runoff >5% --> level spreader shall be provided to ensure effective slope)	0 - 2	Rate of runoff and slope Retention time	Can be overcome with careful site design	Can be overcome with careful site design	Can be overcome with careful site design	Can be overcome with careful site design	Can be overcome with careful site design	Performance fairly rapid decline	Generally not a restriction	Minimum length sufficient to attain residence time Maximum drainage flow path 50 m		Maximum water depth from 75-175 mm
Vegetation/ revegetation			Sand Loamy sand Silt Loam Sandy Clay Loam Clay loam Silty Clay loam Sandy Clay Silty Clay Clay	N/A	0 - 40	Land use and available area	Can be overcome with careful site design	Can be overcome with careful site design	Can be overcome with careful site design	Can be overcome with careful site design	Can be overcome with careful site design	Performance fairly rapid decline	Generally not a restriction	Large available area		
Oil and water separator (high removal of hydrocarbons)		Use only for removal of hydrocarbons	N/A	Generally not a restriction (not appropriate for moderately steep slops > 20%)	"Hotpots" or areas of significant contaminant generation		Generally not a restriction	Can be overcome with careful site design	Generally not a restriction	Generally not a restriction	Negative effect	Negative effect	Generally not a restriction	TSS pre-treatment of separation might be required		
Gross Pollutant Traps, litter traps, hydrodynamic separator		Include devices that intercept some combination of the following: rubbish, grit, coarse sediment, oil, and litter. Includes custom bolt gross pollutant traps, oil and grit traps, rubbish traps and proprietary units	N/A	Generally not a restriction	Depend on device		Generally not a restriction	Generally not a restriction	Generally not a restriction	Generally not a restriction	Generally not a restriction	Generally not a restriction	Generally not a restriction			

Table 4-2: Summary of Stormwater Treatment Devices Quantity/ Quality Control

			Water Quantity/Quality Control					
				Water Quality Capability				
Stormwater Treatment Device		Description (NZWERF on site management)	Water quantity Peak control Capability	Sediment	Metals (Pb, Cu and Zn are only the indicators selected but there are many other metals to consider	TPH	Nutrients	Bacteria
PONDS		Include ponds dug or created by a dam and used for flow detention and treatment	High	Moderate (dry)/High (wet) *	Pb - Moderate (dry) / High (wet) * Cu - Low (dry) / Moderate (wet) * Zn - Low	Low	P - Low (dry) / Moderate (wet) * N - Low	Insufficient Knowledge
WETLANDS		Constructed shallow pond with intensive plantings. It provides multi-purpose quality and peak flow reduction.	High	High	Pb - High Cu - High Zn - High	High	P - High N - High This removal will be high only if harvested in the long term	Insufficient Knowledge
STRUCTURAL FILTERS	For example: Sand filters Cartridge filters Membrane filters	Device to store and treat stormwater by filtration through the media Well suited for industrial and other sites with contaminants attached to the particulates	Low	High	Pb - High Cu - Moderate Zn - High	High		Moderate
RAIN GARDENS		Bio retention systems. Device constructed within in-situ soil where treatment is achieved by flow through a sand/soil medium It can be incorporated within domestic or commercial landscape areas	Low	High	Pb - High Cu - High Zn - High	High	P - High N - Moderate	Insufficient Knowledge

Note:* (dry) refers to extended detention dry ponds and (wet) refers to wet ponds or extended detention wet ponds

Stormwater Treatment Device		Description (NZWERF on site management)	Water Quantity/Quality Control					
			Water quantity Peak control Capability	Water Quality Capability				
				Sediment	Metals (Pb, Cu and Zn are only the indicators selected but there are many other metals to consider	TPH	Nutrients	Bacteria
INFILTRATION	Infiltration basin		Moderate	High	Pb - High Cu - High Zn - High	High	P - High N - Moderate	High
	Infiltration trench	Bio filtration system. Gravelled-filled trench that can be constructed underneath a swale Well suited for commercial, some industrial and other sites	Moderate	High	Pb - High Cu - High Zn - High	High	P - High N - Moderate	High
	Porous Pavement	Pavement that is specially designed to facilitate and maximise infiltration of rainfall through the pavement for stormwater benefit	Moderate	High	Pb - High Cu - High Zn - High	High	P - High N - Moderate	High
SWALES		Device where treatment is achieved via shallow surface flow channels achieving treatment by surface flow It can be incorporated within car parks or within road median strips	Low	High	Pb - High Cu - Moderate Zn - Moderate	Moderate	P - Moderate N - Low	Insufficient Knowledge
FILTER STRIPS		Device where treatment is achieved via shallow surface flow channels achieving treatment by surface flow It can be incorporated within car parks or within road median strips	Low	High	Pb - High Cu - Moderate Zn - Moderate	Moderate	P - Moderate N - Low	Insufficient Knowledge

			Water Quantity/Quality Control					
				Water Quality Capability				
Stormwater Treatment Device		Description (NZWERF on site management)	Water quantity Peak control Capability	Sediment	Metals (Pb, Cu and Zn are only the indicators selected but there are many other metals to consider	TPH	Nutrients	Bacteria
Vegetation/ revegetation			Low	High	Pb - High Cu - Moderate Zn - High	Low	P - Moderate N - Moderate	Low
Oil and water separator (high removal of hydrocarbons)		Use only for removal of hydrocarbons	Low	Low	Insufficient Knowledge	Moderate	Insufficient Knowledge	Insufficient Knowledge
Gross Pollutant Traps, litter traps, hydrodynamic separator		Include devices that intercept some combination of the following: rubbish, grit, coarse sediment, oil, and litter. Includes custom bolt gross pollutant traps, oil and grit traps, rubbish traps and proprietary units	Low	Moderate - (Coarse sediment, letter and debris, unlikely to remove fine sediments or soluble contaminants)	Low	Low	Low	Low

Table 4-3: Summary of Stormwater Treatment Devices Potential Secondary Impacts

Stormwater Treatment Device		Description (NZWERF on site management)	Potential secondary impacts								
			Aquatic habitat creation	No temperature increase	Landscape enhancement	Recreational benefits	Public safety	Community acceptance	Maintenance	Source control or catchment wide (downstream) implementation	Suitability to retrofit
PONDS		Include ponds dug or created by a dam and used for flow detention and treatment	Seldom provided (dry)/ Usually provided (wet) *	Negative effect	Usually provided	Usually provided	Provided with careful design	Usually provided	Regular maintenance required. Forebay: 2-10 years Pond: 5-50 years Maintenance needs to be done by contractor, relatively onerous due to potentially large amount of potentially contaminated material requiring removal and appropriate disposal	Catchment wide implementation	Low
WETLANDS		Constructed shallow pond with intensive plantings. It provides multi-purpose quality and peak flow reduction.	Usually provided	Neutral effect	Provided with design modification	Provided with design modification	Provided with careful design	Provided with design modification	On going specialist maintenance required	Catchment wide implementation	Low
STRUCTURAL FILTERS	For example: Sand filters Cartridge filters Membrane filters	Device to store and treat stormwater by filtration through the media Well suited for industrial and other sites with contaminants attached to the particulates	Seldom provided	Neutral effect	Seldom provided	Seldom provided	Usually provided	Usually provided	High Regular maintenance including removal of accumulated fine material on filter surface is essential. Maintenance minimum every year.	Source control or catchment wide implementation	Moderate (depends on driving head)
RAIN GARDENS		Bio retention systems. Device constructed within in-situ soil where treatment is achieved by flow through a sand/soil medium It can be incorporated within domestic or commercial landscape areas	Seldom provided	Positive effect	Provided with design modification	Seldom provided	Usually provided	Provided with design modification	Regular maintenance required. This maintenance does not required specialist	Source control	High

			Potential secondary impacts									
Stormwater Treatment Device		Description (NZWERF on site management)	Aquatic habitat creation	No temperature increase	Landscape enhancement	Recreational benefits	Public safety	Community acceptance	Maintenance	Source control or catchment wide (downstream) implementation	Suitability to retrofit
INFILTRATION	Infiltration basin		Seldom provided	Neutral effect	Seldom provided	Seldom provided	Usually provided	Usually provided	Regular maintenance required	Catchment wide implementation	Low
INFILTRATION	Infiltration trench	Bio filtration system. Gravelled-filled trench that can be constructed underneath a swale Well suited for commercial, some industrial and other sites	Seldom provided	Positive effect	Seldom provided	Seldom provided	Usually provided	Usually provided	Regular maintenance required. It may require removal of gravel media, need to ensure suspended solids loads will not result in rapid clogging	Source control	High
INFILTRATION	Porous Pavement	Pavement that is specially designed to facilitate and maximise infiltration of rainfall through the pavement for stormwater benefit	Seldom provided	Positive effect	Seldom provided	Seldom provided	Usually provided	Usually provided	Potential significant issues with respect to blinding of the surfaces of pavement with fine material. This may in some situations be able to prevented or minimised by ongoing maintenance. It might require removal and replacement of pavers for renovation	Source control	High
SWALES		Device where treatment is achieved via shallow surface flow channels achieving treatment by surface flow It can be incorporated within car parks or within road median strips	Seldom provided	Slightly positive	Provided with design modification	Seldom provided	Usually provided	Provided with design modification	Regular maintenance required. This maintenance does not required specialist	Source control	High
FILTER STRIPS		Device where treatment is achieved via shallow surface flow channels achieving treatment by surface flow It can be incorporated within car parks or within road median strips	Seldom provided	Neutral effect	Provided with design modification	Seldom provided	Usually provided	Provided with design modification	Regular maintenance required. This maintenance does not required specialist	Source control	Low

			Potential secondary impacts								
Stormwater Treatment Device		Description (NZWERF on site management)	Aquatic habitat creation	No temperature increase	Landscape enhancement	Recreational benefits	Public safety	Community acceptance	Maintenance	Source control or catchment wide (downstream) implementation	Suitability to retrofit
Vegetation/ revegetation			Usually provided	Neutral effect	Usually provided	Provided with design modification	Usually provided	Provided with design modification	Regular maintenance required. This maintenance does not required specialist	Catchment wide implementation	Low
Oil and water separator (high removal of hydrocarbons)		Use only for removal of hydrocarbons	Seldom provided	Neutral effect	Seldom provided	Seldom provided	Usually provided	Usually provided	Ongoing specialist maintenance required	Catchment wide implementation	Moderate
Gross Pollutant Traps, litter traps, hydrodynamic separator		Include devices that intercept some combination of the following: rubbish, grit, coarse sediment, oil, and litter. Includes custom bolt gross pollutant traps, oil and grit traps, rubbish traps and proprietary units	Seldom provided	Neutral effect	Seldom provided	Seldom provided	Usually provided	Usually provided	On going operation and maintenance, including sediment removal. It can be expensive	Often used at the head of at treatment train, for example to prevent coarse sediment entering a wetland or a device	It can be retrofitted into existing development sites

5 Desktop Review of Stormwater Treatment Device Characteristics for Use in Invercargill

The preliminary assessment of the stormwater treatment devices has been focused on the 18 Invercargill stormwater discharges that are currently monitored to determine whether in these cases there are any areas where treatment could be implemented for these discharges. Location plans of the 18 monitored catchment can be found in Appendix A.

In order to determine the potential effectiveness of different stormwater treatment devices on a specific site, it is important to consider the following factors:

- Catchment area draining to the treatment device
- The targeted contaminants at the stormwater discharge locations
- Soils in the location of the intended stormwater management device
- Slopes
- General constraints: space availability, maximum sediment inputs, slope stability (if known), high groundwater table (if known), etc.
- Maintenance opportunities and constraints.

Invercargill lies in the Southland Plans; Invercargill soils generally comprise fluvial outwash deposits. Generally, the closer to the coast, the finer grained, and potentially greater plasticity deposits there are; although there are areas of swampy deposits to the South East of town. Further up in the basin catchments, or nearer steeper streams, there can be coarser (sand and gravel) deposits. The underlying lithology (rock), it is often 10-20m below existing ground level. Consequently wetlands and ponds will be difficult to implement in the locations of discharge without a liner.

Invercargill is reasonably flat so stormwater treatment devices that require high head for good performance will be difficult to incorporate into the existing systems.

The variation in the main contaminants identified in the monitoring for the 18 stormwater discharges were summarised in the report Stormwater Consents: Consultation Information submitted in March 2016 by MWH and are shown in Table 5-1. The shading used in Table 5-1 highlights where elevated contamination levels occur relative to the sampling undertaken, rather than against a particular standard. Catchment area and the contaminants monitored have been the main factors taken into consideration for the Phase 1 assessment of the stormwater devices as shown in Table 5-2.

Age of stormwater and sewage networks and the nature of the catchments (i.e. residential, commercial or industrial) were assessed using the ICC GIS system. The maps of the catchments of each discharge are included in Appendix A and Appendix B.

The patterns in contaminant concentrations between discharges was compared to the catchment types, in terms of land use and age of assets, as summarized in Table 5-2 but no discernable relationship was apparent.

This Phase 1 desktop assessment of catchment and contaminant characteristics indicates that there is only limited potential for effective treatment of stormwater flows in-line or at the discharge point. Source control is therefore likely to have the greatest potential for improvement of the quality of stormwater discharges.

This Phase 1 desk top study was used as the basis for the Phase 2 study. The Phase 2 study used a site walkover to assess the opportunities for implementation of the stormwater treatment devices recommended (based on observed site constraints) in Phase 1 and to assess the possible source of contaminants for each of the monitored discharges.

Table 5-1: Summary table of main contaminants for the 18 monitored stormwater discharges

No	Monitored discharges	Asset ID of discharge	Average of Suspended Solids		Average of Total Copper		Average of Total Zinc		Average of Total Nickel		Average of Total Lead		Average of Ammonia		Average of Nitrate		Geomean of E.coli	
			dry	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet	dry	wet
	Kingswell																	
1	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	S25367	9.8	3.7	0.003	0.003	0.11	0.32	0.001	0.002	0.0009	0.0	0.06	0.05	3.3	0.2	2	475
2	Brown Street North West Drain	S25153	2.3	11.5	0.006	0.007	0.06	0.21	0.001	0.002	0.0008	0.0	0.74	0.09	3.2	0.1	17,692	13,885
3	Elles Road North Drain (Manhole Elles Rd @ Ball St)	S25030	0.9	6.5	0.004	0.006	0.05	0.17	0.001	0.002	0.0009	0.0	0.53	0.09	3.9	0.1	19,785	16,554
	Otepuni																	
4	16 Onslow Street Manhole	S25245	1.4	21.3	0.002	0.007	0.04	0.28	0.002	0.003	0.0003	0.0	0.04	0.09	1.1	1.0	926	5,160
5	34 Onslow Street Manhole	S23233	2.0	14.0	0.003	0.006	0.05	0.25	0.001	0.003	0.0005	0.0	0.05	0.10	1.4	0.9	173	2,322
6	Camden Street Drain (Intersection Camden and Islington)	S23738	0.9	5.3	0.004	0.003	0.10	0.30	0.001	0.001	0.0007	0.0	0.68	0.13	5.0	0.6	16,908	1,863
7	Leven Street Bridge North West Drain	S23357	1.2	8.1	0.003	0.010	0.06	0.29	0.001	0.004	0.0011	0.0	0.21	0.11	3.7	1.1	1,718	4,302
8	Lindisfarne Street Bridge (South West Drain)	S24069	1.1	8.5	0.004	0.008	0.08	0.34	0.001	0.001	0.0007	0.0	0.19	0.09	2.4	0.4	1,277	6,995
9	Ythan Street Drain (Intersection Eye Street North West Corner)	S30340	3.8	6.7	0.004	0.005	0.06	0.42	0.003	0.003	0.0007	0.0	0.32	0.14	3.0	0.7	76	518
	Waihopai																	
10	126 Gladstone Terrace (Manhole Behind)	S29157	0.7	5.2	0.007	0.336	0.03	0.08	0.001	0.002	0.0379	0.0	0.01	0.14	4.0	2.4	37	48
11	274 Talbot Street(Drain Behind)	S20643	7.7	5.2	0.003	0.002	0.08	0.19	0.001	0.001	0.0021	0.0	0.04	0.02	4.6	1.1	27	443
12	61 Rosewood Drive	S20596	1.6	1.9	0.003	0.001	0.03	0.07	0.001	0.001	0.0002	0.0	0.01	0.01	5.4	3.0	9	45
13	Prestonville Discharge	S30975	7.1	21.1	0.004	0.005	0.03	0.12	0.004	0.003	0.0007	0.0	0.11	0.10	2.2	1.6	119	2,335
14	Queens Drive Bridge (Manhole 450m South of Bridge)	S26356	1.5	7.7	0.007	0.008	0.07	0.16	0.001	0.001	0.0015	0.0	1.71	1.22	4.3	1.1	15,985	160,549
15	Russell Street (Discharge to Waihopai)	S20975	0.6	4.1	0.002	0.005	0.05	0.16	0.001	0.001	0.0006	0.0	0.09	0.09	2.9	0.4	932	1,916
16	Thomsons Bush Discharge (Discharge from Backwash)	S29119		2.4													104	177
17	Thomsons Bush Inflow (Discharge to Backwash)		2.5	10.2	0.002	0.002	0.02	0.07	0.002	0.002	0.0025	0.0	0.08	0.13	1.7	0.5	85	592
	Waikiwi																	
18	Discharge to Waikiwi Stream	S35117	12.5	10.4	0.002	0.004	0.06	0.06	0.004	0.004	0.0009	0.0	0.15	0.22	1.1	0.7	54	647

Table Key

Variation in contaminant monitored between sites

Table 5-2: Preliminary assessment of suitability of stormwater treatment devices for the 18 monitored stormwater discharges

No	Catchment	Asset ID of discharge	Description in GIS Records	Contributed Catchment (ha)			Main contaminant as shown in monitoring	Main period of stormwater pipe construction in the catchment	Main period of foul sewer construction in the catchment	Potentially Suitable Stormwater treatment devices (based on catchment and contaminant characteristics)							Estimated required area for the stormwater treatment device (ha)	Comments
				Res	Com	Ind				Pond/ Wetland	Filters	Rain garden	Infiltration systems	Swales /Filter strips	Revegetation /Vegetation	Oil Water Separator		
1	Kingswell	S25367	Drain outfall immediately upstream of the Bluff Highway bridge, at about map reference NZMS 260 E47:532-082	2.8			TSS and Zinc	1960-1990	1960-1980		✓	✓	✓		✓		2240 m^2 if rain gardens are considered 900-450 mm head if filters are considered	Rain garden and infiltration systems could be implemented through the catchment (source control). Filters and revegetation can be implemented at the outfall (catchment wide) Head requirement dependant on filter selection
2	Kingswell	S25153	Outfall at Right True Bank (North) Kingswell Creek, 2m downstream of Brown Street Bridge	55.7			TSS, Copper Zinc, Nickel Lead, Ammonia, Nitrate, E.coli	0-1949 (mainly) 1960-1989 (rest)	0-1949 (mainly) 1950-1979 (rest)									Catchment area larger area than 40 Ha → would need to subdivide the catchments for practical stormwater treatment device implementation Ammonia, Nitrate and E.coli high → suggest cross contamination with sewage → Detailed investigations to identify sewage sources recommended
3	Kingswell	S25030	Drain outfall on northwest side of river at the Elles Road bridge, at about map reference NZMS 260 E47:535-087	30.3	35.3		Copper, Ammonia, Nitrate, E.coli	0 -1999 Residential area on the north SW pipes constructed between 0-1949	0 -1989 Residential area on the north FS pipes constructed between 0-1959									Larger area than 40 Ha → would need to subdivide the catchments for practical stormwater treatment device implementation Ammonia, Nitrate and E.coli high → suggest cross contamination → Detailed investigations to identify sewage sources recommended
4	Otepunil	S25245	Drain at 16 Onslow Street at about map reference NZMS 260 E46:552-115	9.8		12.2	TSS, Zinc, and Nickel	1938-1980	1960-1979	✓	✓	✓	✓		✓		*4400 m^2 for a pond and 8800 m^2 for a wetland	Large industrial catchment included which is a possible source of the main contaminants in the catchment. Catchment is too big to be treated with one stormwater treatment device (apart form a pond or a wetland). A treatment train would likely be required Source control thorough treatment of roofs and other sources could be considered. Rain garden and infiltration systems (except for infiltration basin) could be implemented through the catchment (source control). Filters, infiltration basin and revegetation could be applicable at the outfall (catchment wide) *if wetland or pond will need with a specific liner
5	Otepuni	S23233	Drain at 34 Onslow Street at about map reference NZMS 260 E46:556-116	52.8			TSS, Zinc, and Nickel	1938-1999	1938-1989	✓	✓	✓	✓		✓		*10560 m^2 for a pond and 21120 m^2 for a wetland	Larger area than 40 Ha → would need to subdivide the catchments for any stormwater treatment devices implementation Catchment is too big to be treated with one stormwater treatment device (apart from a pond or wetland). A treatment train would likely be required Source control thorough treatment of roofs and other sources could be considered. Rain garden and infiltration systems (except for infiltration basin) could be implemented through the system (source control). Filters, infiltration basin and revegetation can be applicable at the outfall (catchment wide) *if wetland or pond will need with a specific liner

No	Catchment	Asset ID of discharge	Description in GIS Records	Contributed Catchment (ha)			Main contaminant as shown in monitoring	Main period of stormwater pipe construction in the catchment	Main period of foul sewer construction in the catchment	Potentially Suitable Stormwater treatment devices (based on catchment and contaminant characteristics)							Estimated required area for the stormwater treatment device (ha)	Comments
				Res	Com	Ind				Pond/ Wetland	Filters	Rain garden	Infiltration systems	Swales /Filter strips	Revegetation /Vegetation	Oil Water Separator		
6	Otepunil	S23738	Drain at Camden Street at about map reference NZMS 260 E46:538-116	36.2			Zinc, Ammonia, Nitrate and E.coli	1911-1949 (mainly) 1960-1999 (rest)	1911-1949 (mainly) 1950 – 1979									Ammonia, Nitrate and E.coli high → suggest cross contamination with sewage → Detailed investigations to identify sewage sources recommended
7	Otepuni	S23357	Drain at northwest side of Levin Street bridge at about map reference NZMS 260 E46:521-115		53.8		Zinc, Nickel, moderate E.coli, Ammonia	0-2016 Old pipes 0-1949 in similar location than the FS pipes	0-1949 (majority)									Larger area than 40 Ha → would need to subdivide the catchments for any practical stormwater treatment device implementation Ammonia, Nitrate moderate → suggest possible cross contamination with sewage → Detailed investigations to identify sewage sources recommended
8	Otepunil	S24069	Drain at southwest Lindisfarne Street bridge at about map reference NZMS 260 E46:541-114	65.2			Copper, Zinc, Nickel,, moderate E.coli and Ammonia	0-1949 Three streets 1990-2016 Old pipes 0-1949 in similar location than the 1915-1969 FS pipes	1915-1969 One street 1990-1999									Larger area than 40 Ha → would need to subdivide the catchments for any practical stormwater treatment device implementation Ammonia, Nitrate moderate → suggest possible cross contamination with sewage → Detailed investigations to identify sewage sources recommended
9	Otepuni	S30340	Drain at southwest side of Ythan Street bridge at about map reference NZMS 260 E46:530-112	4.84			TSS, Zinc, Nickel and Copper	0-1949 1970-1979 2000-2009	1915-1949 2000-2009		✓	✓	✓		✓		3872 m^2 if rain gardens are considered 900 - 450 mm head if filters are considered	Rain garden and infiltration systems could be implemented through the catchment (source control). Filters and revegetation could be applicable at the outfall (catchment wide). Head requirement dependant on filter selection
10	Waihopai	S29157	Drain at 126 Gladstone Terrace at about map reference NZMS 260 E46:529-145	5.8			Copper, Lead and Nitrate	1915-1990	1925-1979				✓				4640 m^2 for an infiltration basin	Other infiltration treatment devices could be implemented through the catchment (source control)
11	Waihopai	S20643	Drain at 274 Talbot Street. Access point at about map reference NZMS 260 E46:545-147	4.4			TSS, Zinc and Nitrate	0-1969	1958-1969		✓	✓	✓		✓		3520 m^2 if rain gardens are considered 900-450 mm head if filters are considered	Rain garden and infiltration systems could be implemented through the system (source control). Filters and revegetation can be implemented at the outfall (catchment wide) Head requirement dependant on filter selection
12	Waihopai	S20596	Drain at 61 Rosewood drive at about map reference NZMS 260 E46:533-146	6.8			Nitrate	Pre 1950-2002	2000-2009 1950-1969									

No	Catchment	Asset ID of discharge	Description in GIS Records	Contributed Catchment (ha)			Main contaminant as shown in monitoring	Main period of stormwater pipe construction in the catchment	Main period of foul sewer construction in the catchment	Potentially Suitable Stormwater treatment devices (based on catchment and contaminant characteristics)							Estimated required area for the stormwater treatment device (ha)	Comments
				Res	Com	Ind				Pond/ Wetland	Filters	Rain garden	Infiltration systems	Swales /Filter strips	Revegetation /Vegetation	Oil Water Separator		
13	Waihopai	S30975	Prestonville drain at about map reference NZMS 260 E46:526-145	43.5		30.5	TSS and Nickel	1960-2016	1960-1989	✓	✓	✓	✓		✓		*14800 m^2 for a pond and 29480 m^2 for a wetland	Larger area than 40 Ha → would need to subdivide the catchments for any stormwater treatment devices implementation Rain garden and infiltration systems (except for infiltration basin) could be implemented through the catchment (source control). Filters, infiltration basin and revegetation could be applicable upstream of the outfall (catchment wide) *if wetland or pond will need with a specific liner
14	Waihopai	S26356	Drain '3' which discharges 8m upstream of Queens drive bridge on south side at about map reference NZMS 260 E46:532-142	78.2			Copper, Ammonia, Nitrate and E.coli	0-1989 Old pipes 0-1949 in similar location than the FS pipes	1915-1969									Larger area than 40 Ha → would need to subdivide the catchments for any stormwater treatment devices implementation Ammonia, Nitrate high → suggest cross contamination with sewage → Detailed investigations to identify sewage sources recommended
15	Waihopai	S20975	Russel Street drain at about map reference NZMS 260 E46:523-143	45.0				1922-2009	1915-1969									
16 & 17	Waihopai	S29119	SW drain that discharges to the backwater in Thompsons Bush at about NZTM N1243313 E4852978	33.8			TSS and Lead	0-1989	1970-1979 (majority)	✓	✓	✓	✓	✓	✓		*6760 m^2 for a pond and 13520 m^2 for a wetland	Catchment is too big to be practically treated with a single stormwater treatment device apart from a pond or a wetland. A treatment train would be required Rain garden infiltration systems, (except for infiltration basin), swales and filter strips could be implemented through the catchment (source control). Filters, infiltration basin and revegetation could be applicable at the outfall (catchment wide) *if wetland or pond will need with a specific liner
18	Waikiwi	S35117	Discharge at about map reference NZMS 260 E46:512-164	43.3		10.9	TSS and Nickel	0-2009	1960-1979	✓	✓	✓	✓	✓	✓		*10840 m^2 for a pond and 21680 m^2 for a wetland	Larger area than 40 Ha → would need to subdivide the catchments for study of any stormwater treatment device implementation Catchment is too big to practically be treated with a single stormwater treatment device apart from a pond or a wetland. A treatment train would be required. Rain garden infiltration systems, (except for infiltration basin), swales and filter strips could be implemented through the catchment (source control). Filters, infiltration basin and re vegetation could be applicable at the outfall (catchment wide) *if wetland or pond will need with a specific liner

6 Field Inspection of Feasibility of Installation of Treatment Systems

Phase 2 of the Invercargill Stormwater Consent project consisted of a field inspection of the monitored catchments and discharge points to confirm if the treatment devices identified during Phase 1 could be incorporated into the Invercargill network (either at the point of discharge or upstream of it within the network).

This field inspection was carried out by MWH on the 11th, 12th and 13th of April and was focused on the 18 Invercargill stormwater discharges that are currently monitored in order to identify relevant constraints of each catchment and outfall location to assess the suitability and practicability of construction of the stormwater treatment devices assessed in Phase 1.

A summary of the desktop screening from Phase 1 and the Phase 2 site observations is shown in Table 6-1.

Table 6-1: Results of field inspection of 18 monitored stormwater discharges to determine suitability of stormwater treatment devices

No	Catchment	Asset ID of discharge	Name is GIS	Main contaminants (where elevated in comparison to other discharges)	Phase 1- Suitable Stormwater treatment device based on catchment area and contaminants monitored							Phase 2 – Site visit constraints comments	Phase 2 – Suitable stormwater treatment device based on possible and productive implementation on site
					Pond/ Wetland	Filters	Rain garden	Infiltration systems	Swales/ Filter strips	Revegetation /Vegetation	Oil Water Separator		
1	Kingswell	S25367	Drain outfall immediately upstream of the Bluff Highway bridge, at about map reference NZMS 260 E47:532-082	TSS and Zinc		✓	✓	✓		✓		- No available head on stream side of the stop bank at the outfall. - Not enough land available for overland treatment at the discharge point - Small 1960's housing residential catchment upstream.	- In-line treatment upstream of the discharge would not target any particular risk factor and therefore it is not a recommendation
2	Kingswell	S25153	Outfall at Right True Bank (North) Kingswell Creek, 2m downstream of Brown Street Bridge	TSS, Copper Zinc, Nickel Lead, Ammonia, Nitrate, E.coli								- Large residential catchment upstream - No available head on stream side of the stop bank at the outfall - Possible head for an in-line treatment device - Signs of Foul Sewer and stormwater cross contamination in monitoring, however trenches separated 400 mm	- Key contaminant is sewage. Private cross-connections are likely sewage contamination source. A detailed investigation programme to identify source areas is recommended - In-line treatment upstream of the discharge opportunity would not target any particular risk factor and therefore it is not a recommendation
3	Kingswell	S25030	Drain outfall on northwest side of river at the Elles Road bridge, at about map reference NZMS 260 E47:535-087	Copper, Ammonia, Nitrate, E.coli								- Large Residential and commercial catchment upstream, including the hospital - Large pipe discharging under the bridge for south-bound lanes - Fall from the hospital to the outfall. Potential in line treatment device for majority of the catchment.	- Key contamination is sewage. Private cross-connections are likely sewage contamination source. A detailed investigation programme to identify source areas is recommended - In-line treatment upstream of the discharge opportunity would not target any particular risk factor and therefore it is not a recommendation
4	Otepunil	S25245	Drain at 16 Onslow Street at about map reference NZMS 260 E46:552-115	TSS, Zinc, and Nickel	✓	✓	✓	✓		✓		- Residential and industrial catchment upstream - Unsealed ground and landscape supplies yards within catchment - Vacant industrial catchment that could be used as a stormwater treatment device land at lower end of the catchment	- Expensive to retrofit treatment at the outfall with a requirement of a pump station. It is not recommended
5	Otepuni	S23233	Drain at 34 Onslow Street at about map reference NZMS 260 E46:556-116	TSS, Zinc, and Nickel	✓	✓	✓	✓		✓		- No available head on stream side of the stop bank at the outfall	- Expensive to retrofit treatment at the outfall with a requirement of a pump station. It is not recommended
6	Otepunil	S23738	Drain at Camden Street at about map reference NZMS 260 E46:538-116	Zinc, Ammonia, Nitrate and E.coli								- No available head on stream side of the stop bank at the outfall	- Key contamination is sewage. Private cross-connections are likely sewage contamination source. A detailed investigation programme to identify source areas is recommended
7	Otepuni	S23357	Drain at northwest side of Levin Street bridge at about map reference NZMS 260 E46:521-115	Zinc, Nickel, moderate E.coli, Ammonia								- Commercial area upstream - No available head or land at the outfall	- Limited contamination evident in the discharge, although indicative of likely contamination associated with urban areas and roads.
8	Otepunil	S24069	Drain at southwest Lindisfarne Street bridge at about map reference NZMS 260 E46:541-114	Copper, Zinc, Nickel, moderate E.coli, Ammonia								- Large residential catchment upstream - No available head or land at the outfall	- Key contamination is sewage. Private cross-connections are likely sewage contamination source. A detailed investigation programme to identify source areas is recommended

No	Catchment	Asset ID of discharge	Name is GIS	Main contaminants (where elevated in comparison to other discharges)	Phase 1- Suitable Stormwater treatment device based on catchment area and contaminants monitored							Phase 2 – Site visit constraints comments	Phase 2 – Suitable stormwater treatment device based on possible and productive implementation on site
					Pond/ Wetland	Filters	Rain garden	Infiltration systems	Swales/ Filter strips	Revegetation /Vegetation	Oil Water Separator		
9	Otepuni	S30340	Drain at southwest side of Ythan Street bridge at about map reference NZMS 260 E46:530-112	TSS, Zinc, Nickel and Copper		✓	✓	✓		✓		- No available head on stream side of the stop bank at the outfall or upstream - Commercial and residential catchment upstream	- Limited contamination evident in the discharge - Expensive to retrofit treatment at the outfall with a requirement of a pump station. It is not recommended
10	Waihopai	S29157	Drain at 126 Gladstone Terrace at about map reference NZMS 260 E46:529-145	Copper, Lead and Nitrate				✓				- Minimal potential for cross contamination in Council network due to Foul Sewer and stormwater being constructed in the same trench. Examples in catchment of foul sewer to stormwater separation in the catchment being more than 2 m between trenches - No available head on stream side of the stop bank at the outfall. It might be possible to pump to generate treatment head. - Not enough land available for overland treatment at the discharge point	- Expensive to retrofit treatment at the outfall with a requirement of a pump station. It is not recommended
11	Waihopai	S20643	Drain at 274 Talbot Street. Access point at about map reference NZMS 260 E46:545-147	TSS, Zinc and Nitrate		✓	✓	✓		✓		- Existing discharge to open ditch, then piped under stop bank and flood berm to Waihopai River - No available head on stream side of the stop bank at the outfall - Elevated nitrate source may be from groundwater in the river catchment - Possible room for treatment upstream of the stopbank by enhancement of the open ditch, but will be limited by groundwater and tidal effect	- In-line treatment upstream of the discharge opportunity would not target any particular risk factor and therefore it is not a recommendation
12	Waihopai	S20596	Drain at 61 Rosewood drive at about map reference NZMS 260 E46:533-146	Nitrate								- New housing construction near the outfall. It may explain high nitrate - Outfall below the stream water level. - Elevated nitrate source may be from groundwater in the river catchment - Wide berm between stopbank and river, but not head to drive treatment device	
13	Waihopai	S30975	Prestonville drain at about map reference NZMS 260 E46:526-145	TSS and Nickel	✓	✓	✓	✓		✓		- No available head on stream side of the stop bank at the outfall or upstream - Existing large pump forebay. Pumps to river level - Industrial area and 60's 70's houses upstream	- Only suspended solids (in wet weather) and nickel have significant contaminant levels, although there is a large industrial area in the catchment. - Expensive to retrofit treatment at the outfall with a requirement of additional pump station. A detailed investigation programme to identify source areas is recommended
14	Waihopai	S26356	Drain '3'' which discharges 8m upstream of Queens drive bridge on south side at about map reference NZMS 260 E46:532-142	Copper, Ammonia, Nitrate and E.coli								- Outfall submerged with silt in the base - Housing and school upstream of the catchment - No signs of Foul Sewer and stormwater cross contamination due to being constructed in the same trench. Example of foul sewer to stormwater separation in the catchment is 5 m between trenches	- Key contamination is sewage. Private cross-connections are likely sewage contamination source. A detailed investigation programme to identify source areas is recommended

No	Catchment	Asset ID of discharge	Name is GIS	Main contaminants (where elevated in comparison to other discharges)	Phase 1- Suitable Stormwater treatment device based on catchment area and contaminants monitored							Phase 2 – Site visit constraints comments	Phase 2 – Suitable stormwater treatment device based on possible and productive implementation on site
					Pond/ Wetland	Filters	Rain garden	Infiltration systems	Swales/ Filter strips	Revegetation /Vegetation	Oil Water Separator		
15	Waihopai	S20975	Russel Street drain at about map reference NZMS 260 E46:523-143	None								- No available head on stream side of the stop bank at the outfall - Minimal potential for cross contamination in Council network due to Foul Sewer and stormwater being constructed in the same trench. Examples in catchment of foul sewer to stormwater separation in the catchment being more than 2 m between trenches - Possible available head for in-line treatment upstream of the discharge	- In-line treatment upstream of the discharge opportunity would not target any particular risk factor and therefore it is not a recommendation
16 & 17	Waihopai	S29119	SW drain that discharges to the backwater in Thompsons Bush at about NZTM N1243313 E4852978	TSS and Lead	✓	✓	✓	✓	✓	✓		- Existing discharge to water table with standing water. Water table adjacent to an industrial area. - No available head on stream at discharge point - Possible available head for in-line treatment upstream of the discharge - Industrial area could be pre-treated - 60's Housing catchment upstream	- In-line treatment upstream of the discharge opportunity would not target any particular risk factor and therefore it is not a recommendation - Expensive to retrofit treatment at the outfall with a requirement of a pump station. It is not recommended
18	Waihiwi	S35117	Discharge at about map reference NZMS 260 E46:512-164	TSS and Nickel	✓	✓	✓	✓	✓	✓		- No available head on stream side of the stop bank at the outfall. Existing discharge into a clogged pond - New housing and underdeveloped land use upstream	- In-line treatment upstream of the discharge opportunity would not target any particular risk factor and therefore it is not a recommendation - Expensive to retrofit treatment at the outfall with a requirement of a pump station. It is not recommended

7 Conclusion

The key conclusions of this preliminary assessment of the 18 monitored stormwater discharges and their contributing catchments are as follows.

- The critical contamination appears to be associated with sewage discharges into the stormwater system. Of the 18 monitored catchments, eight show contamination likely to be associated with sewage.
- The sewage contamination is likely to be from direct cross-connections or inflows, or to be from seepage between damaged sewer and stormwater laterals in the same trench in private property. There is no indication that it is associated with seepage connection between public utility services (because of the separation of those services).
- There is no practicable method to treat sewage contamination once it is transferred to the stormwater system.
- Levels of other contaminants are relatively low in most cases, and not consistent. There does not appear to be an identifiable relationship between contaminant type/levels and the catchment and potential source areas.
- There are only a few locations where it may be practical to install treatment systems in the existing reticulation or outfall. Generally there is no head available for treatment at the point of discharge using methods with a small footprint and sufficiently large areas of land for low-head systems are not available. Any retrofitting of treatment at or near outfalls would require major works to implement (such as pumping stormwater to generate head, stream realignment to facilitate areas for low-head systems) and would be expensive.
- In-catchment treatment (such as inline filtration) is only possible at very few locations and catchments, not related to risk contaminants and difficult to implement. There is no clear indication from the water quality monitoring of a need for treatment at those locations where it may be possible to treat.

Overall, this assessment indicates that treatment systems could only be retrofitted at a small number of locations that are not related to areas of high contamination, and would therefore be ineffective for improving the quality of stormwater discharge.

The key contamination (indicator E Coli) is likely to be from sewage inflow and cross-connection. There is not a practicable method to treat this contaminant within the stormwater system. Therefore removal at source is recommended. This could be supported by a programme of screening monitoring to identify particular or high risk source areas, and subsequently a detailed investigation and house-to-house testing in areas shown to be the potential source of contamination.

Appendix A Monitored Catchments Plans

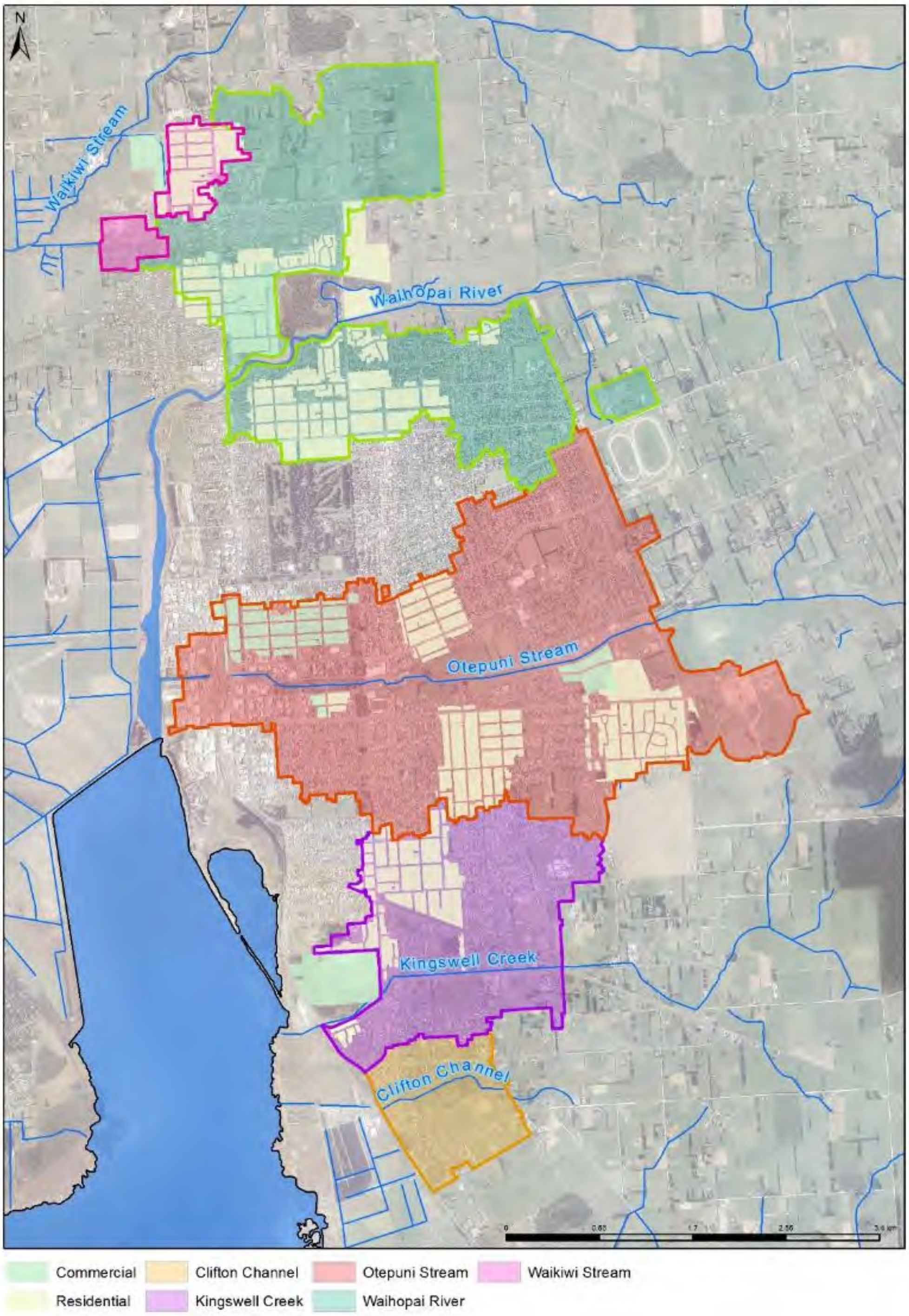


Figure A-1: Monitored catchments overview

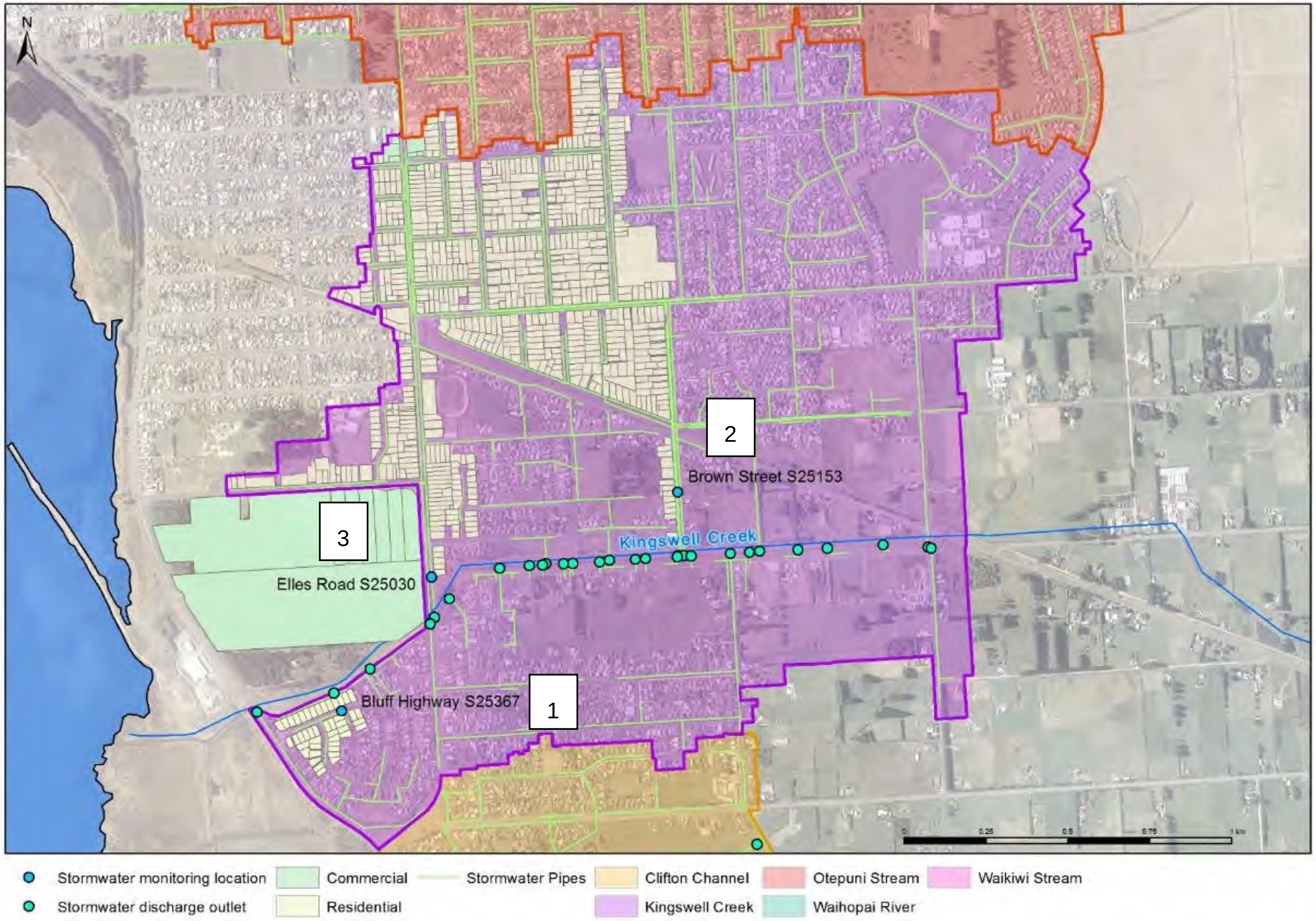


Figure A-2: Kingswell Monitored catchments

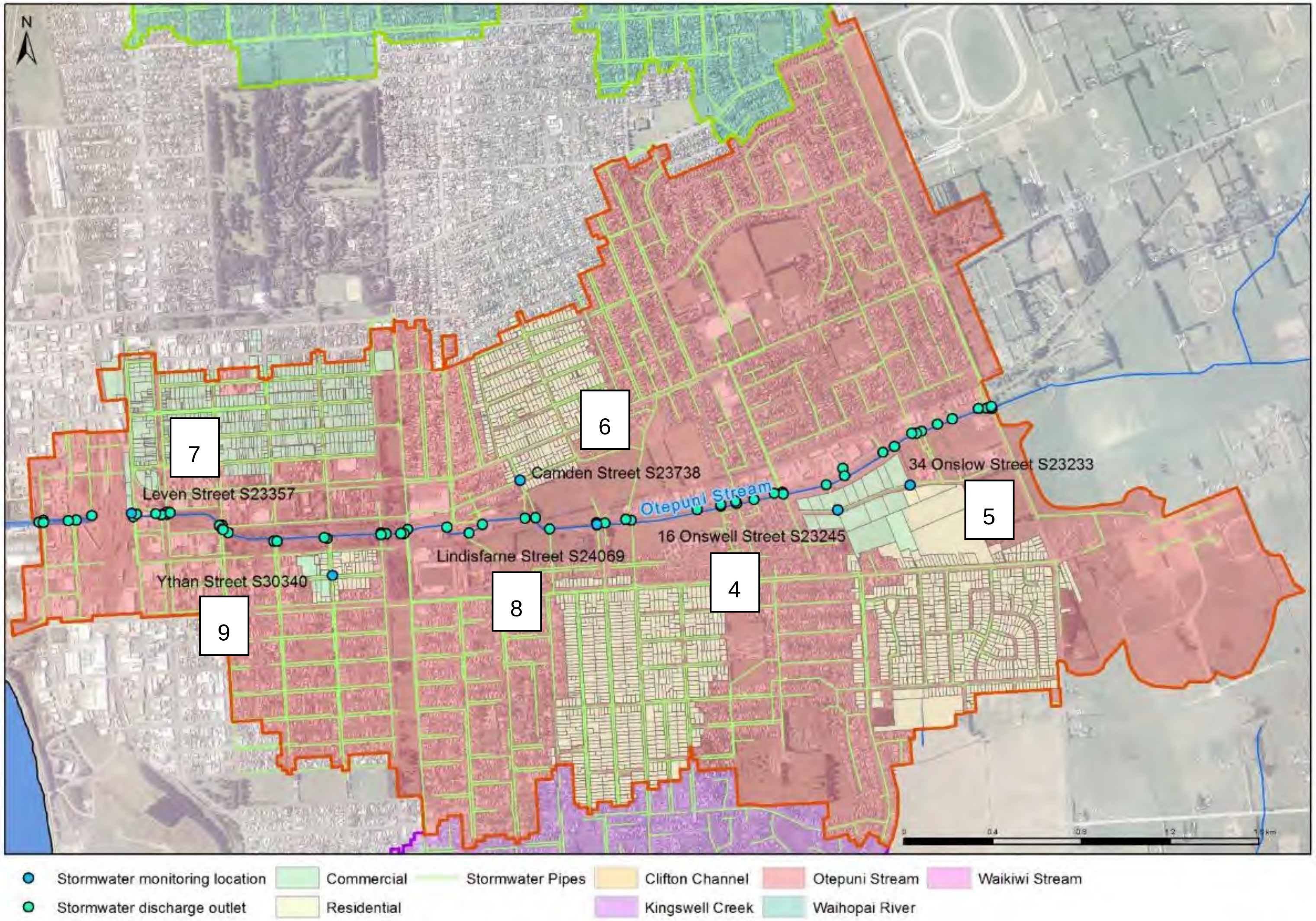


Figure A-3: Otepuni Monitored Catchments

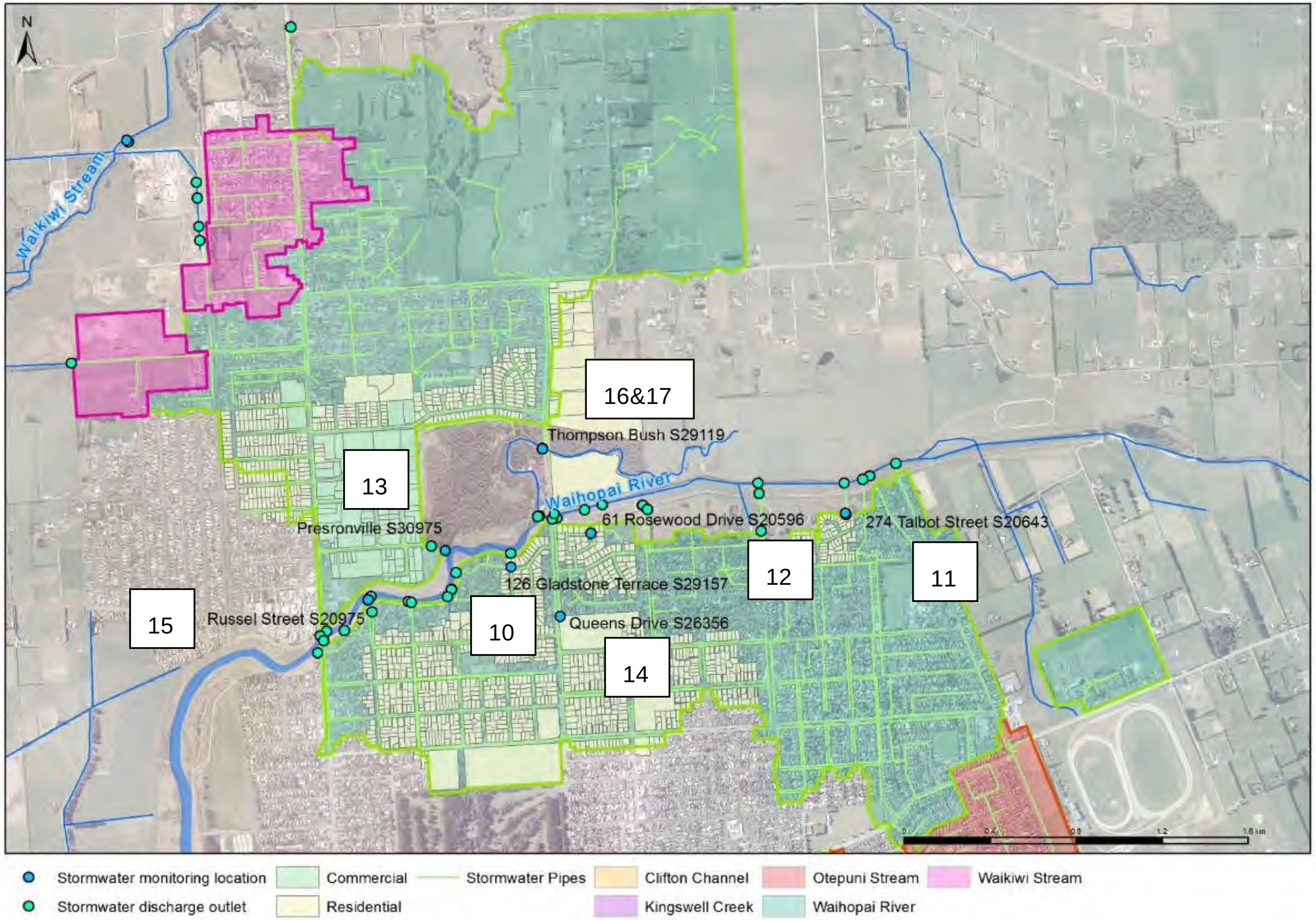


Figure A-4: Waihopai Monitored catchments

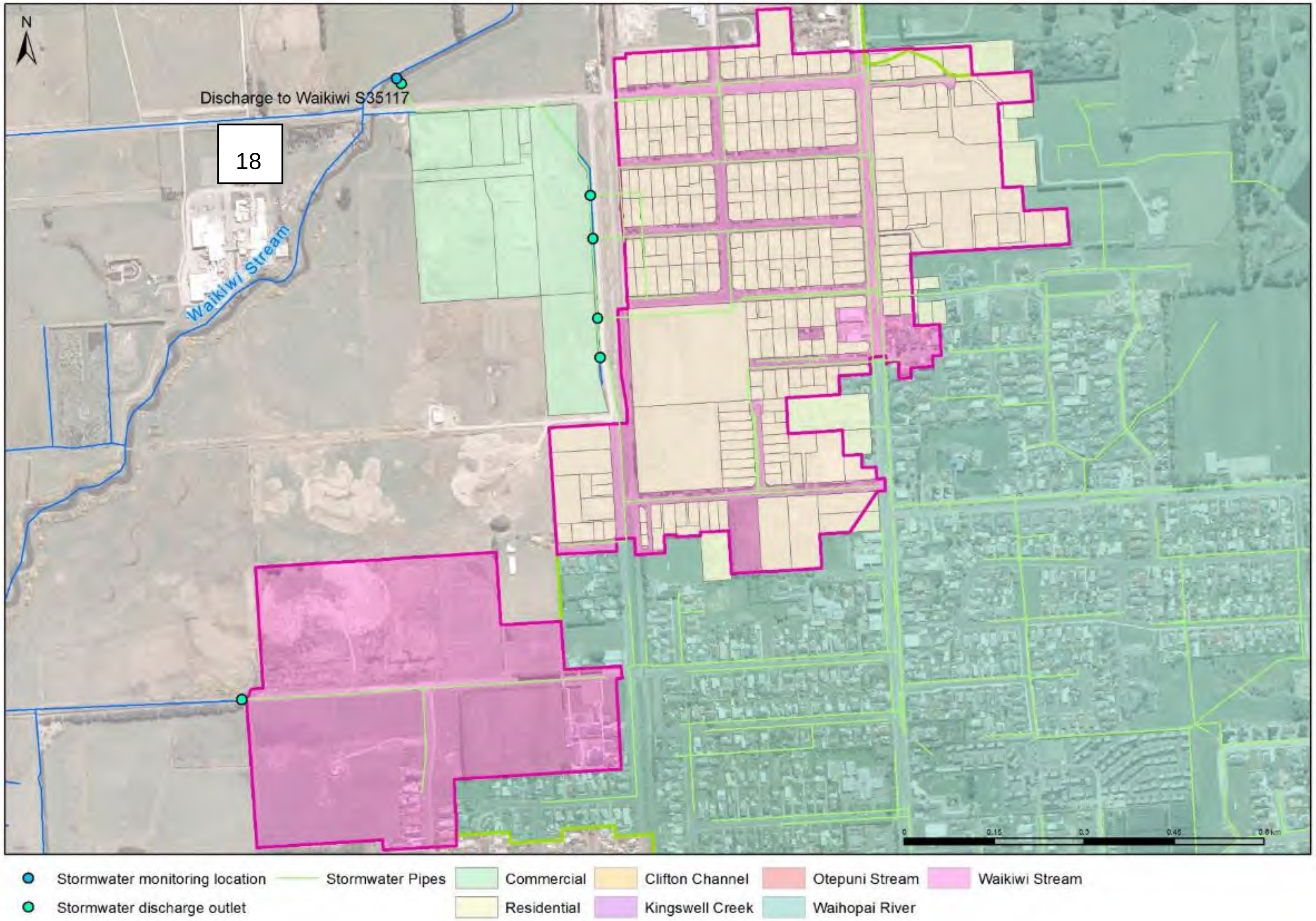
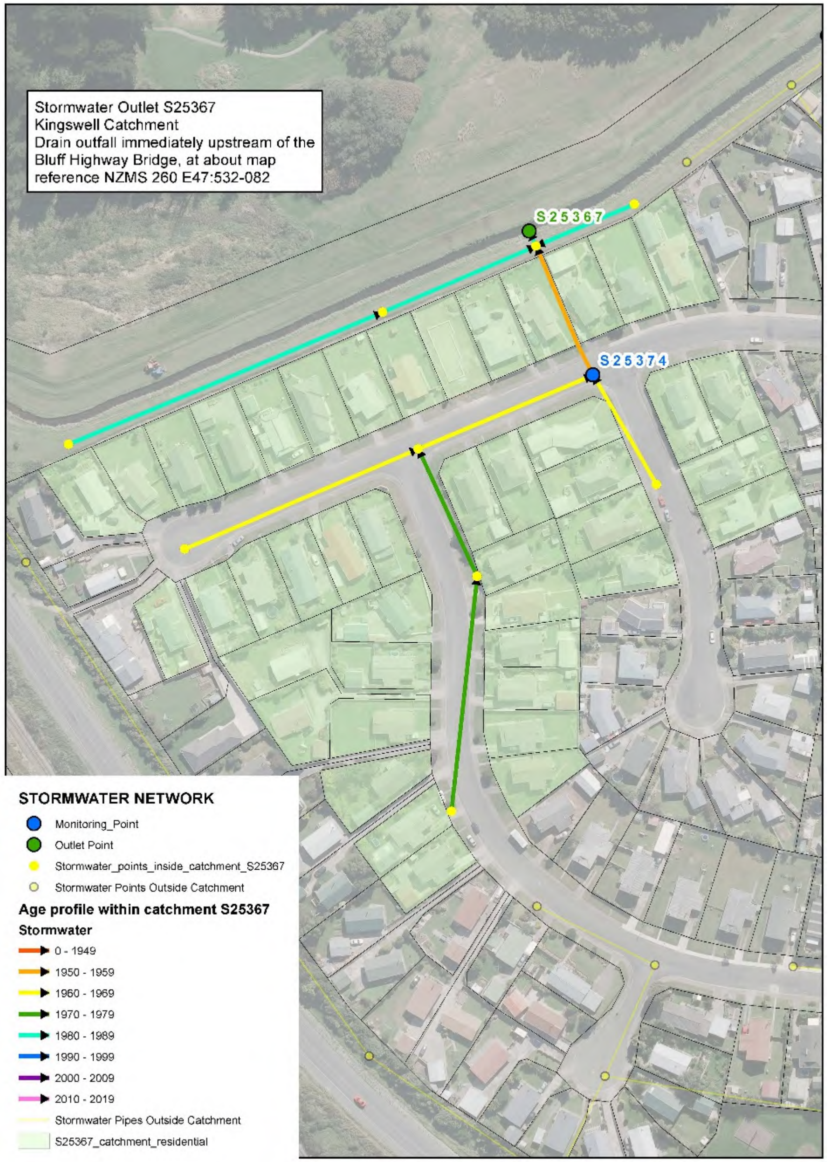


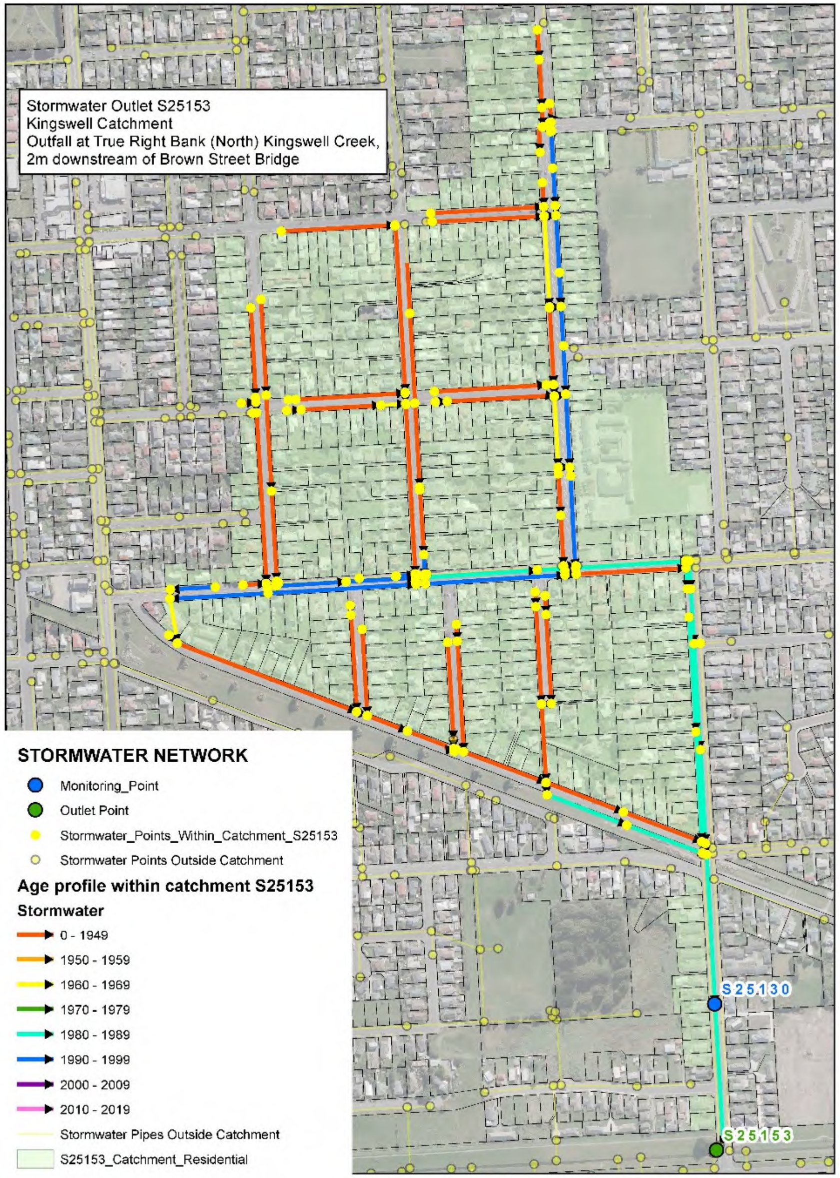
Figure A-5: Waikiwi Monitored Catchment

Appendix B Age of Stormwater and Sewage Networks and the Nature of the Catchments Plans Based on ICC GIS System

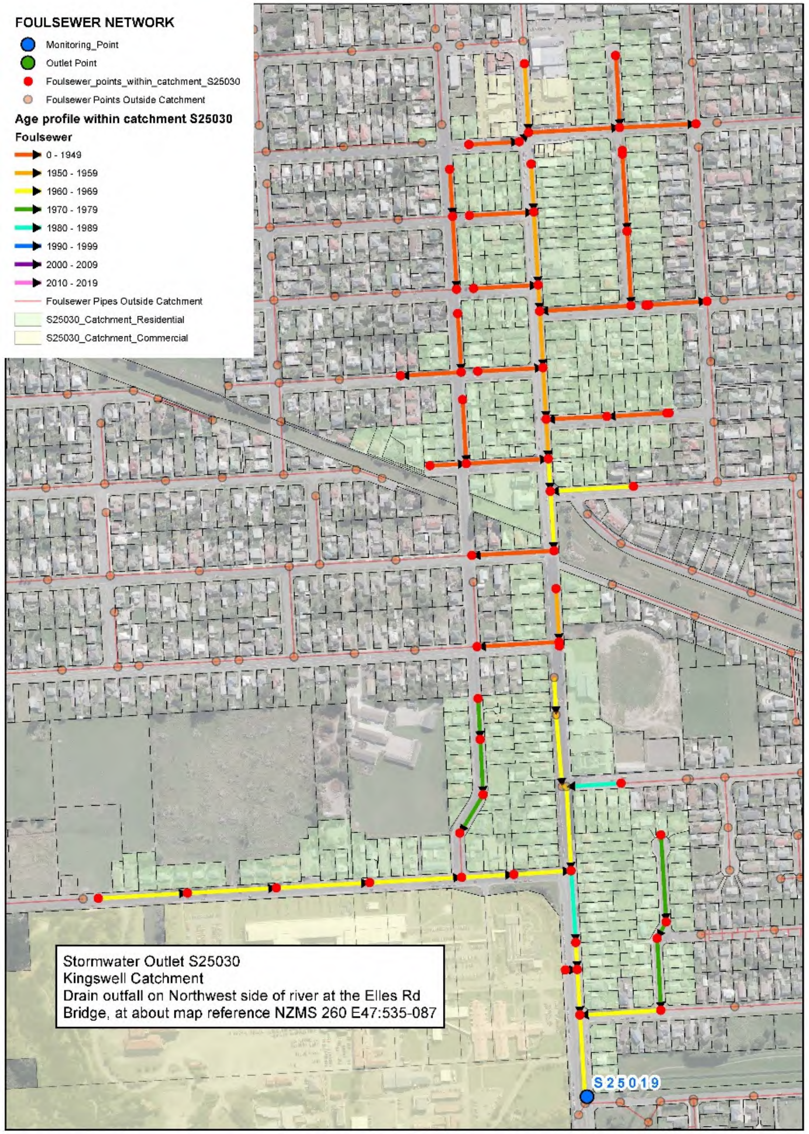
B.1 1. Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)

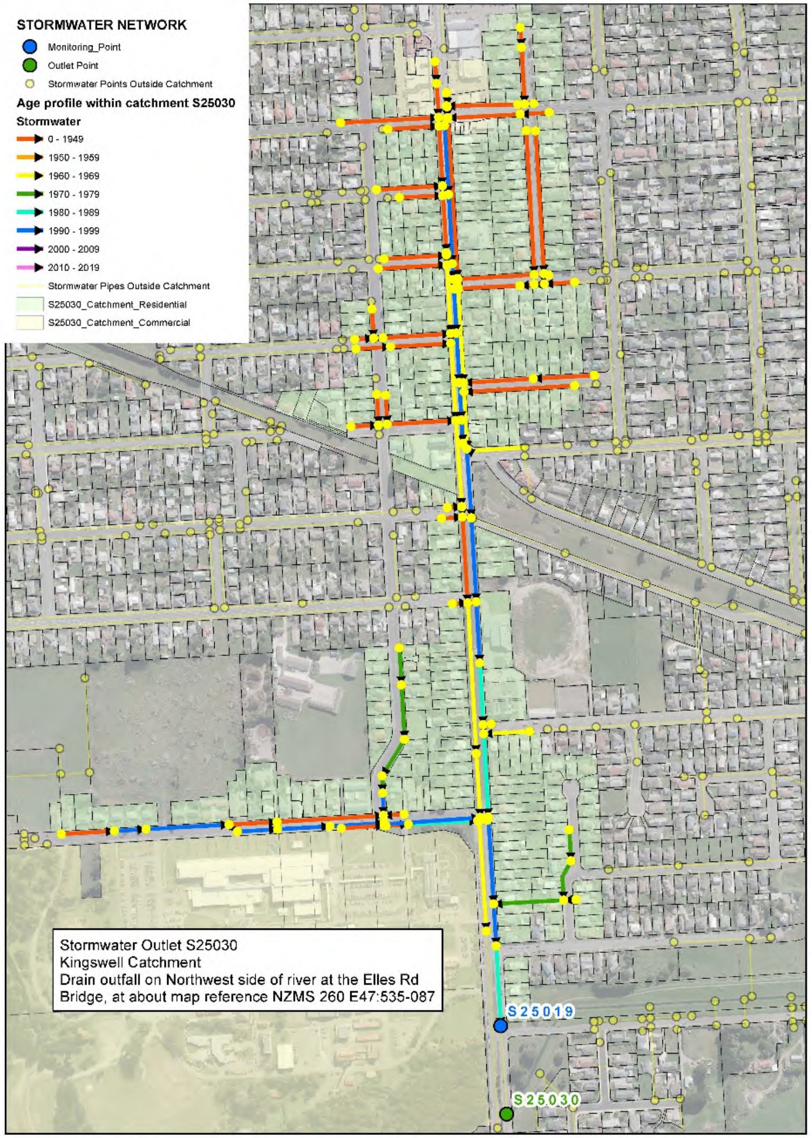


B.2 2. Brown Street North West Drain

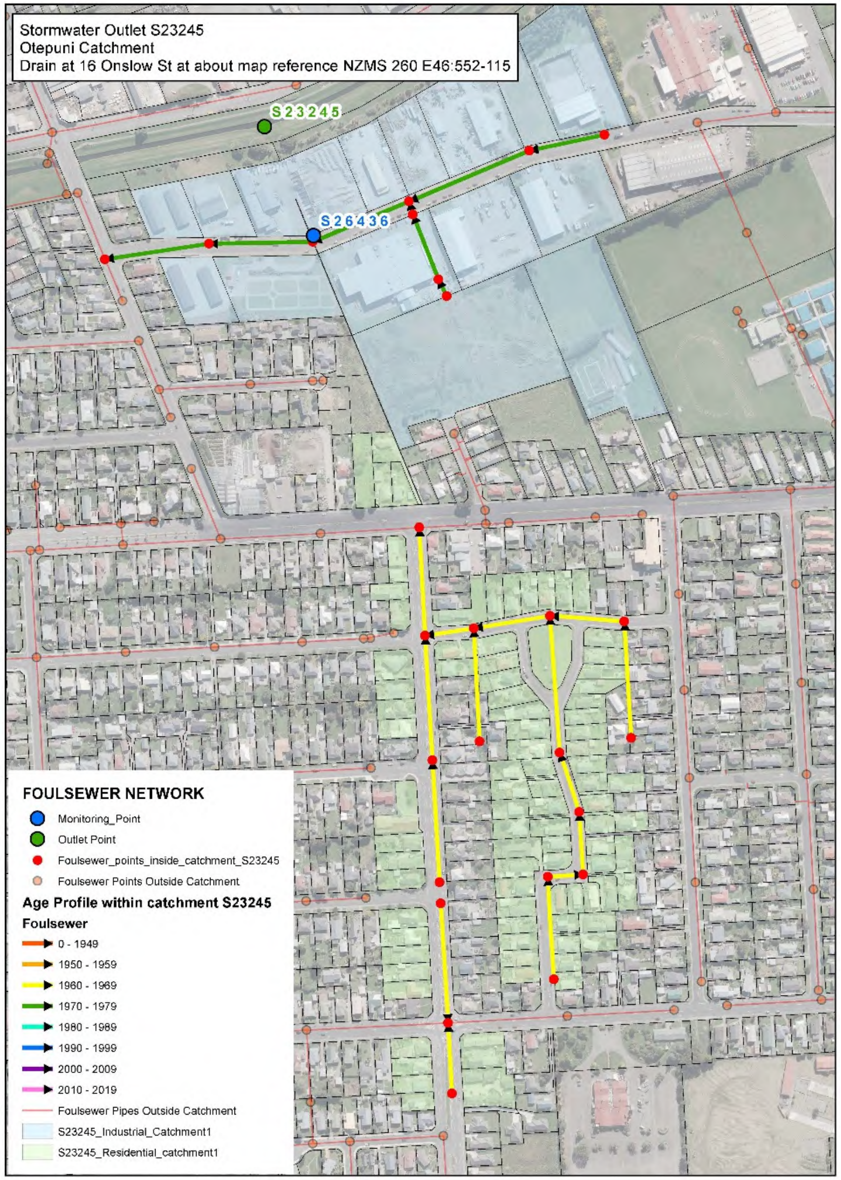


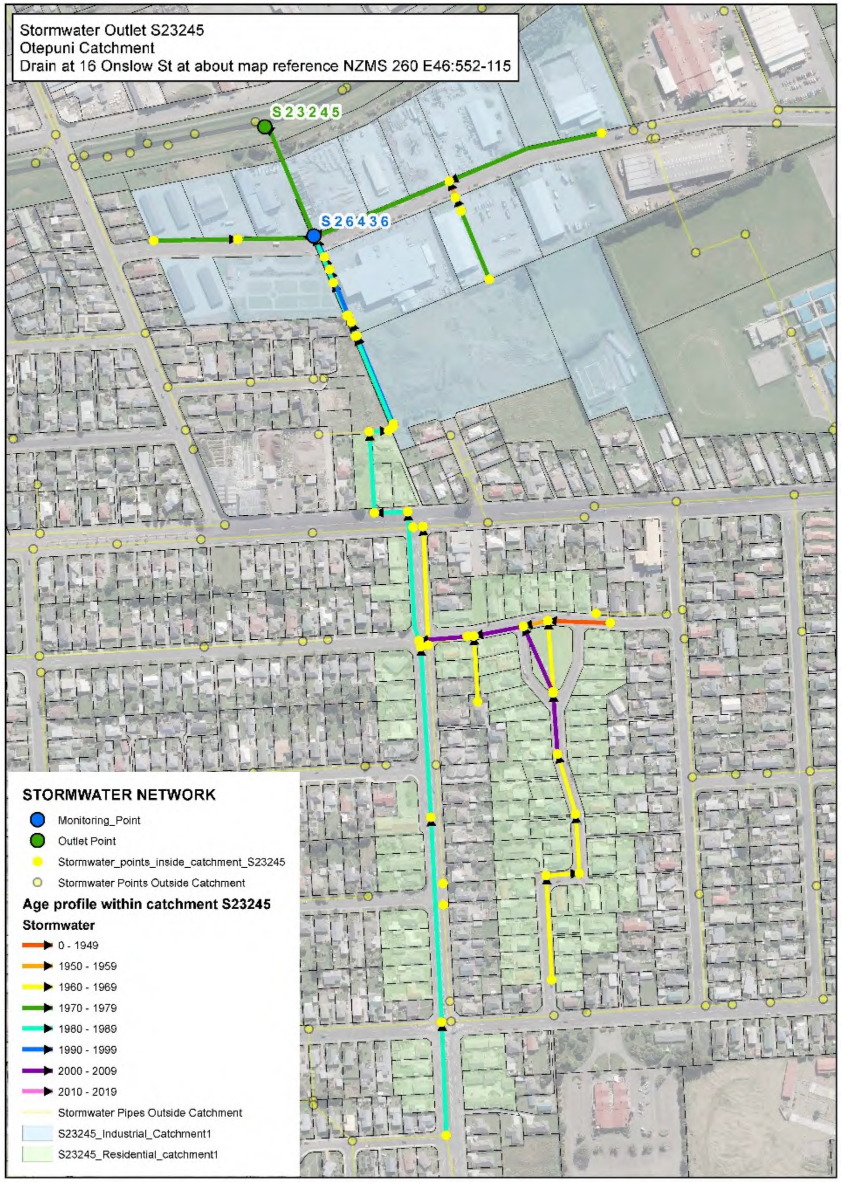
B.3 3. Elles Road North Drain (Manhole Elles Rd @ Ball St)



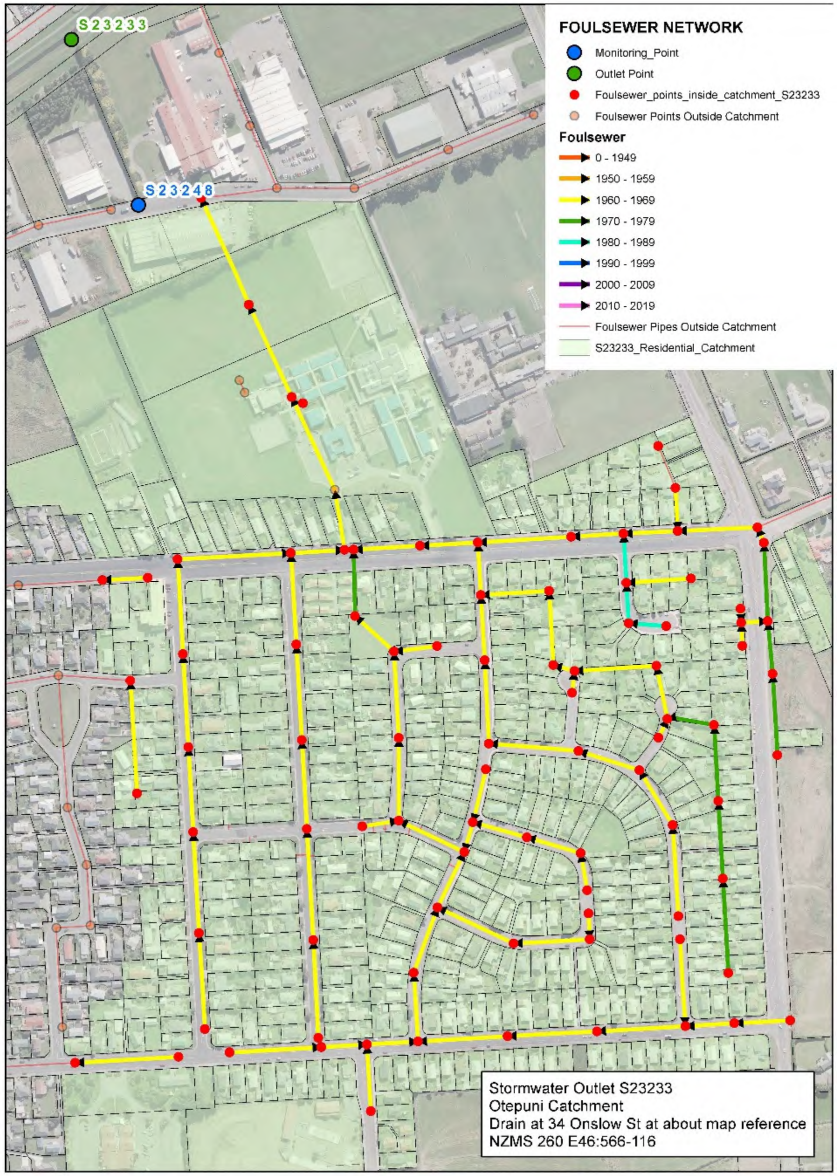


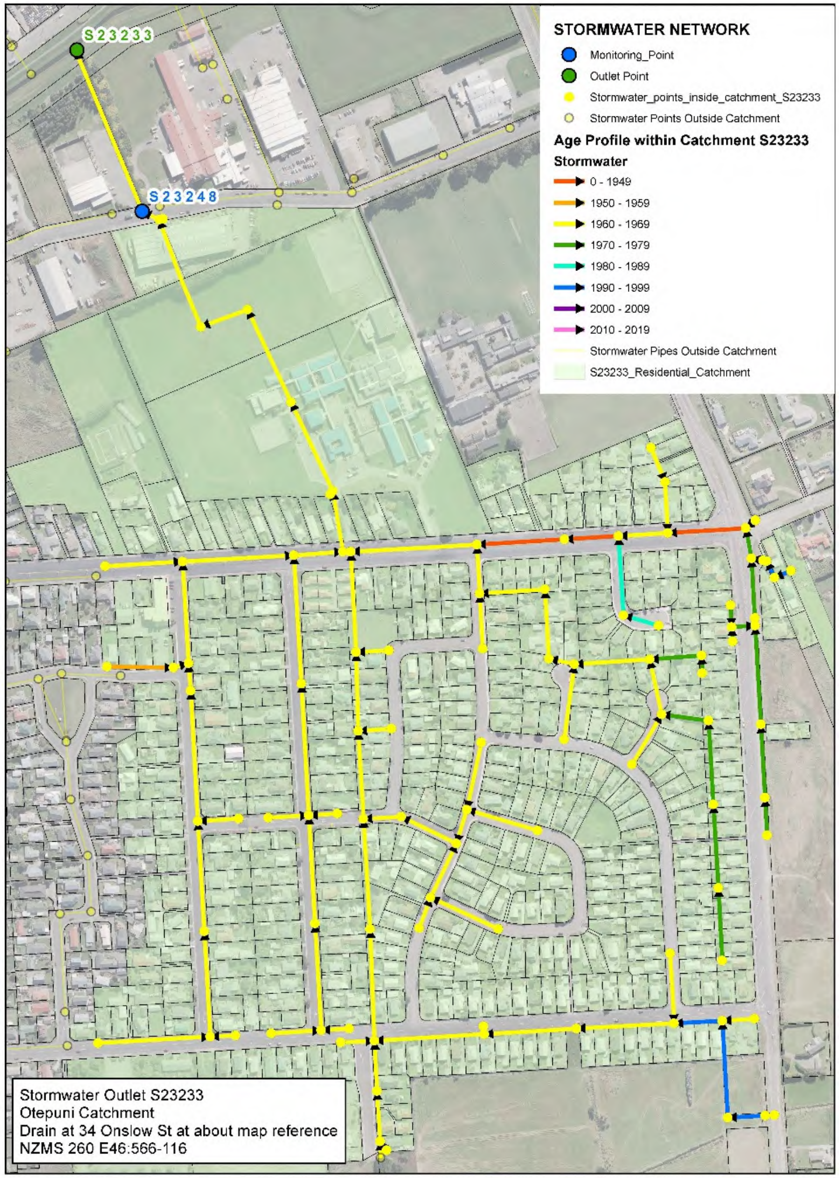
B.4 4. 16 Onslow Street Manhole



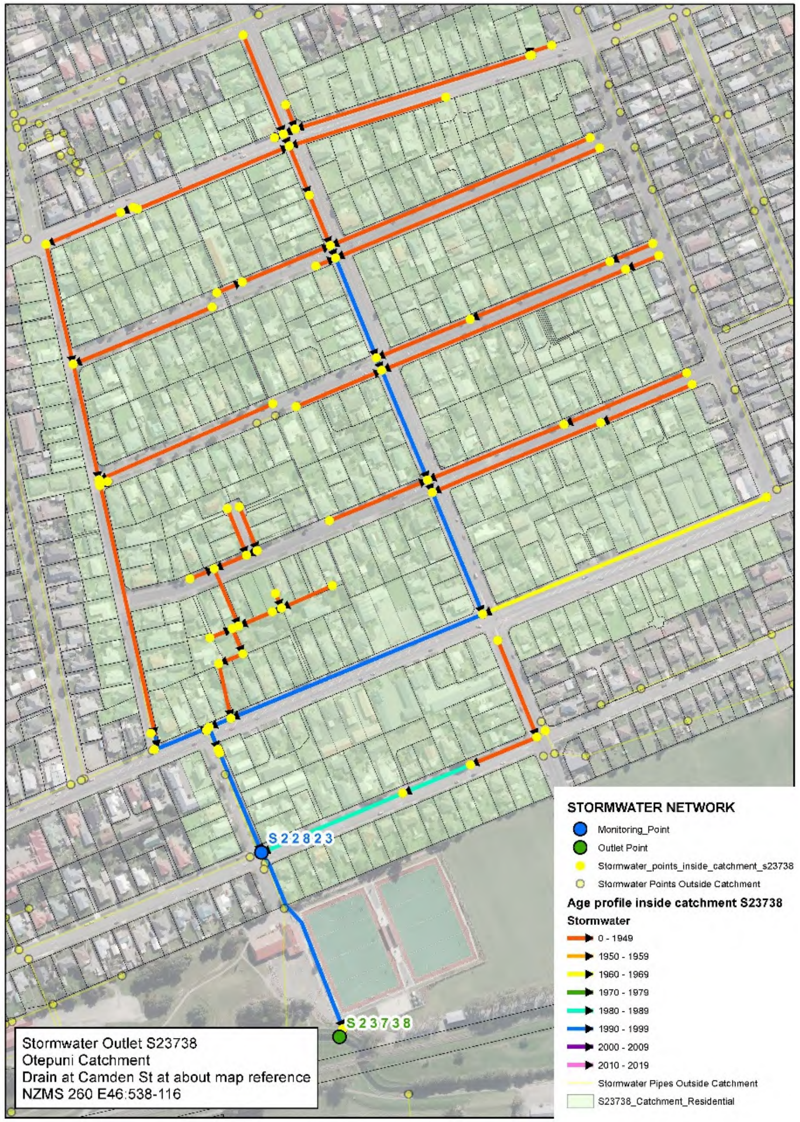


B.5 5. 34 Onslow Street Manhole

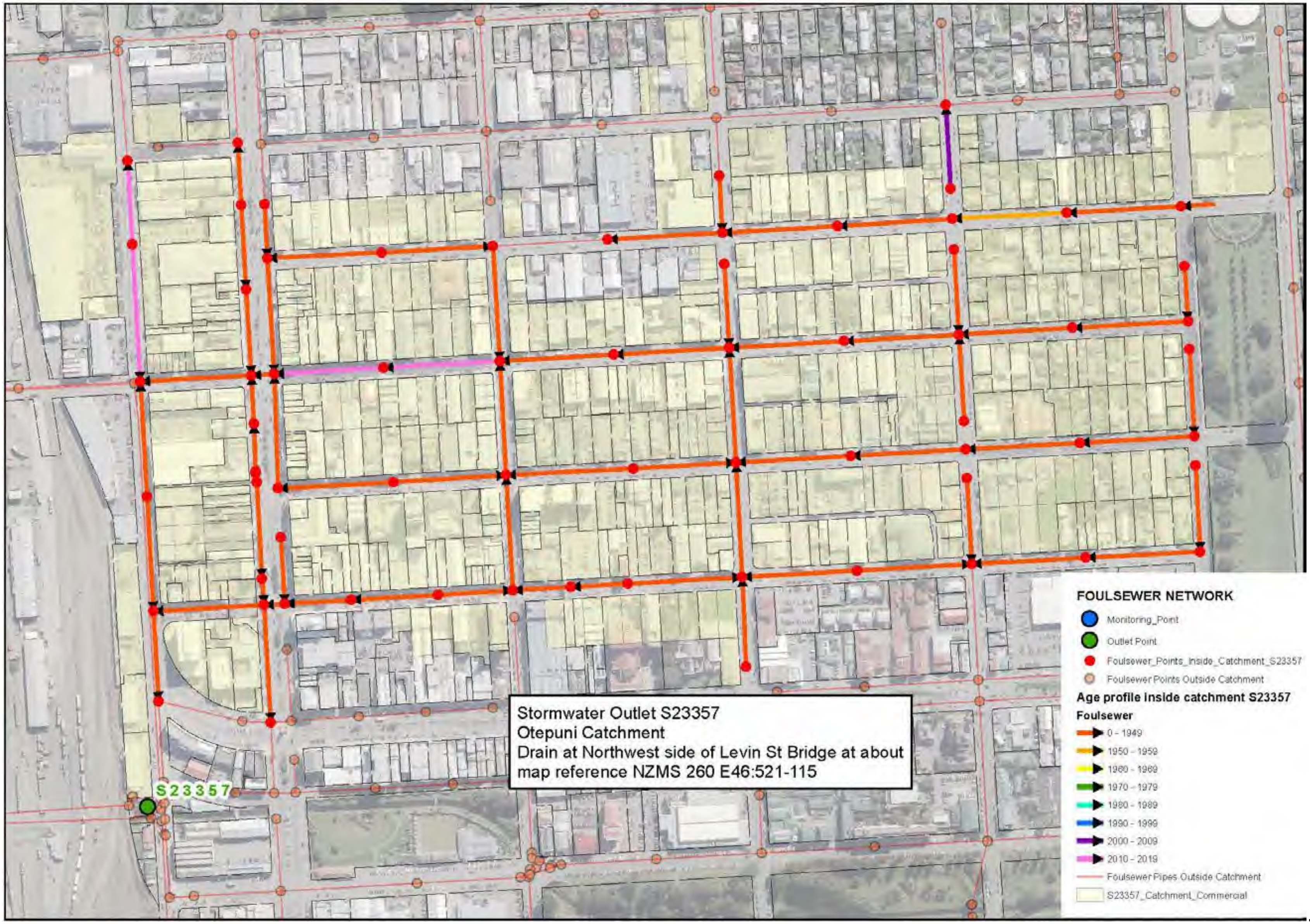


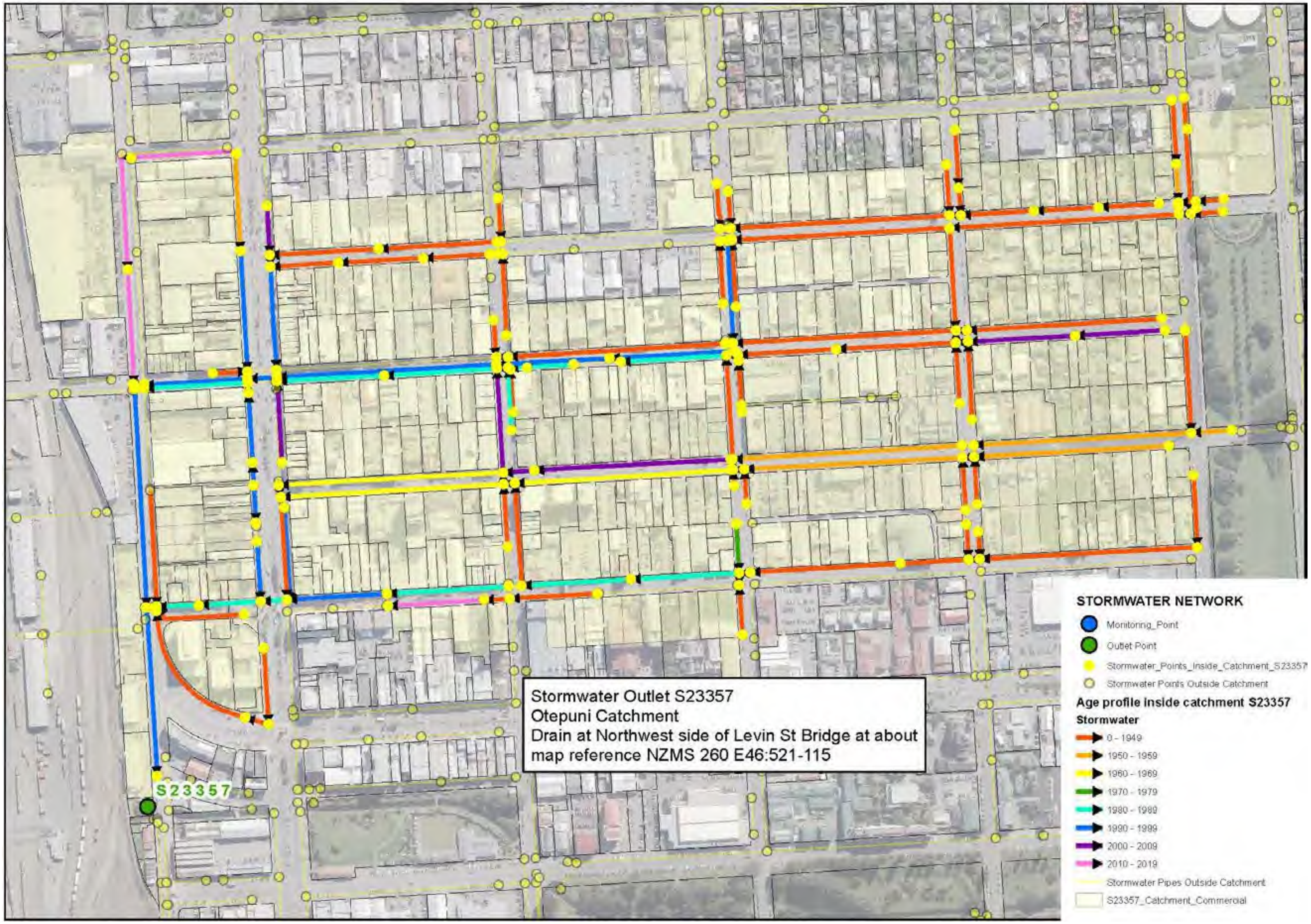


B.6 6. Camden Street Drain (Intersection Camden and Islington)

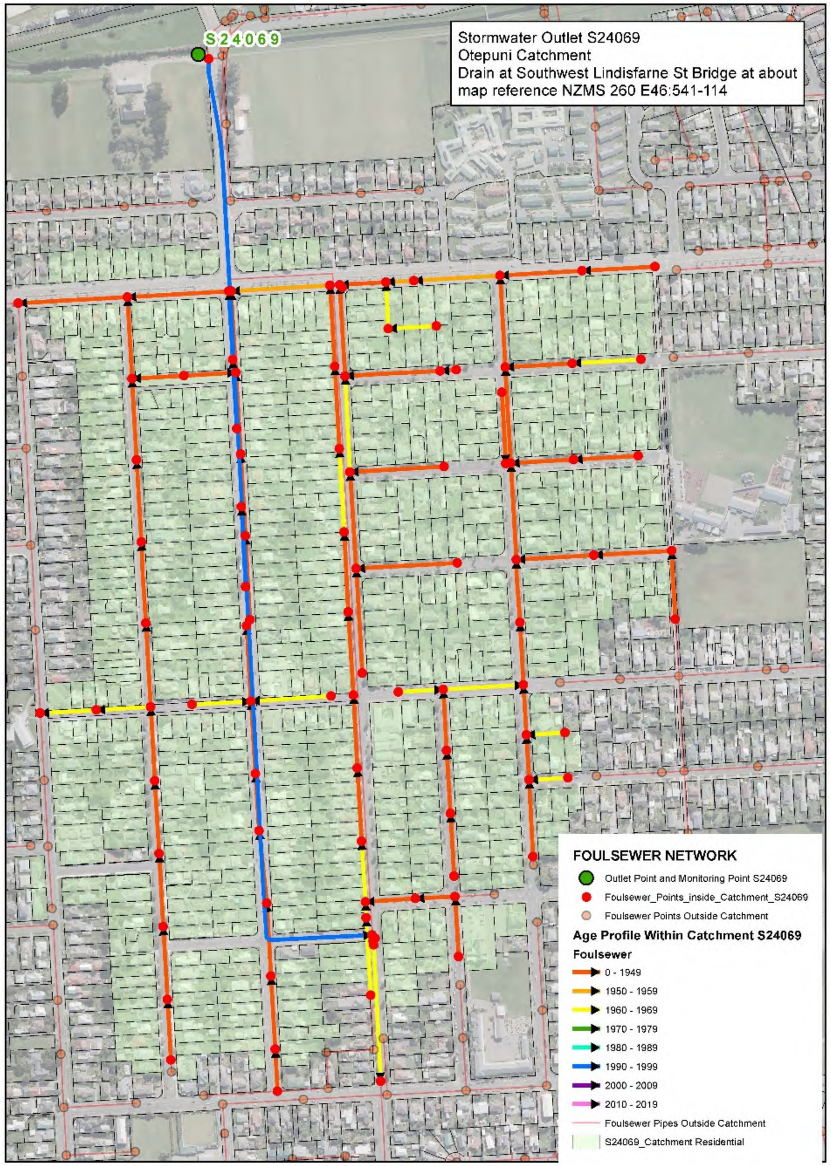


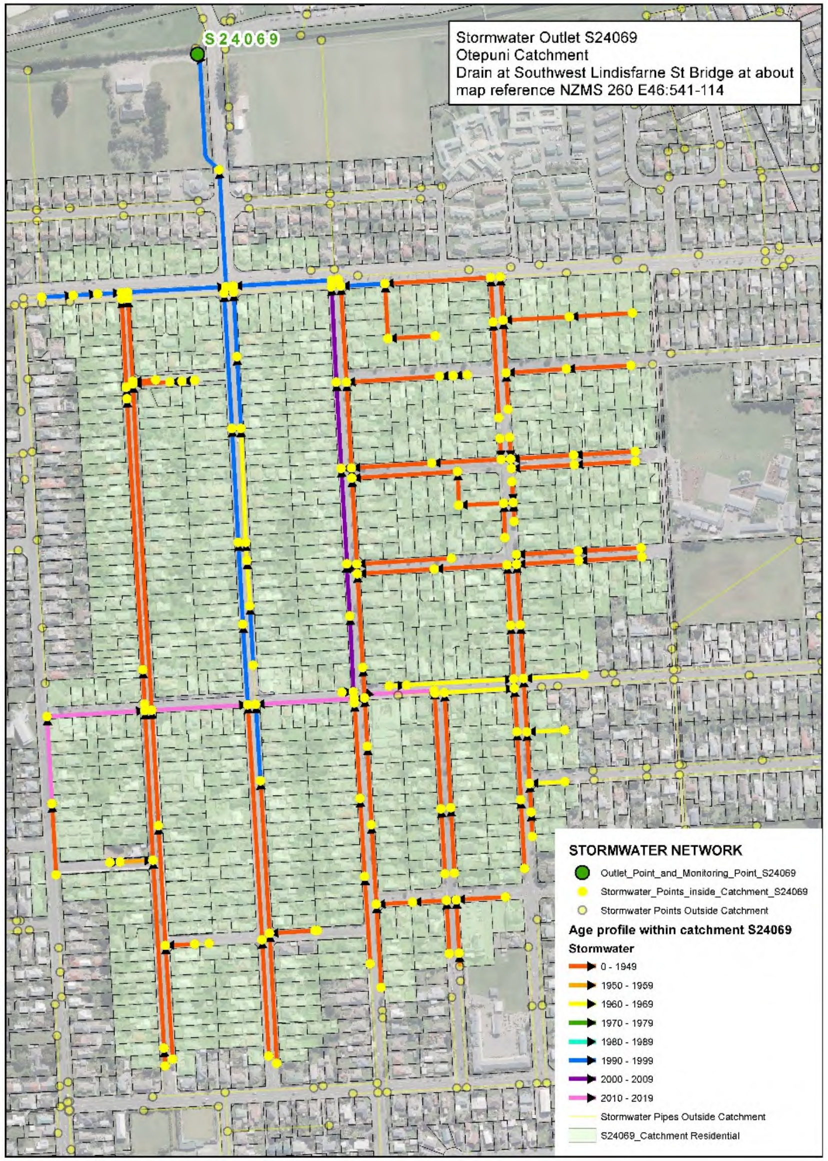
B.7 7. Leven Street Bridge North West Drain



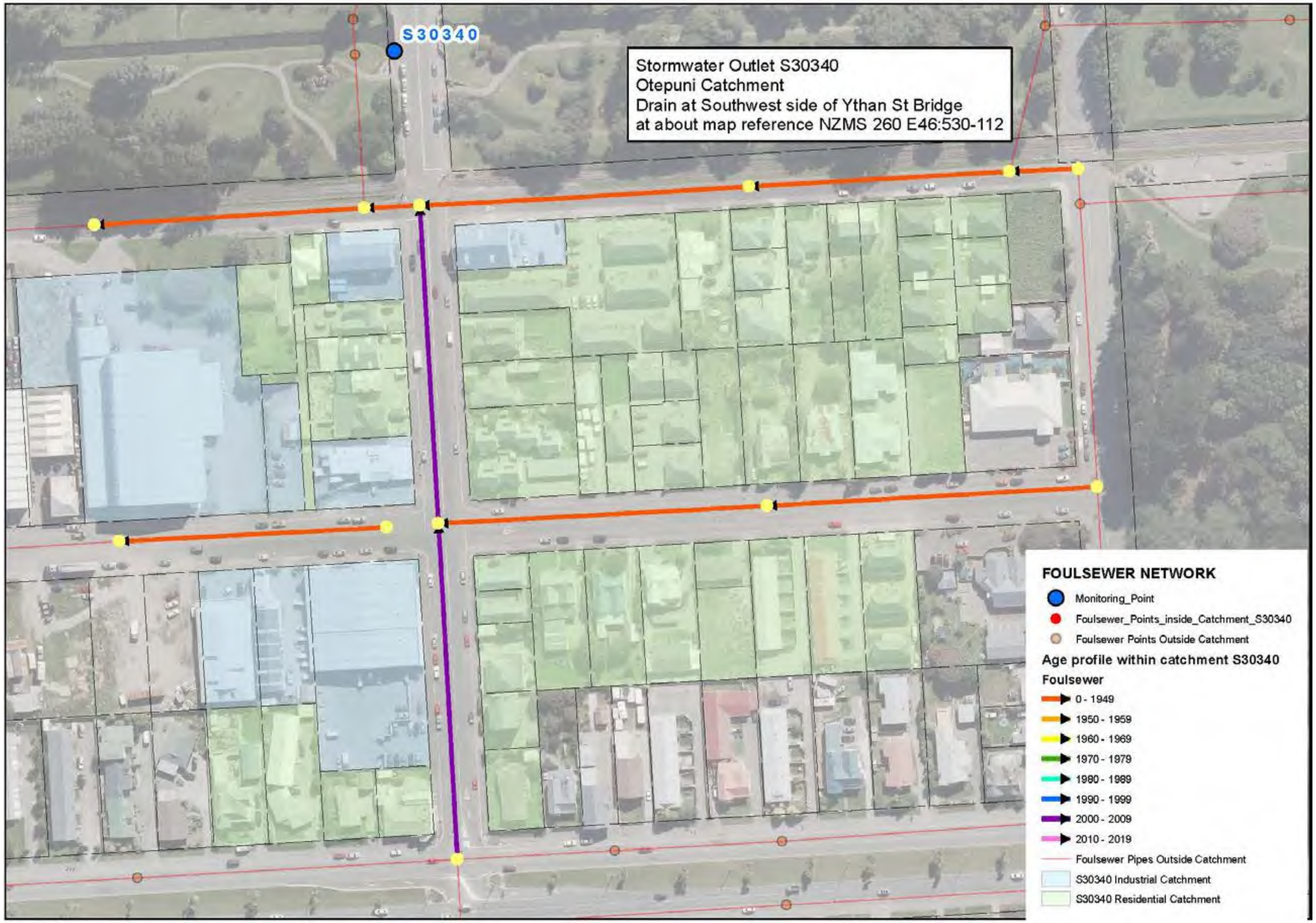

Stormwater Outlet S23357
Otepuni Catchment
Drain at Northwest side of Levin St Bridge at about
map reference NZMS 260 E46:521-115
S23357
STORMWATER NETWORK
Monitoring_Point
Outlet Point
Stormwater_Points_Inside_Catchment_S23357
Stormwater Points Outside Catchment
Age profile inside catchment S23357
Stormwater
0 - 1949
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 1989
1990 - 1999
2000 - 2009
2010 - 2019
Stormwater Pipes Outside Catchment
S23357_Catchment_Commercial

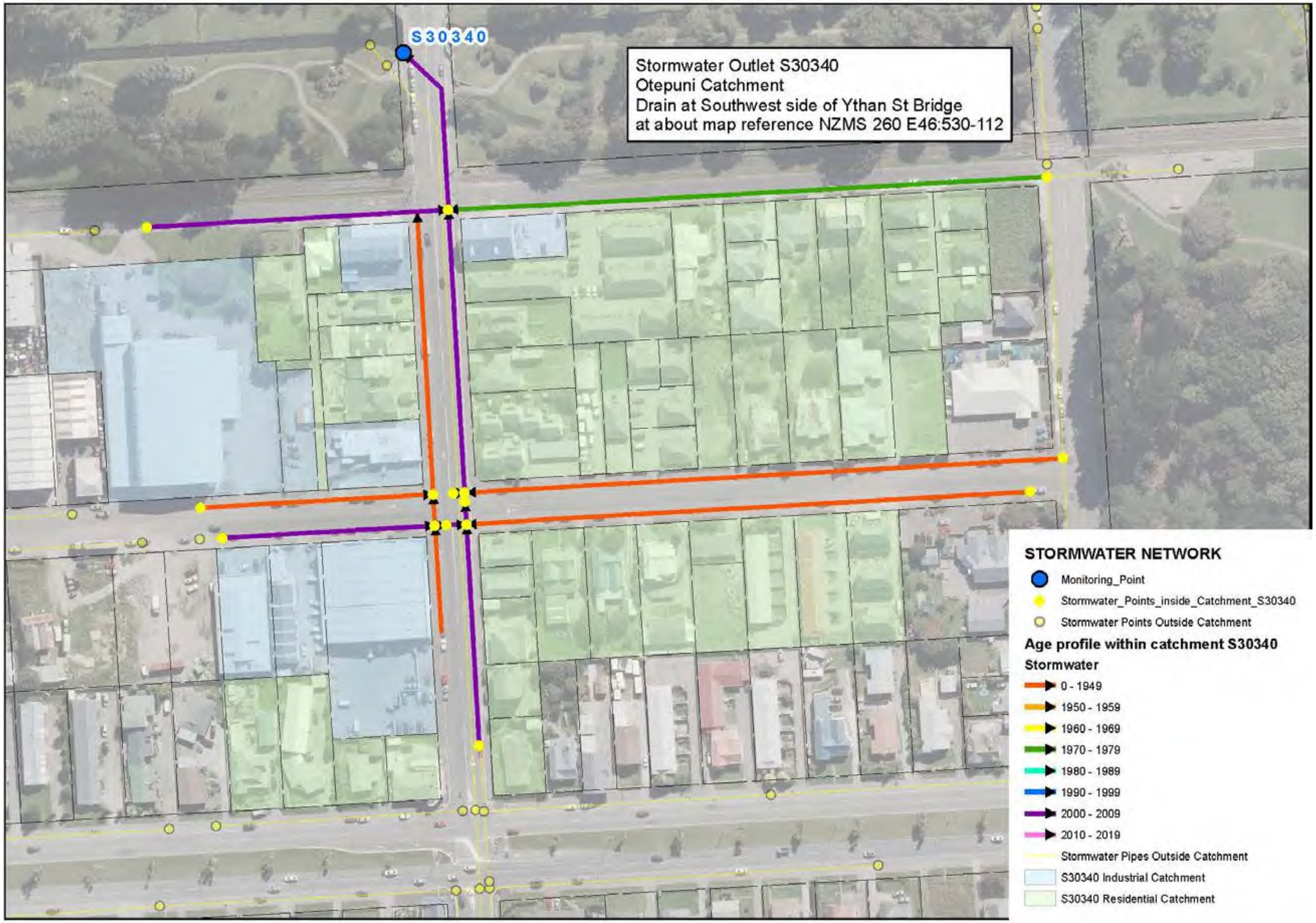
B.8 8. Lindisfarne Street Bridge (South West Drain)



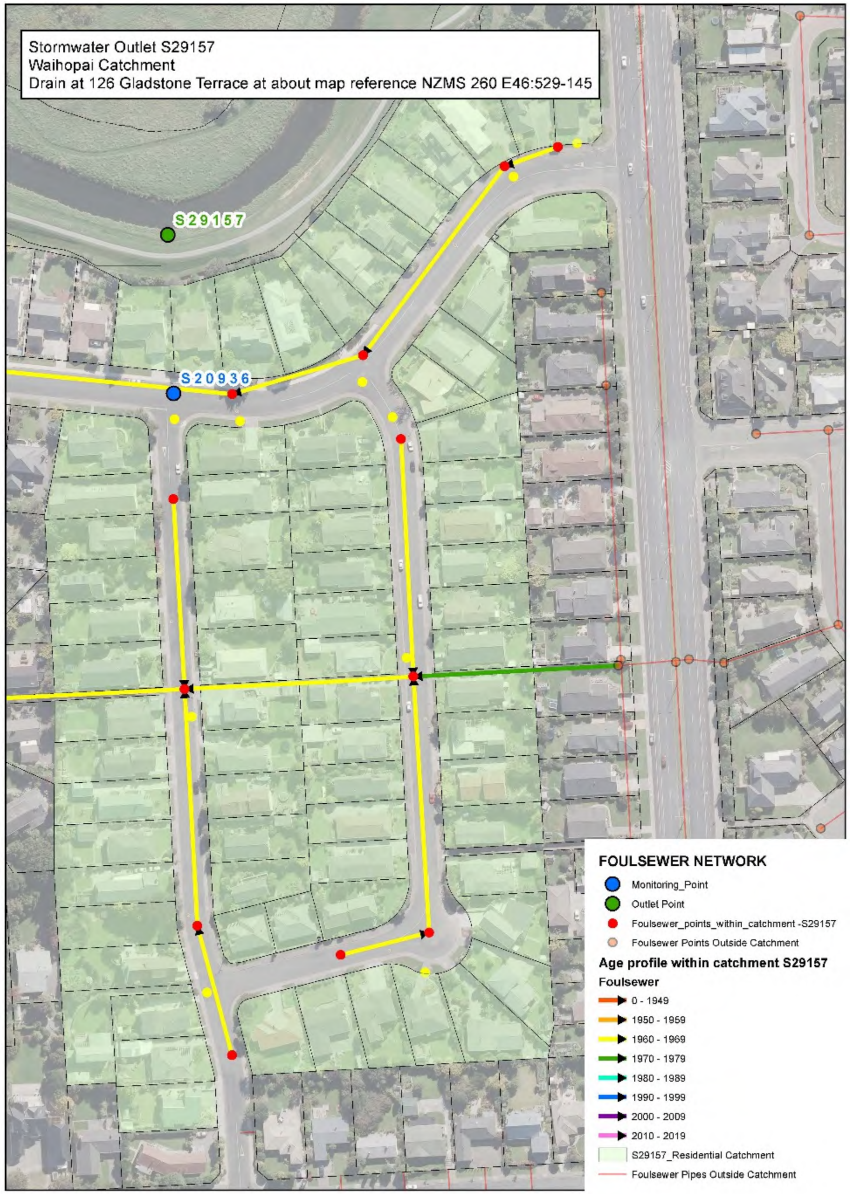


B.9 9. Ythan Street Drain (Intersection Eye Street North West Corner)

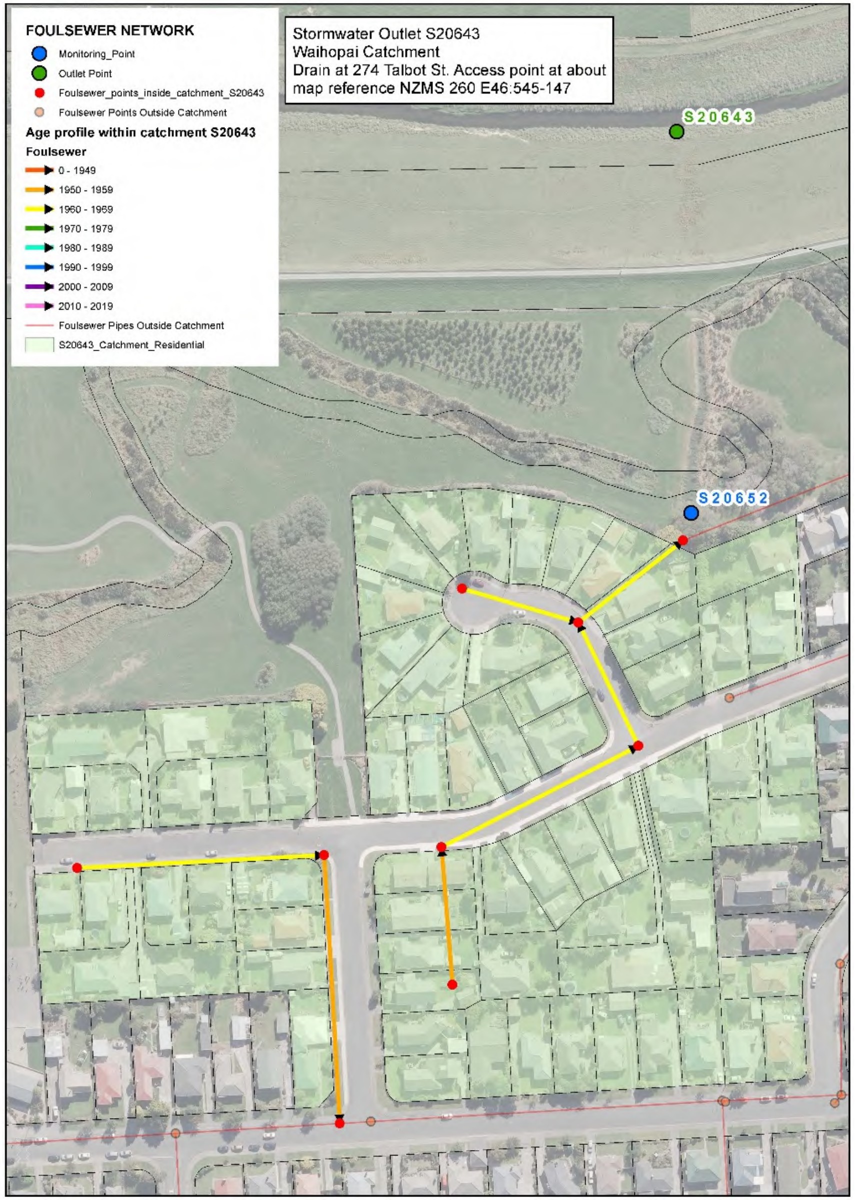


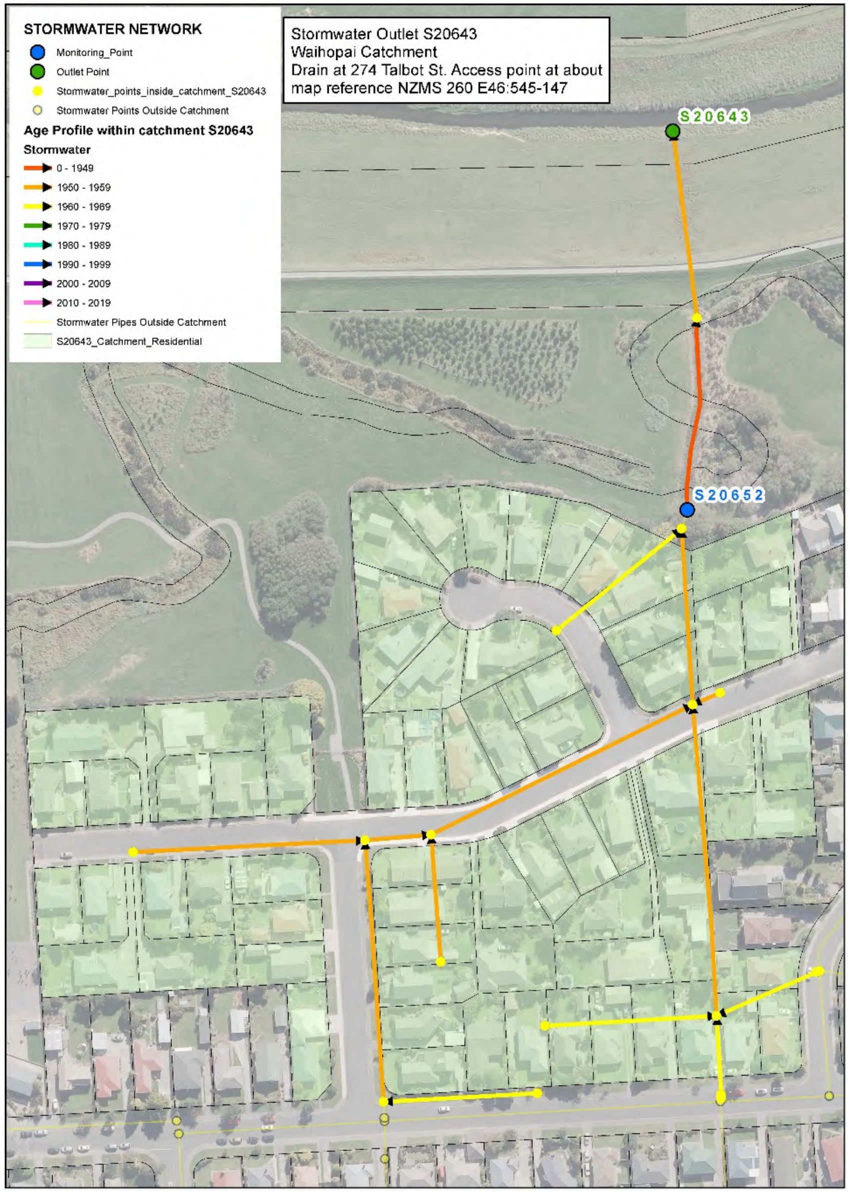

S30340
Stormwater Outlet S30340
Otepuni Catchment
Drain at Southwest side of Ythan St Bridge
at about map reference NZMS 260 E46:530-112
STORMWATER NETWORK
Monitoring_Point
Stormwater_Points_inside_Catchment_S30340
Stormwater Points Outside Catchment
Age profile within catchment S30340
Stormwater
0 - 1949
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 1989
1990 - 1999
2000 - 2009
2010 - 2019
Stormwater Pipes Outside Catchment
S30340 Industrial Catchment
S30340 Residential Catchment

B.10 10. 126 Gladstone Terrace (Manhole Behind)

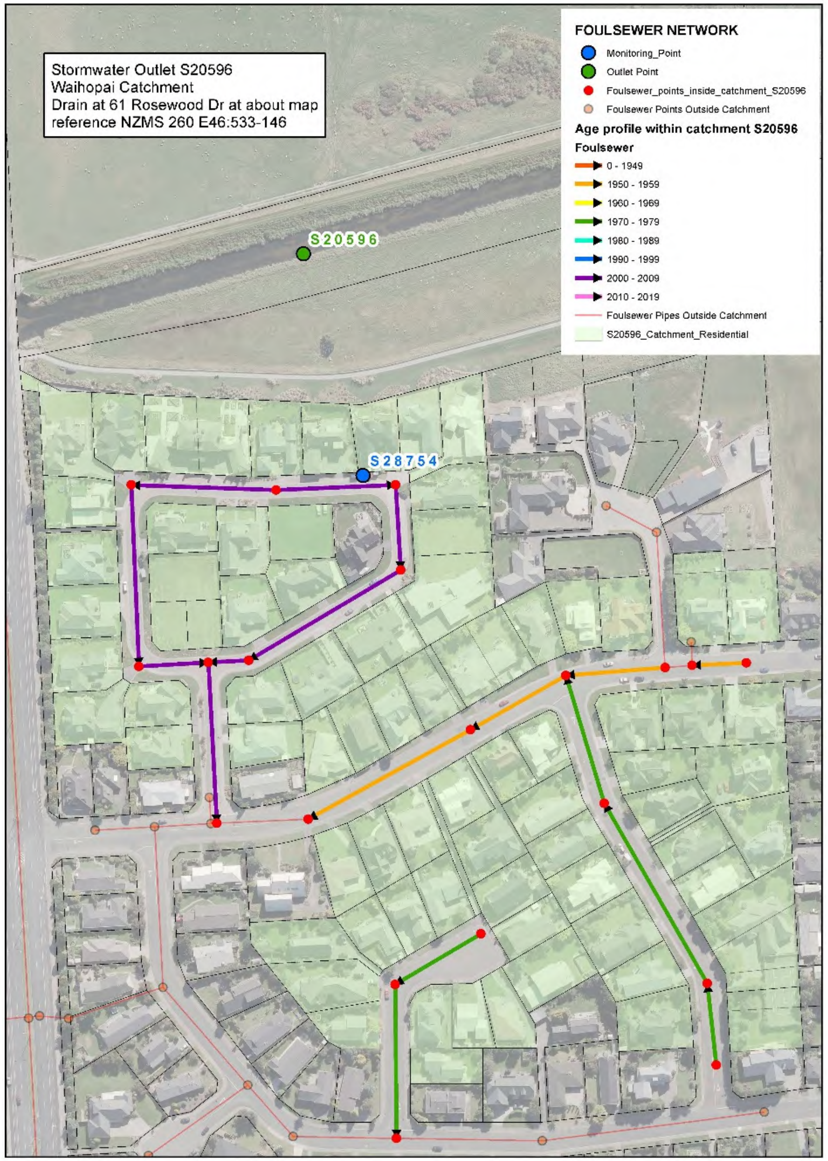


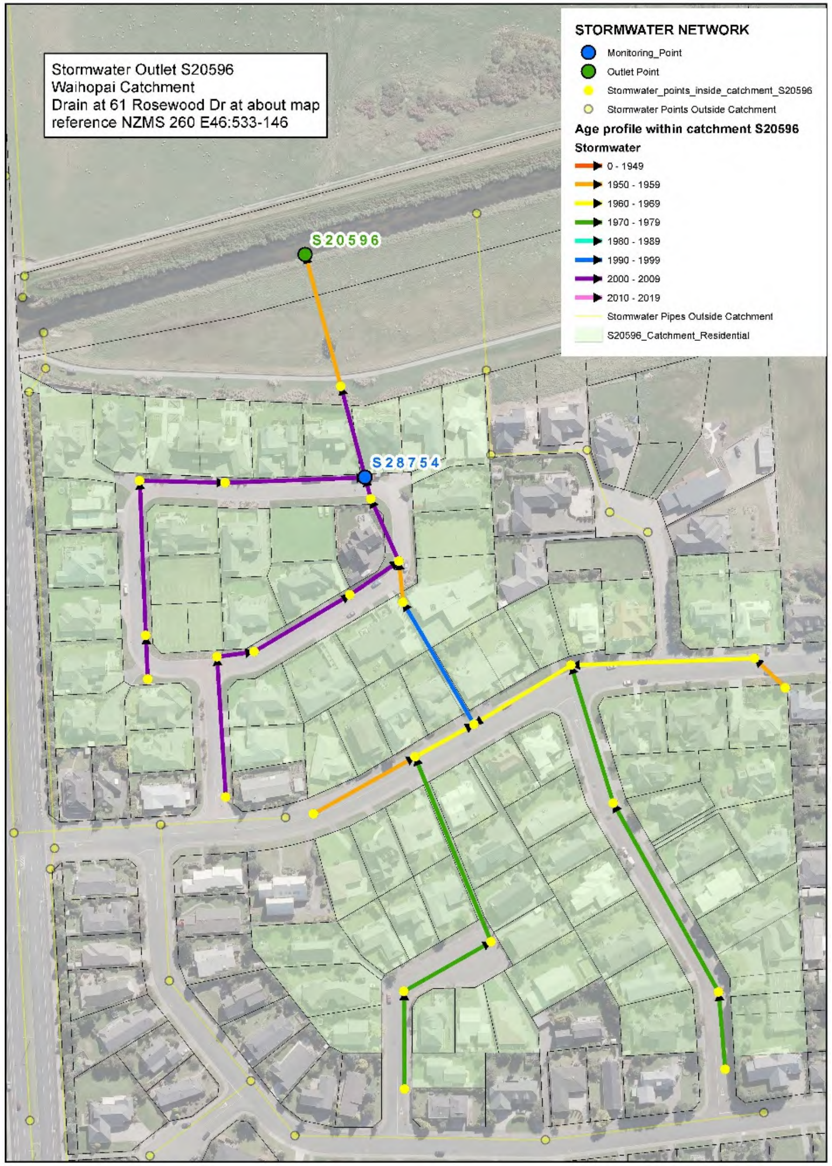
B.11 11. 274 Talbot Street (Drain Behind)



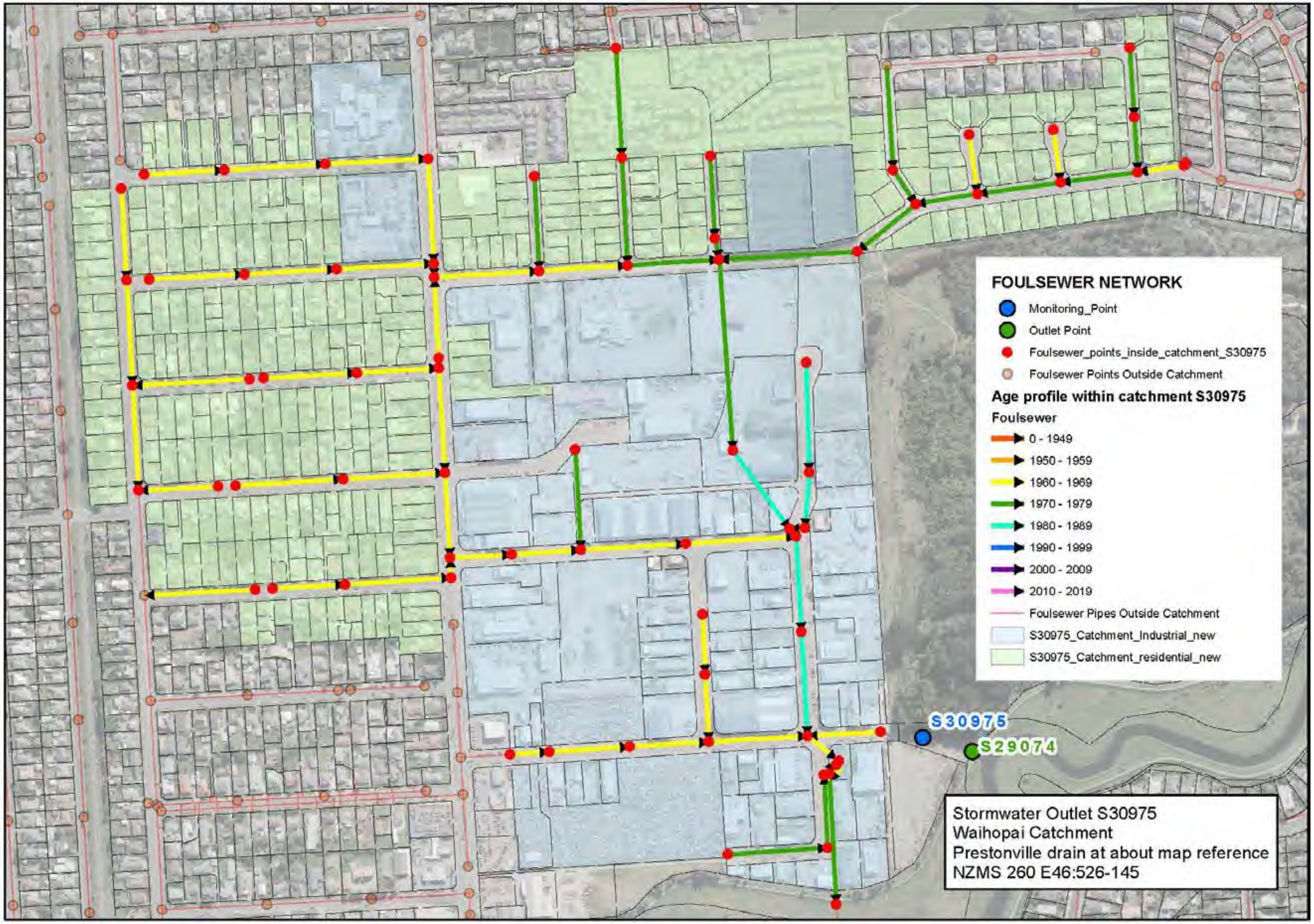


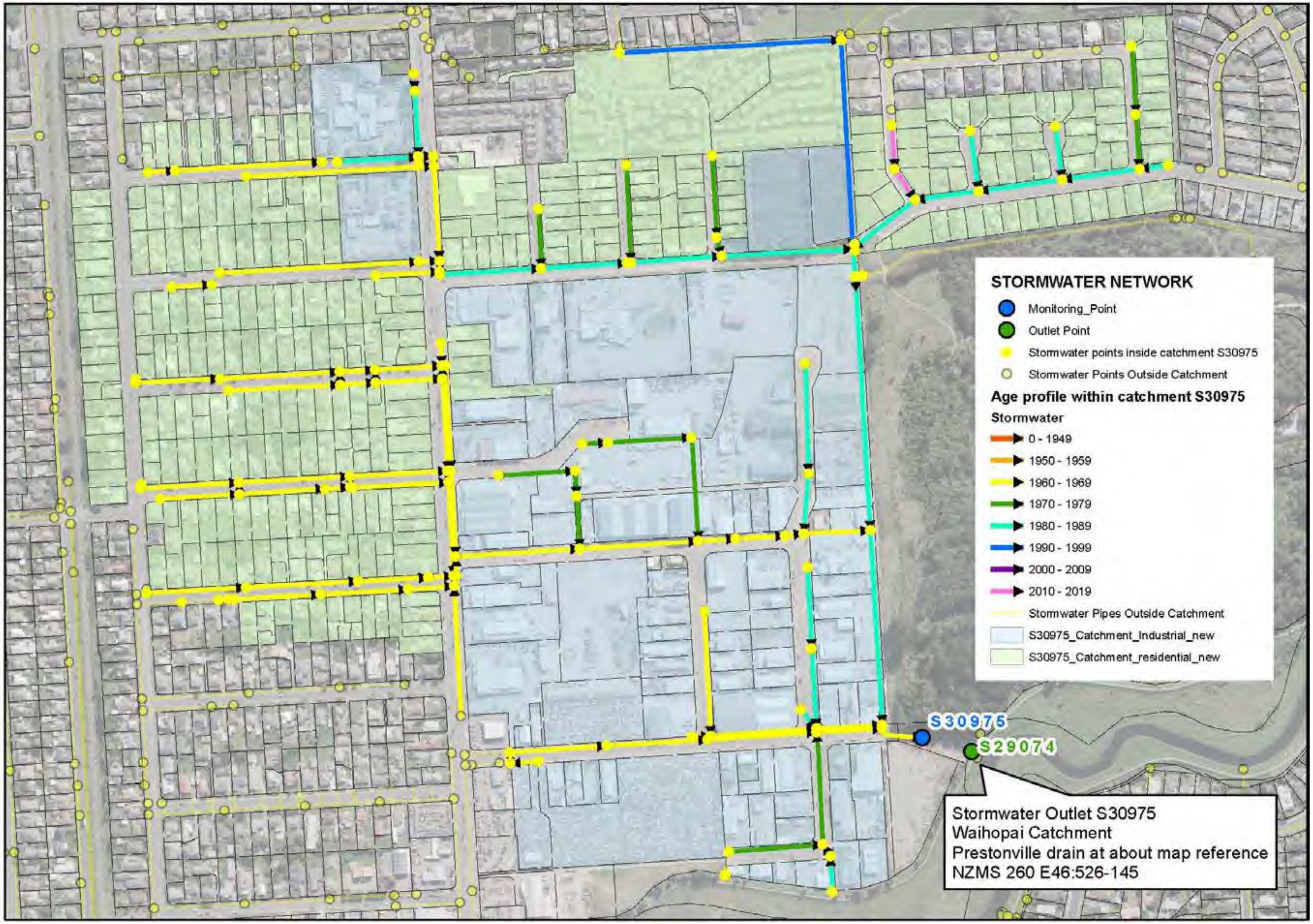
B.12 12. 61 Rosewood Drive



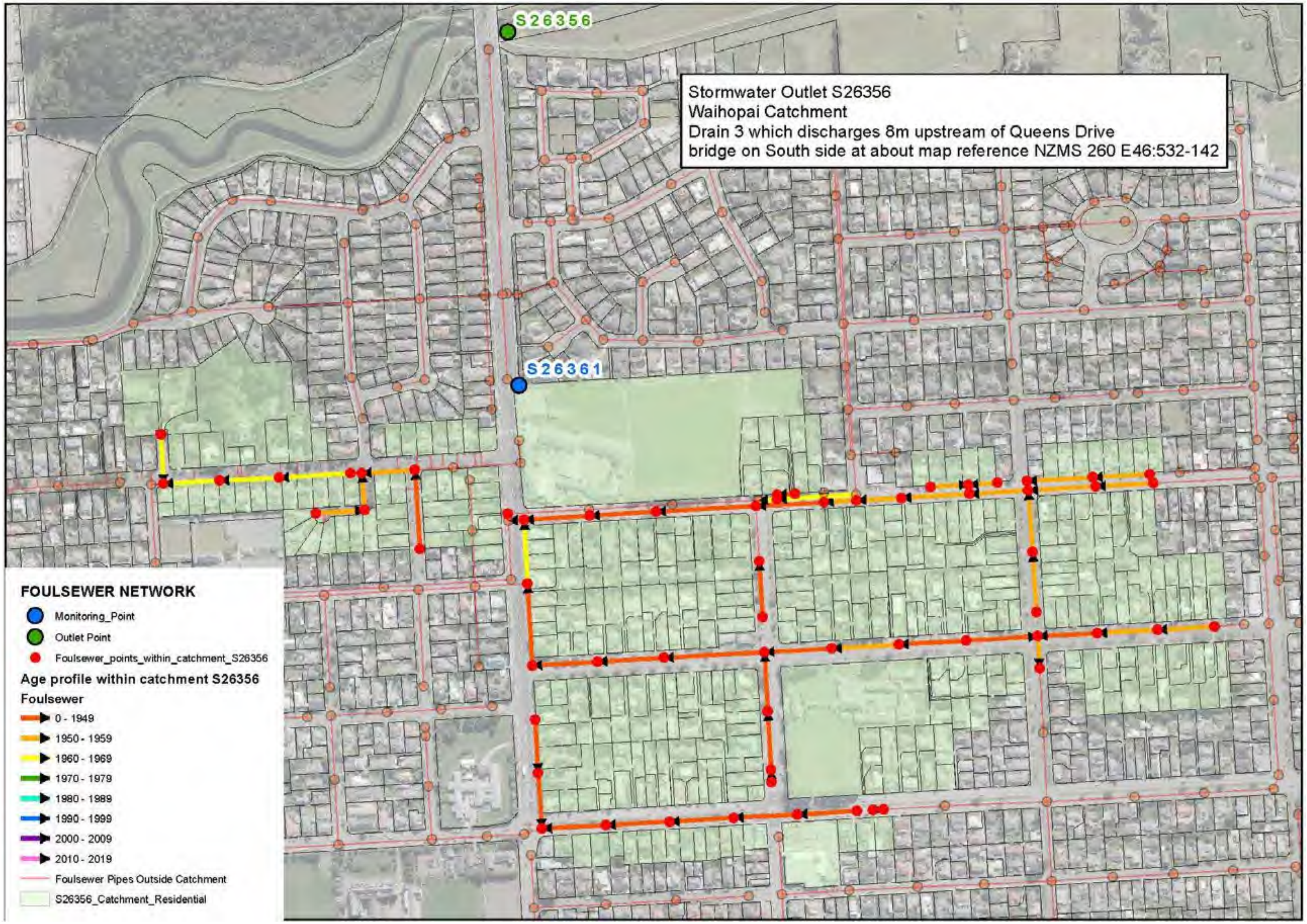


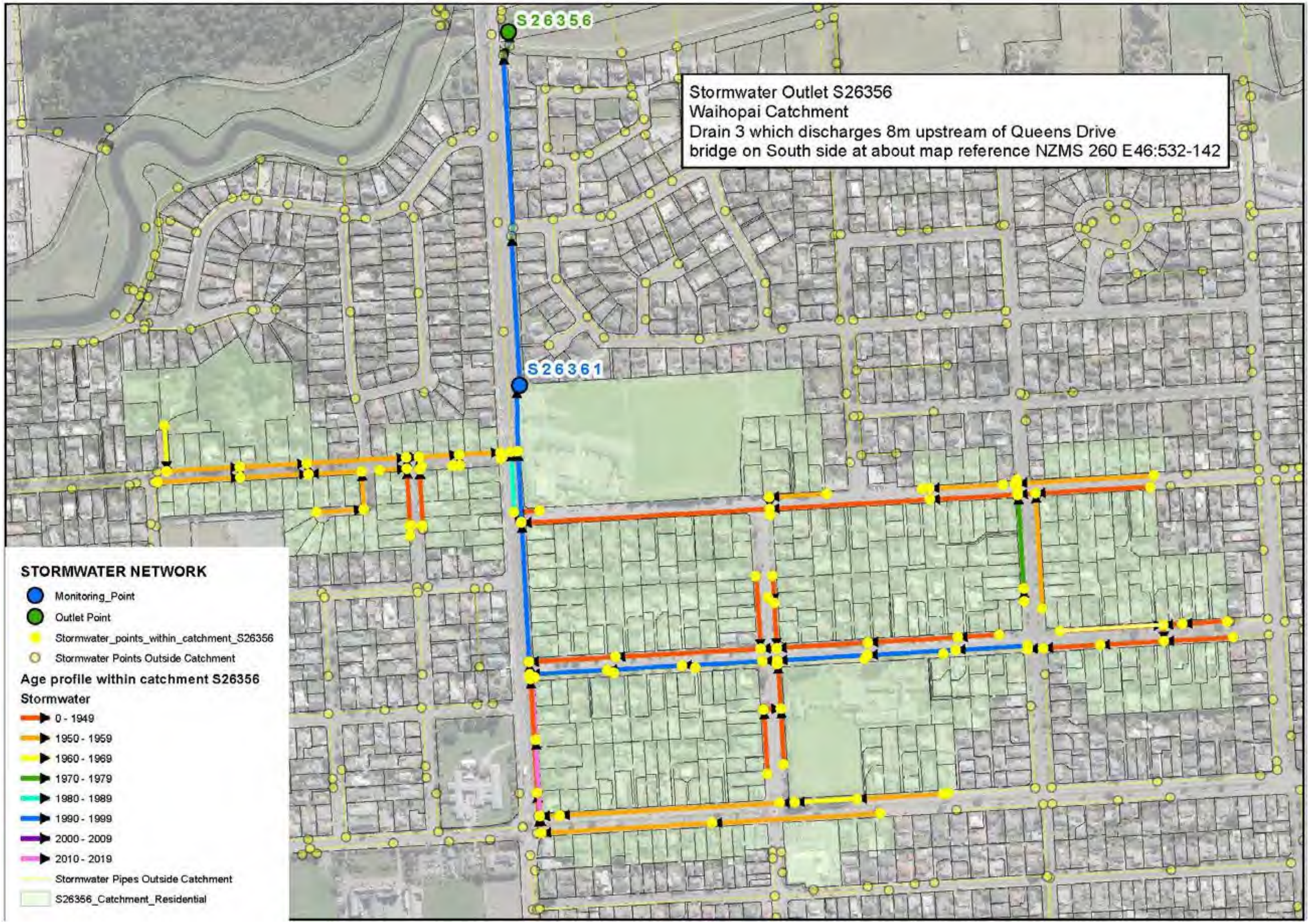
B.13 13. Prestonville Discharge



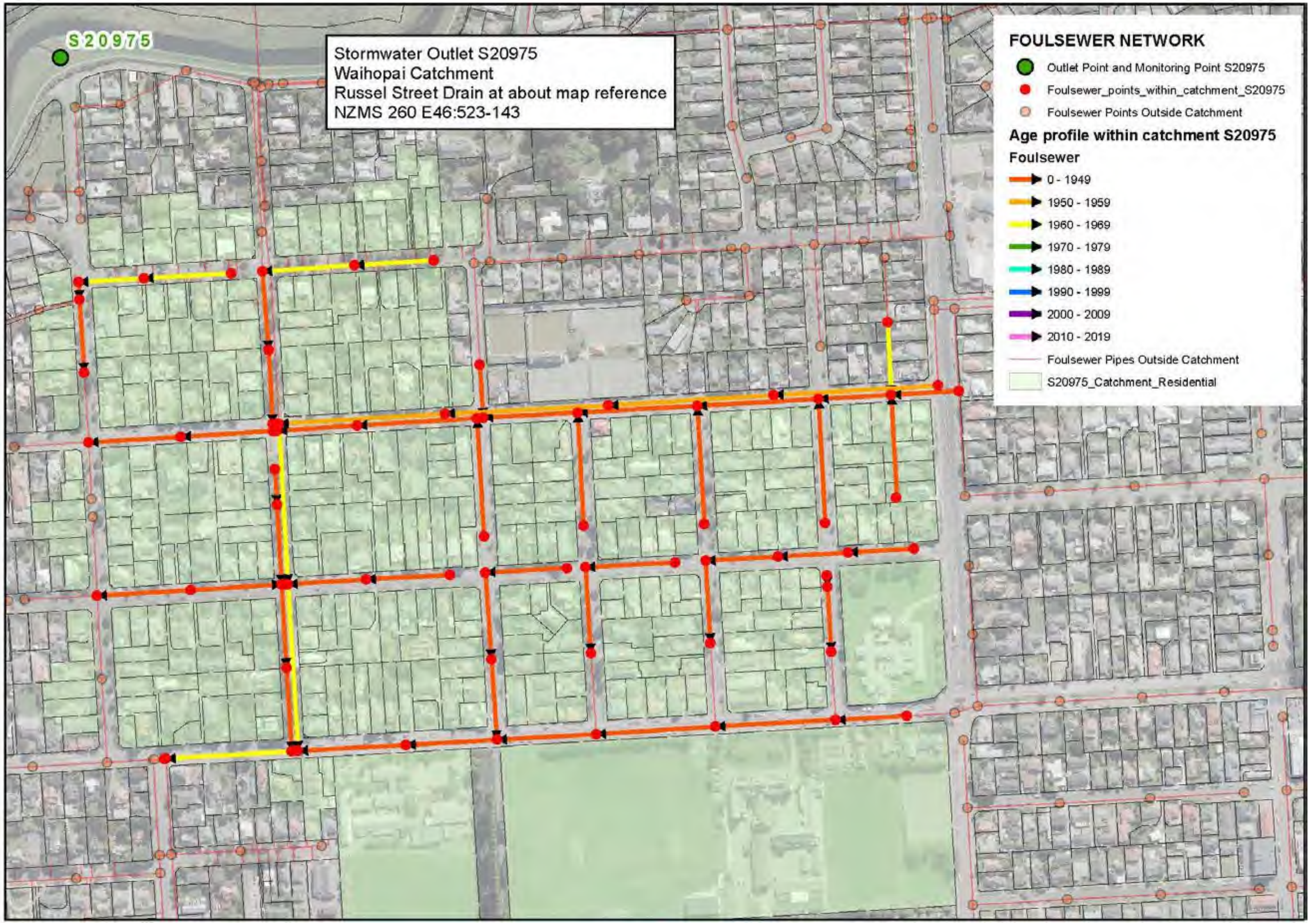

STORMWATER NETWORK
Monitoring_Point
Outlet Point
Stormwater points inside catchment S30975
Stormwater Points Outside Catchment
Age profile within catchment S30975
Stormwater
0 - 1949
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 1989
1990 - 1999
2000 - 2009
2010 - 2019
Stormwater Pipes Outside Catchment
S30975_Catchment_Industrial_new
S30975_Catchment_residential_new
S30975
S29074
Stormwater Outlet S30975
Waihopai Catchment
Prestonville drain at about map reference
NZMS 260 E46:526-145

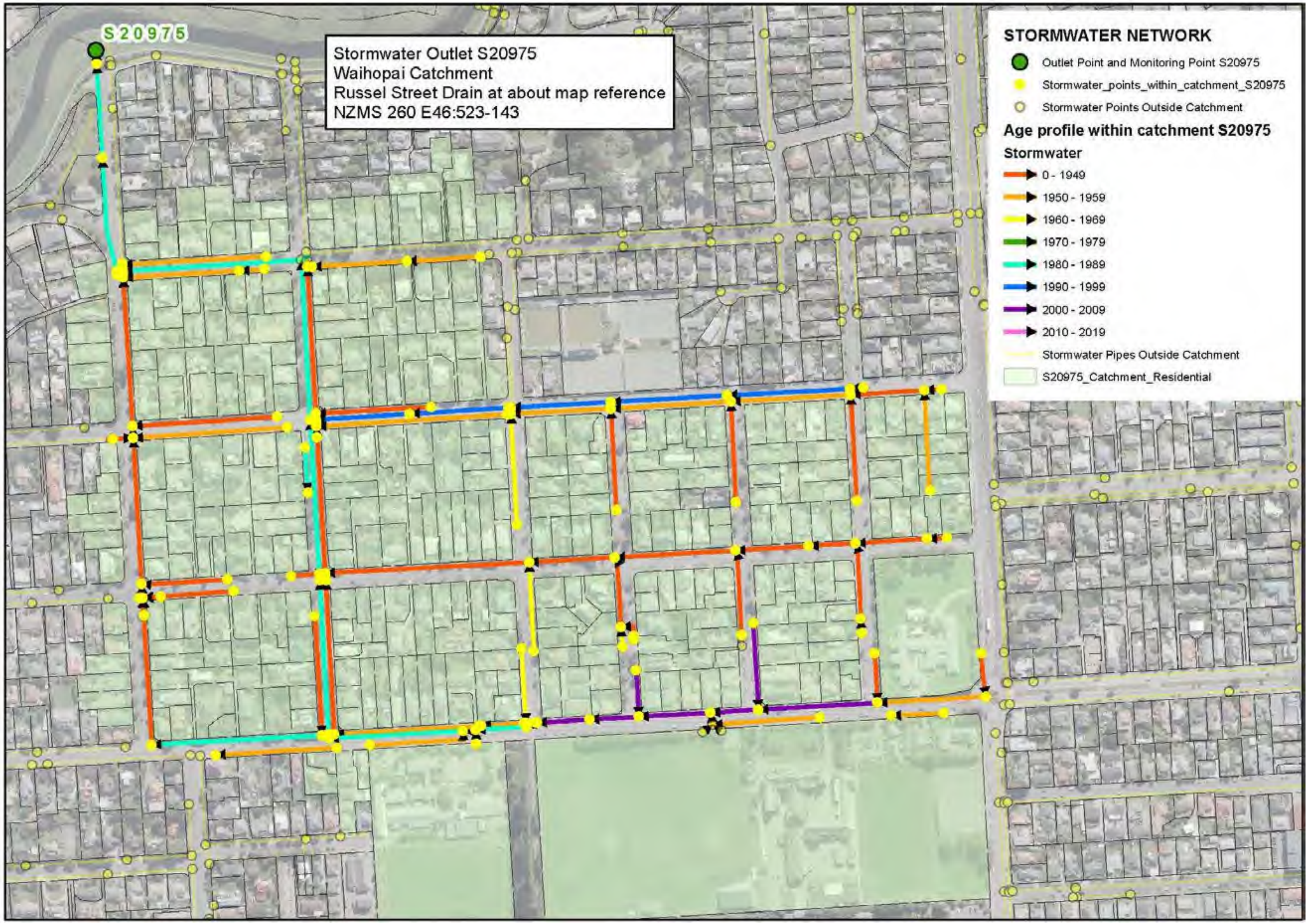
B.14 14. Queens Drive Bridge (Manhole 450m South of Bridge)



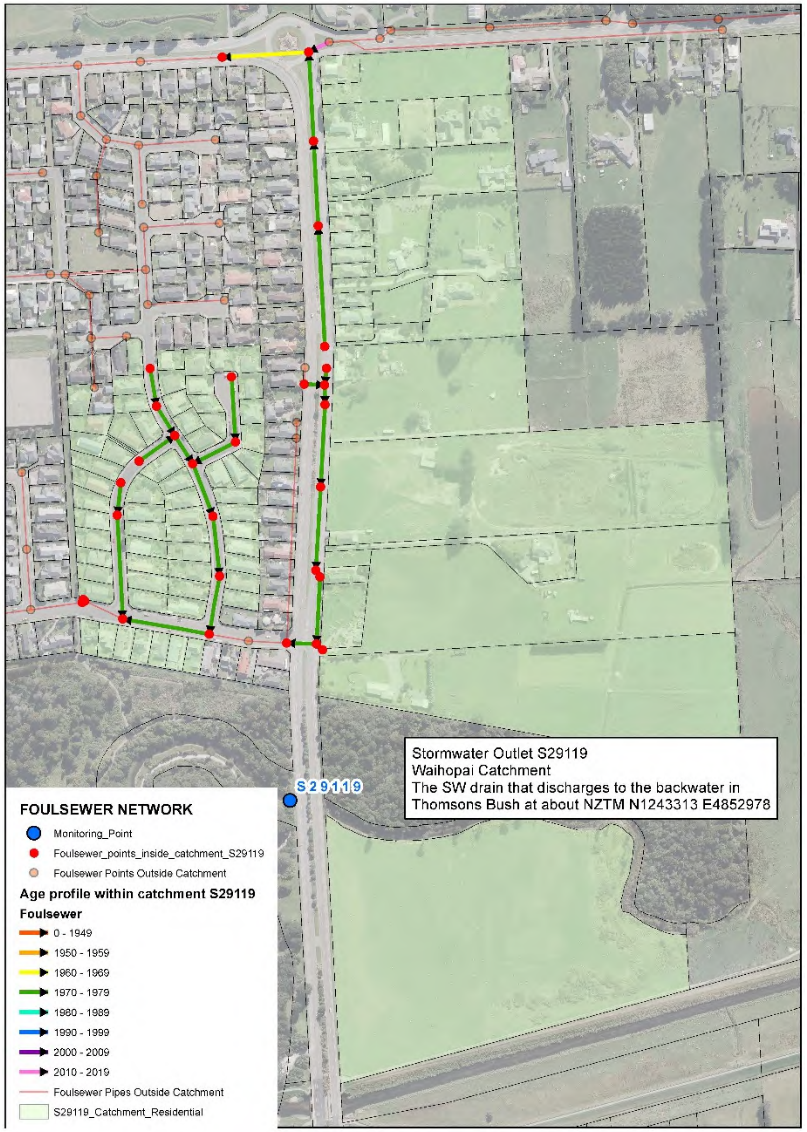

S26356
S26361
Stormwater Outlet S26356
Waihopai Catchment
Drain 3 which discharges 8m upstream of Queens Drive
bridge on South side at about map reference NZMS 260 E46:532-142
STORMWATER NETWORK
Monitoring_Point
Outlet Point
Stormwater_points_within_catchment_S26356
Stormwater Points Outside Catchment
Age profile within catchment S26356
Stormwater
0 - 1949
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 1989
1990 - 1999
2000 - 2009
2010 - 2019
Stormwater Pipes Outside Catchment
S26356_Catchment_Residential

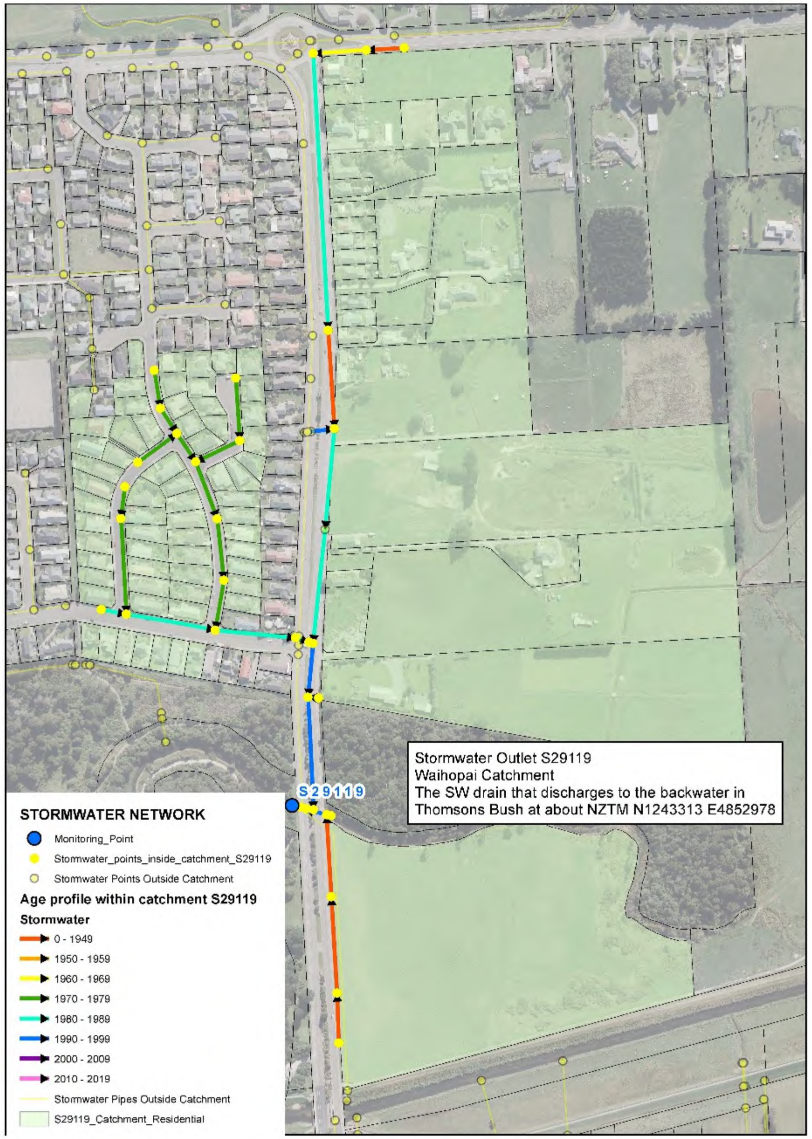
B.15 15. Russell Street (Discharge to Waihopai)



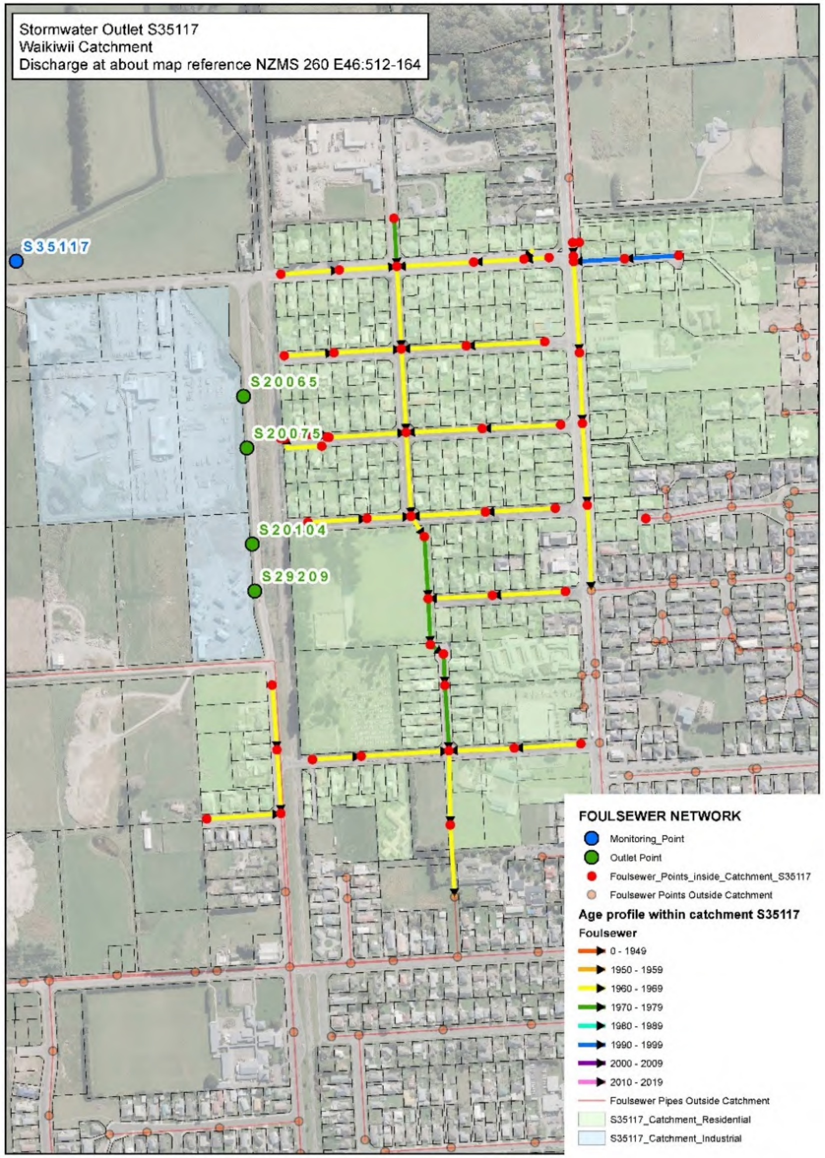

S20975
Stormwater Outlet S20975
Waihopai Catchment
Russel Street Drain at about map reference
NZMS 260 E46:523-143
STORMWATER NETWORK
Outlet Point and Monitoring Point S20975
Stormwater_points_within_catchment_S20975
Stormwater Points Outside Catchment
Age profile within catchment S20975
Stormwater
0 - 1949
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 1989
1990 - 1999
2000 - 2009
2010 - 2019
Stormwater Pipes Outside Catchment
S20975_Catchment_Residential

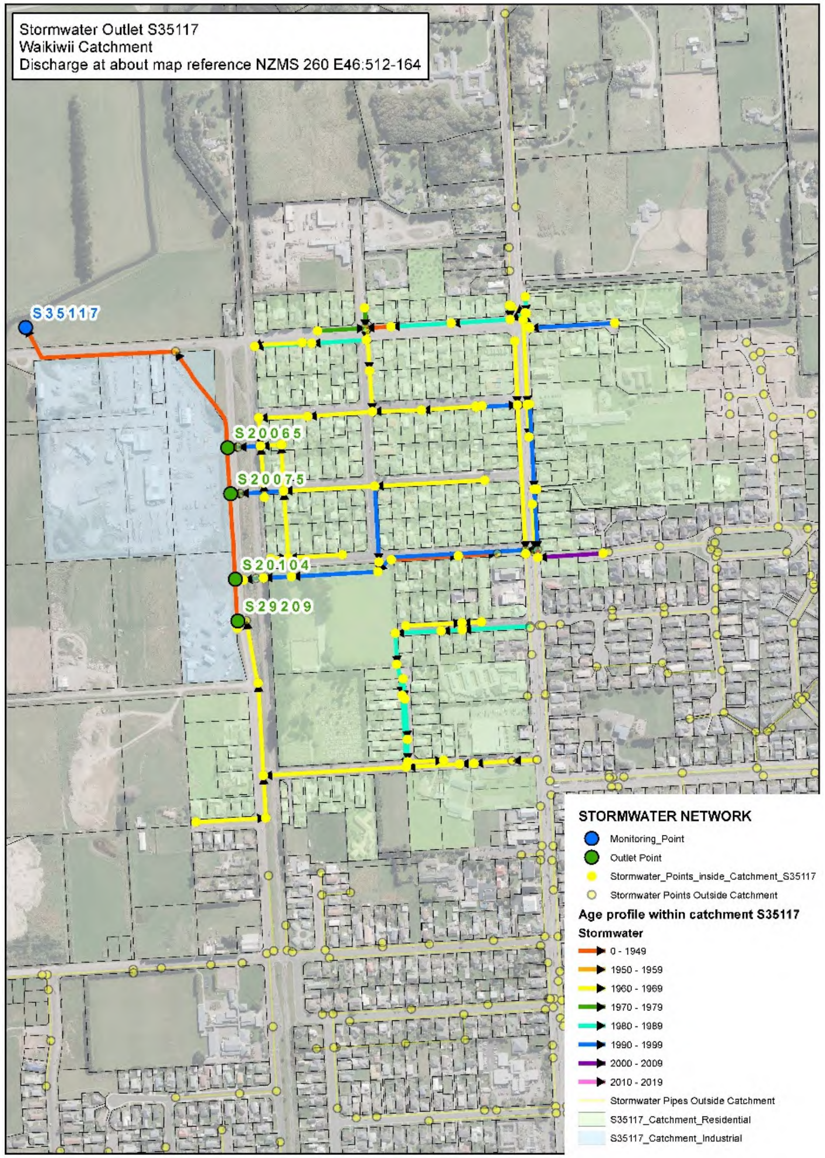
B.16 16 & 17. Thomsons Bush Discharge (Discharge from Backwash & Thomsons Bush Inflow (Discharge to Backwash)





B.17 18. Discharge to Waikiwi Stream





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Appendix B ICC Monitoring Data from 2011 to 2016

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Flow	Sampling Event	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Suspended Solids	Ammonia	Nitrate	Total Nitrogen	Total Kjeldahl Nitrogen	Total Phosphorus	Dissolved Reactive Phosphorus	Total Petroleum Hydrocarbons	Total Zinc	Total Copper	Total Lead	Total Arsenic	Total Nickel	Total Cadmium	Total Chromium	Total Coliform	Faecal Coliform	Escherichia coli	FWA microgram/litre	Calcium	Alkalinity	Comment
1	1	1				1	mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	CFU/100ml	MPN/100ml		mg/l	mg/l as CaCO3	
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	22-Mar-12	10:20	8:41	0.65	Dry Flow	0	0	0	36.5	5	15	6.96	0.188	0.4	0.024	1.52	1.55	0.03	0.006	0.004	<0.7	0.038	0.0009	0.00034	<0.0011	<0.00053	<0.000053	<0.00053	11		1	0.02			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	04-Jul-12	9:20	7:58	2.2	Dry Flow	0	0	0	34.5	20	6	6.81	0.199	0.2	0.024	3.28	3.59	0.31	0.004	0.005	<0.7	0.047	0.0023	0.0003	<0.0011	0.00054	<0.000053	<0.00053	0		0	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	22-Nov-12	15:00	16:12	0.89	Dry Flow	0	0	0.5	15.5	10	14.5	6.79	0.148	1.6	0.03	1.87	2.12	0.25	0.073	0.014	<0.7	0.031	0.0012	0.00033	<0.0011	<0.00053	<0.000053	<0.00053	0		0	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	13-Mar-13	11:45	9:50	0.2	Dry Flow	0	0	0.5	3.5	15	14.4	6.39	0.255	0.7	0.02	3.93	4.09	0.16	0.146	0.015	<0.7	0.13	0.0085	0.00173	<0.0011	0.00157	<0.000053	<0.00053	411		0	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	21-Aug-13	9:45	7:39	1.5	Dry Flow	0	0	0	32	20	10	6.65	0.304	6.3	0.12	5.94	6.41	0.47	0.002	0.003	<0.7	0.23	0.0032	0.00122	<0.0011	0.00144	<0.000053	0.00064	77		2	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	14-Nov-13	8:55	5:59	0.535	Dry Flow	0	0	0	9.5	20	13.6	6.32	0.306	1.1	0.06	4.85	5.28	0.43	0.047	0.033	<0.7	0.153	0.0023	0.00048	<0.0011	0.00102	<0.000053	<0.00053	179		2	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	10-Feb-14	11:50	5:41	0.11	Dry Flow	0	0	0	1	20	17.2	6.33	0.258	0.4	0.06	3.36	3.75	0.39	0.027	0.015	<0.7	0.18	0.0024	0.00154	<0.0011	0.00143	<0.000053	0.0006	780	2	2	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	11-Sep-14	11:10	9:15	0.66	Dry Flow	0	0	0	5.5	25	11.3	6.47	0.287	5.1	0.15	3.4	4.38	0.98	0.018	0.011		0.026	0.0028	0.00125	<0.0011	0.00137	<0.000053	0.00062	194		0				
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	26-Jan-15	11:50	14:44	0.257	Dry Flow	0	0	0	12	15	18.1	6.65	0.225	72.3	0.09	1.93	2.69	0.76	0.012	0.009		0.186	0.00192	0.00052	<0.0011	0.00074	<0.000053	<0.00053	1126		0				
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	28-Aug-15	10:58	6:15	4.81	Dry High Flow	0	0	0.5	58					0.4															82		2				
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	14-Sep-15	8:55	8:25	2.9	Dry Moderate Flow	0	0	5.5	36.5					3.8															41		5				Repeat Sampling due to E.coli >1000 22/3/12
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	02-Dec-15	9:45	8:37	0.71	Dry	0	0	0	42	15	15.1	6.41	0.269	2.6	0.09	4.87	6.08	1.21	0.022	0.01		0.031	0.0022	0.00024	<0.0011	0.00093	<0.000053	0.00079	248		7.5				Repeat Sampling due to E.coli >1000 4/7/12
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	19-Jan-16	11:26	15:57	0.5	Dry Flow	0	0	0	54.5	15	15.8	7.13	0.303	3.6	0.57	3.4	6.44	2.33	0.07	0.031		0.061	0.0048	0.00065	<0.0011	0.00118	<0.000053	0.00064	160		10				Repeat Sampling due to E.coli >1000 22/11/12
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	24-May-16	11:08	9:26	15	Dry Flow	0	3	18.5	76					0.1															6896		370				
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	27-Jun-16	14:53	13:08	1.25	Dry Flow	0	0	0	19					1.2															55		21				
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	27-Apr-12	22:45	0:11	0.3	Storm Flow	6.5	9	9	9	25	12.1	6.43	0.059	5.6	0.05	0.49	1	0.51	0.044	0.021	<0.7	0.37	0.0021	0.0037	<0.0011	0.00103	<0.000053	0.00063	99315		4300	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	16-Jan-14	8:34	9:02	5.45	Wet Flow	1.5	3.5	9	50.5					0.4															19863		794				
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	24-Jan-14	11:46	14:42	3.1	Wet Flow	0	1	22	28.5					0.4															3328		5				
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	05-May-14	8:45	12:20	1.9	Storm Flow	0.5	9.5	9.5	43	25	12.3	6.15	0.056	4.3	0.04	0.18	0.73	0.55	0.067	0.043	<0.7	0.37	0.0026	0.0035	0.0011	0.00158	<0.000053	0.00127	20630		980	<0.01			
Kingswell	Bluff Highway Up Stream South Drain (Manhole Paisley St @ Burns St)	26-Jan-15	14:15	14:44	0.255	Storm Flow	3.5	9	9	21	20	18.5	6.55	0.037	7.8	0.06	0.01	0.51	0.5	0.045	0.037		0.22	0.0028	0.003	<0.0011	0.0027	<0.000053	0.00089	24196		1439				
Kingswell	Brown Street North West Drain	22-Mar-12	13:15	8:41	0.65	Dry Flow	0	0	0	36.5	35	15.6	7.12	0.311	0.7	0.581	3.19	4	0.81	0.119	0.083	<0.7	0.077	0.0042	0.00067	<0.0011	0.00115	<0.000053	0.00066	100240		79360	5.1			
Kingswell	Brown Street North West Drain	23-Mar-12	15:00	9:19	0.52	Elevated E. coli Repeat Sample	0	1	1	33																				16640		5760				
Kingswell	Brown Street North West Drain	04-Jul-12	9:40	7:58	2.2	Dry Flow	0	0	0	34.5	45	9.6	6.8	0.307	2.9	0.673	1.16	2.67	1.51	0.087	0.079	<0.7	0.064	0.0055	0.00097	<0.0011	0.00093	<0.000053	0.00081	51720		17220	0.07			
Kingswell	Brown Street North West Drain	05-Jul-12	14:20	8:49	1.7	Elevated E. coli Repeat Sample	0	0	0	31.5																				107100		27200				
Kingswell	Brown Street North West Drain	22-Nov-12	14:40	16:12	0.89	Dry Flow	0	0	0.5	15.5	40	14	6.91	0.27	3.2	0.42	4.51	5.1	0.59	0.13	0.046	<0.7	0.06	0.0039	0.00098	<0.0011	0.00102	<0.000053	<0.00053	72700		48840	0.36			
Kingswell	Brown Street North West Drain	23-Nov-12	14:05	17:09	0.85	Elevated E. coli Repeat Sample	0	0.5	0.5	15.5																				19350		7540				
Kingswell	Brown Street North West Drain	13-Mar-13	11:20	9:50	0.2	Dry Flow	0	0	0.5	3.5	30	14.2	6.98	0.266	5.5	0.32	4.39	4.88	0.49	0.259	0.225	<0.7	0.062	0.0046	0.00132	<0.0011	0.00183	<0.000053	0.0032	111985		41060	0.42			
Kingswell	Brown Street North West Drain	14-Mar-13	15:40	10:33	0.2	Elevated E. coli Repeat Sample	0	0	0	2																				32000		8750				
Kingswell	Brown Street North West Drain	21-Aug-13	10:00	7:39	1.5	Dry Flow	0	0	0	32	30	10	6.72	0.296	1.7	0.79	3.66	4.98	1.32	0.062	0.045	<0.7	0.054	0.0034	0.00038	<0.0011	0.0009	<0.000053	0.00069	77655		27375	0.19			
Kingswell	Brown Street North West Drain	14-Nov-13	9:15	5:59	0.535	Dry Flow	0	0	0	9.5	40	13	6.87	0.291	2.1	2.41	2.89	5.84	2.95	0.295	0.199	<0.7	0.055	0.0042	0.00084	<0.0011	0.00106	<0.000053	0.0006	83600		34100	0.35			
Kingswell	Brown Street North West Drain	10-Feb-14	11:35	5:41	0.11	Dry Flow	0	0	0	1	30	17	6.86	0.244	2.2	0.68	3.02	3.84	0.82	0.188	0.115	<0.7	0.039	0.004	0.00037	<0.0011	0.00102	<0.000053	<0.00053	29700	11650	10500	0.58			Repeat Sampling due to E.coli >1000 13/3/13
Kingswell	Brown Street North West Drain	11-Sep-14	11:20	9:15	0.66	Dry Flow	0	0	0	5.5	30	11.3	6.77	0.283	1	0.45	3.01	3.7	0.69	0.073	0.022		0.074	0.0033	0.00049	<0.0011	0.00089	<0.000053	0.00055	26300		6700				
Kingswell	Brown Street North West Drain	26-Jan-15	12:00	14:44	0.257	Dry Flow	0	0	0	12	20	17.1	6.91	0.257	1.5	0.35	3.17	4.39	1.22	0.142	0.108		0.072	0.0187	0.00105	<0.0011	0.00152	<0.000053	<0.00053	22845		8945				
Kingswell	Brown Street North West Drain	28-Aug-15	10:49	6:15	4.81	Dry High Flow	0	0	0.5	58					1.2															77010		77010				
Kingswell	Brown Street North West Drain	14-Sep-15	8:50	8:25	2.9	Dry Moderate Flow	0	0	5.5	36.5					1															8570		1350				
Kingswell	Brown Street North West Drain	02-Dec-15	9:28	8:37	0.71	Dry	0	0	0	42	20	15	6.46	0.274	30.4	1.01	4.52	5.33	0.81	0.118	0.065		0.089	0.0057	0.0024	<0.0011	0.0026	<0.000053	0.0021	241960		111990				
Kingswell	Brown Street North West Drain	19-Jan-16	11:34	17:57	0.5	Dry Flow	0	0	0	54.5	35	15.3	6.54	0.275	2	0.1	3.66	3.97	0.31	0.023	0.011		0.22	0.0034	0.00028	<0.0011	0.0034	<0.000053	<0.00053	2380		1350				
Kingswell	Brown Street North West Drain	24-May-16	10:57	9:26	15	Dry Flow	0	3	18.5	76					0.1															9330		2690				
Kingswell	Brown Street North West Drain	27-Jun-16	16:25	13:08	1.25	Dry Flow	0	0	0	19					2															9920		1260				
Kingswell	Brown Street North West Drain	27-Apr-12	22:28	0:11	0.3	Storm Flow	6.5	9	9	9	80	13	6.41	0.037	37.2	0.07	0.29	1.03	0.74	0.048	0.045	<0.7	0.24	0.0075	0.0083	<0.0011	0.0027	<0.000053	0.00108	173290		3180	0.05			
Kingswell	Brown Street North West Drain	16-Jan-14	11:31	9:02	5.45	Wet Flow	1.5	3.5	9	50.5					0.8															16660		7860				
Kingswell	Brown Street North West Drain	24-Jan-14	11:53	14:42	3.1	Wet Flow	0	1	22	28.5					2.6															120980		55995				
Kingswell	Brown Street North West Drain	05-May-14	8:35	12:20	1.9	Storm Flow	0.5	9.5	9.5	43	20	12.8	6.13	0.051	9.3	0.08	0.12	0.96	0.84	0.152	0.032	<0.7	0.22	0.0051	0.0031	<0.0011	0.00131	<0.000053	0.00075	78900		31300	0.01			Repeat Sampling due to E.coli >1000 22/3/12
Kingswell	Brown Street North West Drain	26-Jan-15	15:35	14:44	0.255	Storm Flow	3.5	9	9	21	35	18.1	6.41	0.044	7.4	0.11	0.01	1.05	1.04	0.053	0.043		0.167	0.007	0.0026	<0.0011	0.0012	<0.000053	0.00081	86640		11780				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	22-Mar-12	10:30	8:41	0.65	Dry Flow	0	0	0	36.5	20	15.5	7.11	0.299	0.3	0.147	3.5	3.96	0.46	0.048	0.041	<0.7	0.076	0.0021	0.00042	<0.0011	0.00067	<0.000053	<0.00053	154020		97680	0.18			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	23-Mar-12	15:04	9:19	0.52	Elevated E. coli Repeat Sample	0	1	1	33																				141360		48840				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	04-Jul-12	9:30	7:58	2.2	Dry Flow	0	0	0	34.5	25	10	6.73	0.29	0.5	0.136	4.29	4.78	0.49	0.024	0.02	<0.7	0.077	0.0049	0.0038	<0.0011	0.0026	<0.000053	0.00087	307600		290900	<0.01			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	05-Jul-12	14:15	8:49	1.7	Elevated E. coli Repeat Sample	0	0	0	31.5																				152900		112500				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	22-Nov-12	14:50	16:12	0.89	Dry Flow	0	0	0.5	15.5	15	14	6.79	0.285	0.6	0.11	4.92	5.32	0.4	0.059	0.032	<0.7	0.049	0.0021	0.00029	<0.0011	0.00082	<0.000053	<0.00053	7330		5830	0.08			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	23-Nov-12	14:10	17:09	0.85	Elevated E. coli Repeat Sample	0	0.5	0.5	15.5																				3930		2260				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	13-Mar-13	11:35	9:50	0.2	Dry Flow	0	0	0.5	3.5	15	14.3	6.98	0.32	0.7	0.04	3.42	3.64	0.22	0.122	0.114	<0.7	0.057	0.0026	0.00081	<0.0011	0.00135	<0.000053	<0.00053	20460		850	0.03			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	21-Aug-13	9:50	7:39	1.5	Dry Flow	0	0	0	32	20	10.6	6.85	0.285	0.3	0.2	4.83	5.55	0.72	0.012	0.025	<0.7	0.043	0.0027	0.00034	<0.0011	0.00083	<0.000053	<0.00053	21760		6180	<0.01			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	14-Nov-13	9:05	5:59	0.535	Dry Flow	0	0	0	9.5	20	13	6.87	0.281	1.1	0.15	4.47	5.15	0.68	0.054	0.046	<0.7	0.037	0.0024	0.00079	<0.0011	0.00087	<0.000053	<0.00053	77460		52040	<0.01			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	10-Feb-14	11:42	5:41	0.11	Dry Flow	0	0	0	1	20	17.1	6.82	0.28	0.4	0.56	3.36	4.13	0.77	0.085	0.07	<0.7	0.027	0.0027	0.00043	<0.0011	0.00103	<0.000053	<0.00053	26675	13425	11200	0.68			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	11-Sep-14	11:15	9:15	0.66	Dry Flow	0	0	0	5.5	20	11.8	6.67	0.302	1.3	3.33	4.04	7.54	3.5	0.243	0.189		0.046	0.0067	0.00039	<0.0011	0.00101	<0.000053	<0.00053	806400		61160				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	26-Jan-15	11:55	14:44	0.257	Dry Flow	0	0	0	12	25	19.2	6.97	0.245	2.6	0.07	1.84	3.34	1.5	0.044	0.038		0.05	0.0108	0.00055	<0.0011	0.00084	<0.000053	<0.00053	29090		9340				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	28-Aug-15	10:53	6:15	4.81	Dry High Flow	0	0	0.5	58					0.4															310		100				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	14-Sep-15	8:53	8:25	2.9	Dry Moderate Flow	0	0	5.5	36.5					0.2															610		100				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	02-Dec-15	9:28	8:37	0.71	Dry	0	0	0	42	20	15	6.49	0.278	0.1	0.17	4.36	5.2	0.84	0.047	0.036		0.063	0.0023	0.00051	<0.0011	0.00084	<0.000053	<0.00053	54750		26130				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	19-Jan-16	11:18	17:57	0.5	Dry Flow	0	0	0	54.5	30	15.4	7.21	0.251	2	0.08	3.71	4.11	0.4	0.026	0.025		0.037	0.0028	0.0005	<0.0011	0.00078	<0.000053	<0.00053	97680		82100				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	24-May-16	11:03	9:26	15	Dry Flow	0	3	18.5	76					1.6															1100		410				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	27-Jun-16	16:20	13:08	1.25	Dry Flow	0	0	0	19					1.7															122620		61520				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	27-Apr-12	22:37	0:11	0.3	Storm Flow	6.5	9	9	9	30	12.6	6.35	0.043	9.7	0.14	0.23	0.98	0.75	0.055	0.05	<0.7	0.198	0.0062	0.0056	<0.0011	0.0021	<0.000053	0.00096			72700	0.04			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	16-Jan-14	11:28	9:02	5.45	Wet Flow	1.5	3.5	9	50.5					0.4															25820		23960				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	24-Jan-14	11:50	14:42	3.1	Wet Flow	0	1	22	28.5					2.4															40820		17240				
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	05-May-14	9:00	12:20	1.9	Storm Flow	0.5	9.5	9.5	43	30	12.5	6.18	0.044	11.2	0.01	0.05	0.94	0.89	0.131	0.047	<0.7	0.183	0.0047	0.0026	<0.0011	0.00167	<0.000053	0.0008	48700		6300	<0.01			
Kingswell	Elles Road North Drain (Manhole Elles Rd @ Ball St)	26-Jan-15	15:30	14:44	0.255	Storm Flow	3.5	9	9	21	35	18.3	6.47	0.037	9	0.11	0.01	0.83	0.82	0.055	0.032		0.132	0.006	0.0024	<0.0011	0.00193	<0.000053	0.00088	120330		6570				
Otepuni	16 Onslow Street Manhole	22-Mar-12	11:40	8:41	0.65	Dry Flow	0	0	0	36.5	50	14.9	6.94	0.287	1	0.026	1.03	1.38	0.35	0.051	0.046	<0.7	0.071	0.00181	0.00045	<0.0011	0.00179	<0.000053	0.00083			7765	0.29			
Otepuni	16 Onslow Street Manhole	23-Mar-12	10:30	9:19	0.53	Elevated E. coli Repeat Sample	0	1	1	33																				12033		2589				
Otepuni	16 Onslow Street Manhole	04-Jul-12	13:36	7:58	2.2	Dry Flow	0	0	0	34.5	65	8.9	6.53	0.245	0.6	0.03	1	1.53	0.53	0.009	0.006	<0.7	0.047	0.0031	0.00017	<0.0011	0.00186	<0.000053	0.00077	852		436	<0.01			
Otepuni	16 Onslow Street Manhole	11-Dec-12	8:25	6:33	0.67	Dry Flow	0	0	0	47	150	13.3	6.66	0.28	4.1	0.035	1.36	2.54	1.18	0.041	0.035	<0.7	0.034	0.0025	0.00023	<0.0011	0.0024	<0.000053	0.00084	3873		1935	<0.01			
Otepuni	16 Onslow Street Manhole	12-Dec-12	14:20	7:29	0.45	Elevated E. coli Repeat Sample	0	0	2	12.5																				81640		48392				
Otepuni	16 Onslow Street Manhole	14-Mar-13	11:25	10:33	0.2	Dry Flow	0	0	0	2	60	16.2	6.6	0.312	0.4	0.03	1.24	1.85	0.61	0.026	0.021	<0.7	0.03	0.00134	0.00021	<0.0011	0.00199	<0.000053	0.00072	15000		6910	<0.01			
Otepuni	16 Onslow Street Manhole	15-Mar-13	12:55	11:16	0.19	Elevated E. coli Repeat Sample	0	0.5	0.5	2																				5794		907				
Otepuni	16 Onslow Street Manhole	21-Aug-13	10:15	7:39	1.5	Dry Flow	0	0	0	32	40	9.5	6.33	0.255	0.3	0.02	0.86	1.24	0.38	0.008	0.003	<0.7	0.028	0.0026	0.00012	<0.0011	0.00196	<0.000053	0.00081	488		63	<0.01			
Otepuni	16 Onslow Street Manhole	19-Nov-13	8:50	9:48	0.54	Dry Flow	0	0	0	9.5	120	12.8	6.54	0.284	1.3	0.02	1.04	1.58	0.54	0.03	0.022	<0.7	0.051	0.00176	0.00052	<0.0011	0.0028	<0.000053	0.00101	3232		1772	<0.01			
Otepuni	16 Onslow Street Manhole	11-Feb-14	8:45	6:32	0.1	Dry Flow	0	0	0	1	60	16	6.69	0.297	2.7	0.06	1.35	1.76	0.41	0.033	0.018	<0.7	0.032	0.0021	0.00034	<0.0011	0.0025	<0.000053	0.00094	3500	950	940	<0.01			
Otepuni	16 Onslow Street Manhole	11-Sep-14	8:40	9:15	0.66	Dry Flow	0	0	0	5.5	80	11	6.48	0.273	1.9	0.07	0.58	0.76	0.18	0.057	0.021		0.079	0.00139	0.00029	<0.0011	0.00111	<0.000053	0.00075	315		5				
Otepuni	16 Onslow Street Manhole	25-Jun-15	9:10	14:31	5.7	Dry Flow	0	0	0	33	75	8.4	6.23	0.252	0.4	0.05	1.1	2.16	1.06	0.031	0.011		0.03	0.0027	0.0004	<0.0011	0.0021	<0.000053	0.00074	279		148				
Otepuni	16 Onslow Street Manhole	28-Aug-15	11:49	6:15	4.81	Dry High Flow	0	0	0.5	58					0.8															720		50				
Otepuni	16 Onslow Street Manhole	09-Sep-15	14:58	17:21	4.6	Dry Moderate Flow	0	0	2.5	46					1.6															933		256				
Otepuni	16 Onslow Street Manhole	19-Jan-16	10:23	17:57	0.5	Dry Flow	0	0	0	54.5	80	15	6.64	0.294	4	0.03	2.14	3.42	1.28	0.045	0.035		0.036	0.002	0.00041	<0.0011	0.0023	<0.000053	0.00074	3744		498				
Otepuni	16 Onslow Street Manhole	04-May-16	9:35	5:20	1.32	Dry Flow	0	0	0	11.5	50	13	6.5	0.242	0.8	0.03	0.71	1.56	0.85	0.019	0.012		0.027	0.0015	<0.0001	0.00035	0.00019	<0.00005	0.00091	1618		240				
Otepuni	16 Onslow Street Manhole	24-May-16	10:39	9:26	15	Dry Flow	0	3	18.5	76					2.8															310		100				
Otepuni	16 Onslow Street Manhole	27-Jun-16	14:15	13:08	1.25	Dry Flow	0	0	0	19					2.4															682		148				
Otepuni	16 Onslow Street Manhole	27-Apr-12	23:28	0:11	0.3	Storm Flow	6.5	10	10	10	100	11.5	6.26	0.048	2.9	0.08	0.12	0.73	0.61	0.238	0.216	<0.7	0.184	0.0024	0.0021	0.0012	0.00125	<0.000053	<0.00053	99315		34335	<0.01			
Otepuni	16 Onslow Street Manhole	16-Jan-14	10:17	9:02	5.45	Wet Flow	0	3.5	9	50.5					0.4															5630		550				
Otepuni	16 Onslow Street Manhole	24-Jan-14	13:35	14:42	3	Wet Flow	0	0	22	28.5					1.2															10344		3578				
Otepuni	16 Onslow Street Manhole	16-Apr-14	10:13	9:27	0.6	Storm Flow	0.5	20	20	27.5	130	13.5	6.55	0.252	6.9	0.16	2.04	3.03	0.99	0.088	0.043	<0.7	0.24	0.0034	0.00133	0.0013	0.00189	<0.000053	0.00117	866400		64480	0.02			
Otepuni	16 Onslow Street Manhole	26-Jan-15	13:00	14:44	0.255	Storm Flow	5	5	5	18	55	18	6.63	0.113	95	0.04	0.69	2.21	1.52	0.06	0.014		0.42	0.0151	0.02	0.0105	0.0051	0.000093	0.0033	2300		840				
Otepuni	34 Onslow Street Manhole	22-Mar-12	11:45	8:41	0.65	Dry Flow	0	0	0	36.5	60	14.2	7.37	0.234	1.3	0.016	1.18	1.75	0.57	0.027	0.017	<0.7	0.088	0.0028	0.00036	<0.0011	0.00139	<0.000053	0.00097	2897		968	0.12			
Otepuni	34 Onslow Street Manhole	04-Jul-12	13:40	7:58	2.2	Dry Flow	0	0	0	34.5	55	8	6.22	0.239	1.5	0.07	1.5	2.04	0.54	0.024	0.006	<0.7	0.059	0.0032	0.00031	<0.0011	0.0011	<0.000053	0.00092	754		31	<0.01			
Otepuni	34 Onslow Street Manhole	11-Dec-12	8:25	6:33	0.67	Dry Flow	0	0	0	47	70	13	6.59	0.24	4.2	0.07	1.91	2.88	0.97	0.032	0.025	<0.7	0.049	0.003	0.00035	<0.0011	0.0027	<0.000053	0.00082	9208		464	0.01			
Otepuni	34 Onslow Street Manhole	14-Mar-13	11:20	10:33	0.2	Dry Flow	0	0	0	2	40	16.7	6.58	0.224	0.6	0.02	1.06	1.39	0.33	0.024	0.01	<0.7	0.064	0.0028	0.00035	<0.0011	0.00099	<0.000053	0.00068	1650		52	0.01			
Otepuni	34 Onslow Street Manhole	21-Aug-13	10:05	7:39	1.5	Dry Flow	0	0	0	32	50	9.6	6.35	0.232	2.1	0.04	1.66	2.15	0.49	0.004	0.002	<0.7	0.031	0.0023	0.00031	<0.0011	0.00124	<0.000053	0.00102	1565		987	<0.01			
Otepuni	34 Onslow Street Manhole	19-Nov-13	8:40	9:48	0.54	Dry Flow	0	0	0	9.5	80	13.5	6.36	0.226	0.9	0.05	1.56	1.96	0.4	0.064	0.018	<0.7	0.041	0.002	0.00051	<0.0011	0.00121	<0.000053	0.00068	6896		1022	<0.01			
Otepuni	34 Onslow Street Manhole	11-Feb-14	8:49	6:32	0.1	Dry Flow	0	0	0	1	50	16	6.54	0.188	3.2	0.05	1.01	1.28	0.27	0.042	0.029	<0.7	0.046	0.0037	0.0006	<0.0011	0.0012	<0.000053	0.00082	1000	120	120	<0.01			
Otepuni	34 Onslow Street Manhole	11-Sep-14	8:35	9:15	0.66	Dry Flow	0	0	0	5.5	90	10.5	6.48	0.242	2.3	0.04	0.52	0.71	0.19	0.048	0.016		0.061	0.00182	0.00025	<0.0011	0.00129	<0.000053	0.00086	550		155				
Otepuni	34 Onslow Street Manhole	25-Jun-15	9:00	14:31	5.7	Dry Flow	0	0	0	33	70	8	6.26	0.244	2.2	0.07	2.15	3.25	1.1	0.082	0.019		0.029	0.0052	0.00128	<0.0011	0.00143	<0.000053	0.00104	697		10				
Otepuni	34 Onslow Street Manhole	28-Aug-15	11:47	6:15	4.81	Dry High Flow	0	0	0.5	58					1.6															50		50				
Otepuni	34 Onslow Street Manhole	09-Sep-15	14:55	17:21	4.6	Dry Moderate Flow	0	0	2.5	46					1.6															301		30				
Otepuni	34 Onslow Street Manhole	19-Jan-16	10:08	17:57	0.5	Dry Flow	0	0	0	54.5	50	15.3	6.6	0.248	4.8	0.02	2.8	3.48	0.68	0.032	0.027		0.054	0.0025	0.00039	<0.0011	0.00143	<0.000053	0.00078	2108		62				
Otepuni	34 Onslow Street Manhole	04-May-16	9:27	5:20	1.32	Dry Flow	0	0	0	11.5	60	13	6.52	0.268	2.6	0.05	1.1	2.03	0.93	0.03	0.014		0.027	0.0017	0.0002	0.00038	0.001	<0.00005	0.001	1866		104				
Otepuni	34 Onslow Street Manhole	24-May-16	10:42	9:26	15	Dry Flow	0	3	18.5	76					1															1414		140				
Otepuni	34 Onslow Street Manhole	27-Jun-16	14:20	13:08	1.25	Dry Flow	0	0	0	19					2.3															196		10				
Otepuni	34 Onslow Street Manhole	27-Apr-12	23:11	0:11	0.3	Storm Flow	6.5	10	10	10	40	12.5	6.09	0.048	2.7	0.09	0.18	0.69	0.51	0.355	0.282	<0.7	0.2	0.00196	0.0021	<0.0011	0.00105	<0.000053	<0.00053	99315		2825	<0.01			
Otepuni	34 Onslow Street Manhole	16-Jan-14	10:14	9:02	5.45	Wet Flow	0	3.5	9	50.5					0.4															7308		808				
Otepuni	34 Onslow Street Manhole	24-Jan-14	13:32	14:42	3	Wet Flow	0	0	22	28.5					1.6															5226		1040				
Otepuni	34 Onslow Street Manhole	16-Apr-14	10:18	9:27	0.6	Storm Flow	0.5	20	20	27.5	90	13	6.35	0.206	4.1	0.05	1.66	2.48	0.82	0.083	0.03	<0.7	0.175	0.0039	0.001	<0.0011	0.00136	<0.000053	0.00123	17270		6770	<0.01			
Otepuni	34 Onslow Street Manhole	26-Jan-15	12:55	14:44	0.255	Storm Flow	5	5	5	18	45	17.6	6.45	0.072	61	0.15	0.89	1.96	1.07	0.107	0.047		0.36	0.0108	0.0145	0.0024	0.006	0.000087	0.0029	46500		4196				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	22-Mar-12	11:15	8:41	0.65	Dry Flow	0	0	0	36.5	15	15.4	6.99	0.271	0.5	1.458	4.29	5.88	1.59	0.29	0.233	<0.7	0.167	0.0043	0.0007	<0.0011	<0.00053	<0.000053	<0.00053	118700		75900	8.6			
Otepuni	Camden Street Drain (Intersection Camden and Islington)	23-Mar-12	16:00	21:40	0.53	Elevated E. coli Repeat Sample	0	1	1	33																				56500		23300				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	04-Jul-12	11:15	7:58	2.2	Dry Flow	0	0	0	34.5	25	9.8	6.69	0.274	0.3	0.54	5.92	7.01	1.09	0.066	0.061	<0.7	0.154	0.0033	0.00047	<0.0011	<0.00053	0.000065	<0.00053	36540		17250	0.02			
Otepuni	Camden Street Drain (Intersection Camden and Islington)	05-Jul-12	14:45	8:49	1.7	Elevated E. coli Repeat Sample	0	0	0	31.5																				33600		16900				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	11-Dec-12	9:00	6:33	0.67	Dry Flow	0	0	0	47	15	13.4	6.82	0.225	0.8	1.382	5.46	8.1	2.64	0.274	0.262	<0.7	0.068	0.0035	0.00042	<0.0011	0.00053	<0.000053	<0.00053	38700		5500	0.12			
Otepuni	Camden Street Drain (Intersection Camden and Islington)	12-Dec-12	14:30	7:29	0.45	Elevated E. coli Repeat Sample	0	0	2	12.5																				50180		5240				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	14-Mar-13	11:35	10:33	0.2	Dry Flow	0	0	0	2	20	16.6	6.75	0.21	1.6	0.34	3.62	3.73	0.11	0.304	0.264	<0.7	0.15	0.0065	0.0021	<0.0011	0.00113	<0.000053	<0.00053	305000		86000	0.71			

Discharge Results 2012 to July 2016

31/08/2016

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Flow	Sampling Event	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Suspended Solids	Ammonia	Nitrate	Total Nitrogen	Total Kjeldahl Nitrogen	Total Phosphorus	Dissolved Reactive Phosphorus	Total Petroleum Hydrocarbons	Total Zinc	Total Copper	Total Lead	Total Arsenic	Total Nickel	Total Cadmium	Total Chromium	Total Coliform	Faecal Coliform	Escherichia coli	FWA microgram/litre	Calcium	Alkalinity	Comment
1	1	1				1	mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	CFU/100ml	MPN/100ml		mg/l	mg/l as CaCO3	
Otepuni	Camden Street Drain (Intersection Camden and Islington)	15-Mar-13	13:20	11:16	0.19	Elevated E. coli Repeat Sample	0	0.5	0.5	2																				46200		17200				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	21-Aug-13	11:30	7:39	1.5	Dry Flow	0	0	0	32	10	10.5	6.8	0.254	0.5	0.37	6.22	6.8	0.58	0.108	0.082	<0.7	0.073	0.0028	0.00037	<0.0011	0.00075	<0.000053	<0.00053	249670		14930	0.02			
Otepuni	Camden Street Drain (Intersection Camden and Islington)	19-Nov-13	9:10	9:48	0.54	Dry Flow	0	0	0	9.5	10	13.1	6.86	0.284	0.1	1.07	4.55	5.8	1.25	0.392	0.33	<0.7	0.067	0.0032	0.00054	<0.0011	0.00068	<0.000053	<0.00053	17300		4100	0.13			Repeat Sampling due to E.coli >1000 4/7/12
Otepuni	Camden Street Drain (Intersection Camden and Islington)	11-Feb-14	8:57	6:32	0.1	Dry Flow	0	0	0	1	10	15.9	6.84	0.186	2.1	0.66	4.38	5.19	0.81	0.26	0.211	<0.7	0.054	0.0026	0.00056	<0.0011	0.00081	<0.000053	<0.00053	137340	14750	13600	0.19			
Otepuni	Camden Street Drain (Intersection Camden and Islington)	11-Sep-14	9:00	9:15	0.66	Dry Flow	0	0	0	5.5	5	11.2	6.67	0.229	1.7	0.24	5.41	7.68	2.27	0.153	0.11		0.086	0.0036	0.00051	<0.0011	0.00066	<0.000053	<0.00053	204360		153700				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	25-Jun-15	9:25	14:31	5.7	Dry Flow	0	0	0	33	10	9.8	6.52	0.285	0.3	0.02	5.56	6.6	1.04	0.085	0.062		0.069	0.0026	0.00035	<0.0011	0.00064	<0.000053	<0.00053	2420		3282				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	28-Aug-15	11:59	6:15	4.81	Dry High Flow	0	0	0.5	58					1.2															1610		200				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	09-Sep-15	16:00	17:21	4.6	Dry Moderate Flow	0	0	2.5	46					0.2															12262		6152				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	19-Jan-16	10:35	17:57	0.5	Dry Flow	0	0	0	54.5	40	15.3	6.32	0.238	1.6	0.76	5.17	6.69	1.52	0.215	0.193		0.051	0.0031	0.00065	<0.0011	0.00172	<0.000053	<0.00053	173287		14140				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	04-May-16	9:55	5:20	1.32	Dry Flow	0	0	0	11.5	10	14.3	6.8	0.284	2	2.95	3.25	8.5	5.25	0.481	0.408		0.054	0.0037	0.00048	0.00036	0.0006	<0.00005	0.00076	3000000		1300000				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	24-May-16	10:32	9:26	15	Dry Flow	0	3	18.5	76					2															5940		3090				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	27-Jun-16	14:09	13:08	1.25	Dry Flow	0	0	0	19					3.3															154020		103440				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	27-Apr-12	23:54	0:11	0.3	Storm Flow	6.5	10	10	10	55	12.7	6.33	0.063	1.5	0.11	0.52	1.03	0.51	0.07	0.053	<0.7	0.27	0.004	0.00191	<0.0011	0.00064	<0.000053	<0.00053	111990		8800	0.08			
Otepuni	Camden Street Drain (Intersection Camden and Islington)	16-Jan-14	11:38	9:02	5.45	Wet Flow	0	3.5	9	50.5					0.4															14010		2650				Repeat Sampling due to E.coli >1000 22/11/12
Otepuni	Camden Street Drain (Intersection Camden and Islington)	24-Jan-14	13:44	14:42	3	Wet Flow	0	0	22	28.5					1.2															173280		1552				
Otepuni	Camden Street Drain (Intersection Camden and Islington)	16-Apr-14	10:32	9:27	0.6	Storm Flow	0.5	20	20	27.5	15	13.6	6.53	0.113	3.2	0.13	1.01	1.44	0.43	0.103	0.099	<0.7	0.4	0.0033	0.003	<0.0011	0.00089	<0.000053	<0.00053	83900		3100	0.06			
Otepuni	Camden Street Drain (Intersection Camden and Islington)	26-Jan-15	13:20	14:44	0.255	Storm Flow	5	5	5	18	60	17.5	6.35	0.033	20	0.14	0.35	1.91	1.56	0.107	0.064		0.24	0.003	0.0069	<0.0011	0.00172	<0.000053	0.00108	4960		200				
Otepuni	Leven Street Bridge North West Drain	22-Mar-12	8:55	8:41	0.65	Dry Flow	0	0	0	36.5	10	14.6	6.88	0.33	0.8	0.151	3.46	3.7	0.24	0.05	0.034	<0.7	0.09	0.003	0.00098	<0.0011	0.00132	<0.000053	<0.00053	17329		1354	0.15			
Otepuni	Leven Street Bridge North West Drain	23-Mar-12	10:00	9:19	0.53	Elevated E. coli Repeat Sample	0	1	1	33																						3244				
Otepuni	Leven Street Bridge North West Drain	04-Jul-12	8:47	7:58	2.2	Dry Flow	0	0	0	34.5	25	10	6.46	0.315	0.1	0.23	4.82	5.34	0.52	0.042	0.028	<0.7	0.074	0.0022	0.00082	<0.0011	0.00135	<0.000053	<0.00053			1483	0.01			
Otepuni	Leven Street Bridge North West Drain	05-Jul-12	8:49	8:49	1.8	Elevated E. coli Repeat Sample	0	0	0	31.5																				13734		1114				
Otepuni	Leven Street Bridge North West Drain	11-Dec-12	9:20	6:33	0.67	Dry Flow	0	0	0	47	20	14	6.59	0.284	1	0.14	4.18	4.67	49	0.063	0.064	<0.7	0.064	0.0058	0.00121	<0.0011	0.00129	<0.000053	<0.00053	61310		17850	0.01			
Otepuni	Leven Street Bridge North West Drain	12-Dec-12	10:15	7:29	0.45	Elevated E. coli Repeat Sample	0	0	2	12.5																				20100		1050				
Otepuni	Leven Street Bridge North West Drain	14-Mar-13	11:55	10:33	0.2	Dry Flow	0	0	0	2	10	17	6.57	0.436	1.4	0.49	3.4	3.48	0.08	0.129	0.084	<0.7	0.058	0.0049	0.0021	<0.0011	0.00148	<0.000053	<0.00053	17330		6510	0.04			
Otepuni	Leven Street Bridge North West Drain	15-Mar-13	13:30	11:16	0.19	Elevated E. coli Repeat Sample	0	0.5	0.5	2																				13775		7650				
Otepuni	Leven Street Bridge North West Drain	21-Aug-13	7:40	7:39	1.5	Dry Flow	0	0	0	32	80	11.8	6.53	0.448	1.2	0.13	2.62	3.04	0.42	0.089	0.036	<0.7	0.061	0.00192	0.00058	<0.0011	0.00122	<0.000053	<0.00053	1040		220	0.03			
Otepuni	Leven Street Bridge North West Drain	19-Nov-13	9:20	9:48	0.54	Dry Flow	0	0	0	9.5	10	14	6.55	0.301	1.9	0.13	3.69	4.67	0.98	0.094	0.046	<0.7	0.053	0.0025	0.00085	<0.0011	0.00096	<0.000053	<0.00053	5380		310	0.01			
Otepuni	Leven Street Bridge North West Drain	11-Feb-14	8:22	6:32	0.1	Dry Flow	0	0	0	1	10	16.1	6.52	0.35	1	0.09	4.15	4.47	0.32	0.068	0.015	<0.7	0.04	0.0022	0.00072	<0.0011	0.00114	<0.000053	<0.00053	21400	850	830	0.01			
Otepuni	Leven Street Bridge North West Drain	11-Sep-14	9:10	9:15	0.66	Dry Flow	0	0	0	5.5	5	12	6.45	0.371	2.8	0.06	2.84	3.21	0.37	0.083	0.033		0.061	0.0031	0.00096	<0.0011	0.00129	<0.000053	<0.00053	8704		80				
Otepuni	Leven Street Bridge North West Drain	25-Jun-15	14:20	14:31	5.7	Dry Flow	0	0	0	33	15	10.9	6.49	0.292	0.2	0.5	4.28	6.93	2.65	0.102	0.067		0.083	0.0034	0.0021	<0.0011	0.00154	<0.000053	<0.00053	69000		37000				
Otepuni	Leven Street Bridge North West Drain	28-Aug-15	8:55	6:15	4.81	Dry High Flow	0	0	0.5	58					0															8120		260				
Otepuni	Leven Street Bridge North West Drain	09-Sep-15	16:15	17:21	4.6	Dry Moderate Flow	0	0	2.5	46					1.6															15390		1870				
Otepuni	Leven Street Bridge North West Drain	19-Jan-16	15:50	17:57	0.5	Dry Flow	0	0	0	54.5	70	15.1	6.57	0.415	5.2	0.01	3.49	4.64	1.15	0.183	0.104		0.072	0.0167	0.0032	<0.0011	0.00186	0.000057	<0.00053	38505		8615				
Otepuni	Leven Street Bridge North West Drain	04-May-16	8:49	5:20	1.32	Dry Flow	0	0	0	11.5	20	15.5	6.64	0.291	1.4	0.11	2.45	2.76	0.31	0.039	0.014		0.05	0.0018	0.0008	0.00014	0.001	<0.00005	<0.0005	12960		630				
Otepuni	Leven Street Bridge North West Drain	24-May-16	10:10	9:26	15	Dry Flow	0	3	18.5	76					2															3350		3820				
Otepuni	Leven Street Bridge North West Drain	27-Jun-16	14:00	13:08	1.25	Dry Flow	0	0	0	19					1.6															36540		740				
Otepuni	Leven Street Bridge North West Drain	28-Apr-12	0:25	0:11	0.3	Storm Flow	6.5	10	10	10	30	13.1	6.35	0.214	1.5	0.12	1.29	1.81	0.52	0.066	0.029	<0.7	0.29	0.0078	0.00157	<0.0011	0.00187	<0.000053	<0.00053	41060		5760	0.07			
Otepuni	Leven Street Bridge North West Drain	16-Jan-14	10:29	9:02	5.45	Wet Flow	0	3.5	9	50.5					1.2															16328		2548				
Otepuni	Leven Street Bridge North West Drain	24-Jan-14	13:54	14:42	3	Wet Flow	0	0	22	28.5					2															90767		32900				
Otepuni	Leven Street Bridge North West Drain	16-Apr-14	8:42	9:27	0.6	Storm Flow	0.5	20	20	27.5	10	14	6.49	0.174	1.2	0.07	1.91	2.42	0.51	0.06	0.032	<0.7	0.25	0.0048	0.00145	<0.0011	0.00136	<0.000053	<0.00053	13820		600	<0.01			
Otepuni	Leven Street Bridge North West Drain	26-Jan-15	13:35	14:44	0.255	Storm Flow	5	5	5	18	70	17.5	6.53	0.038	34.4	0.14	0.24	1.09	0.85	0.031	0.058		0.32	0.0188	0.0111	<0.0011	0.0089	0.00008	0.0024	14545		5085				
Otepuni	Lindisfarne Street Bridge (South West Drain)	22-Mar-12	11:30	8:41	0.65	Dry Flow	0	0	0	36.5	50	15.4	7.32	0.287	0.6	0.362	2.44	3.39	0.95	0.084	0.053	<0.7	0.124	0.0094	0.00112	<0.0011	0.0015	<0.000053	0.00109	34657		828	4.3			
Otepuni	Lindisfarne Street Bridge (South West Drain)	04-Jul-12	11:23	7:58	2.2	Dry Flow	0	0	0	34.5	70	9.5	6.78	0.337	1.3	0.28	2.67	3.99	1.32	0.087	0.056	<0.7	0.11	0.006	0.00062	<0.0011	0.00138	<0.000053	0.00089	17329		2481	0.08			
Otepuni	Lindisfarne Street Bridge (South West Drain)	05-Jul-12	9:00	8:49	1.8	Elevated E. coli Repeat Sample	0	0	0	31.5																				22397		1720				
Otepuni	Lindisfarne Street Bridge (South West Drain)	11-Dec-12	8:45	6:33	0.67	Dry Flow	0	0	0	47	150	14.1	7.19	0.274	1.9	0.113	2.08	2.73	0.65	0.054	0.045	<0.7	0.069	0.0037	0.00052	<0.0011	0.00169	<0.000053	0.00084	4430		740	0.1			
Otepuni	Lindisfarne Street Bridge (South West Drain)	14-Mar-13	10:45	10:33	0.2	Dry Flow	0	0	0	2	30	16.5	7.13	0.269	1.4	0.15	2.64	3.07	0.43	0.093	0.07	<0.7	0.061	0.0025	0.00049	<0.0011	0.00154	<0.000053	0.00058	9220		2092	0.24			
Otepuni	Lindisfarne Street Bridge (South West Drain)	15-Mar-13	13:10	11:16	0.19	Elevated E. coli Repeat Sample	0	0.5	0.5	2																				10460		180				
Otepuni	Lindisfarne Street Bridge (South West Drain)	21-Aug-13	7:30	7:39	1.5	Dry Flow	0	0	0	32	20	10.5	6.79	0.292	0.9	0.09	2.58	3.04	0.46	0.023	0.021	<0.7	0.082	0.0041	0.0006	<0.0011	0.00139	<0.000053	0.00111	5510		942	0.02			
Otepuni	Lindisfarne Street Bridge (South West Drain)	19-Nov-13	9:00	9:48	0.54	Dry Flow	0	0	0	9.5	40	13.2	7.07	0.258	0.6	0.1	1.96	2.48	0.52	0.047	0.038	<0.7	0.063	0.003	0.00058	<0.0011	0.00151	<0.000053	0.00093	6896		914	<0.01			
Otepuni	Lindisfarne Street Bridge (South West Drain)	11-Feb-14	8:30	6:32	0.1	Dry Flow	0	0	0	1	30	16	6.61	0.245	1.9	0.13	1.29	2.54	1.25	0.07	0.034	<0.7	0.054	0.0037	0.00086	<0.0011	0.00182	<0.000053	0.00087	8100	2100	2050	0.06			
Otepuni	Lindisfarne Street Bridge (South West Drain)	11-Sep-14	8:52	9:15	0.66	Dry Flow	0	0	0	5.5	40	10.5	6.82	0.265	1.1	0.2	2.46	3.16	0.7	0.044	0.023		0.08	0.0029	0.00041	<0.0011	0.0014	<0.000053	0.00079	15380		2320				
Otepuni	Lindisfarne Street Bridge (South West Drain)	25-Jun-15	9:20	14:31	5.7	Dry Flow	0	0	0	33	60	9.4	6.86	0.328	0.3	0.24	3.55	4.94	1.39	0.054	0.026		0.076	0.0046	0.00069	<0.0011	0.00121	<0.000053	0.00079	11199		3654				
Otepuni	Lindisfarne Street Bridge (South West Drain)	28-Aug-15	9:07	6:15	4.81	Dry High Flow	0	0	0.5	58					5.6															5630		660				
Otepuni	Lindisfarne Street Bridge (South West Drain)	09-Sep-15	15:03	17:21	4.6	Dry Moderate Flow	0	0	2.5	46					1.2															17329		1785				
Otepuni	Lindisfarne Street Bridge (South West Drain)	19-Jan-16	10:29	17:57	0.5	Dry Flow	0	0	0	54.5	50	15.4	7.01	0.284	1.2	0.32	3.02	3.87	0.85	0.079	0.07		0.076	0.0038	0.00072	<0.0011	0.0018	<0.000053	0.00091	43320		11910				
Otepuni	Lindisfarne Street Bridge (South West Drain)	04-May-16	9:50	5:20	1.32	Dry Flow	0	0	0	11.5	50	14.3	7.03	0.307	1.2	0.18	2	4.05	2.05	0.052	0.021		0.058	0.0036	0.00047	0.00052	0.00013	<0.00005	0.0011	43320		10395				
Otepuni	Lindisfarne Street Bridge (South West Drain)	24-May-16	10:35	9:26	15	Dry Flow	0	3	18.5	76					0.5															10000		2419				
Otepuni	Lindisfarne Street Bridge (South West Drain)	27-Jun-16	14:12	13:08	1.25	Dry Flow	0	0	0	19					0.6															14545		2735				
Otepuni	Lindisfarne Street Bridge (South West Drain)	27-Apr-12	23:36	0:11	0.3	Storm Flow	6.5	10	10	10	75	13.1	6.8	0.067	3.9	0.08	0.39	0.92	0.53	0.079	0.069	<0.7	0.42	0.005	0.0032	<0.0011	0.00087	<0.000053	<0.00053	120980		4410	0.03			
Otepuni	Lindisfarne Street Bridge (South West Drain)	16-Jan-14	10:20	9:02	5.45	Wet Flow	0	3.5	9	50.5					0.4															25994		3450				
Otepuni	Lindisfarne Street Bridge (South West Drain)	24-Jan-14	13:40	14:42	3	Wet Flow	0	0	22	28.5					2.4															104620		51720				
Otepuni	Lindisfarne Street Bridge (South West Drain)	16-Apr-14	10:28	9:27	0.6	Storm Flow	0.5	20	20	27.5	45	13.9	6.47	0.176	6.6	0.16	0.57	1.19	0.62	0.079	0.048	<0.7	0.35	0.0059	0.0027	<0.0011	0.00154	0.000062	0.00199	21430		9850	0.03			
Otepuni	Lindisfarne Street Bridge (South West Drain)	26-Jan-15	13:10	14:44	0.255	Storm Flow	5	5	5	18	45	17.5	6.39	0.056	29	0.02	0.2	1.56	1.36	0.068	0.053		0.25	0.0119	0.0066	0.0013	0.002	0.000061	0.00143	9530		2160				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	22-Mar-12	11:05	8:41	0.65	Dry Flow	0	0	0	36.5	80	16	6.71	0.35	1.6	0.438	1.85	2.4	0.55	0.055	0.053	<0.7	0.186	0.0046	0.0025	0.0012	0.0057	<0.000053	0.00174	12095		479	1.34			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	04-Jul-12	9:00	7:58	2.2	Dry Flow	0	0	0	34.5	120	9	6.19	0.349	20.5	0.4	2.65	3.67	1.02	0.024	0.019	<0.7	0.092	0.006	0.00072	<0.0011	0.0053	<0.000053	0.00091	573		86	<0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	11-Dec-12	9:10	6:33	0.67	Dry Flow	0	0	0	47	200	14.9	6.44	0.375	3.7	0.421	3.19	4.18	0.99	0.043	0.057	<0.7	0.036	0.0047	0.00033	<0.0011	0.0047	<0.000053	0.00134	3076		780	0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	14-Mar-13	11:45	10:33	0.2	Dry Flow	0	0	0	2	40	18.1	6.35	0.278	0.9	0.21	2.04	2.17	0.13	0.028	0.016	<0.7	0.038	0.0042	0.00032	<0.0011	0.00198	<0.000053	0.00101	341		31	<0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	21-Aug-13	11:05	7:39	1.5	Dry Flow	0	0	0	32	5	10.8	6.27	0.319	2	0.25	4.75	5.08	0.33	0.032	0.012	<0.7	0.044	0.0029	0.00024	<0.0011	0.0028	<0.000053	0.00112	842		110	<0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	19-Nov-13	10:40	9:48	0.54	Dry Flow	0	0	0	9.5	100	13.6	6.32	0.319	0.5	0.22	3.22	3.75	0.53	0.032	0.032	<0.7	0.021	0.0037	0.0004	<0.0011	0.003	<0.000053	0.0026	556		106	<0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	11-Feb-14	9:09	6:32	0.1	Dry Flow	0	0	0	1	40	18	6.41	0.288	2.8	0.29	2.75	3.25	0.5	0.024	0.003	<0.7	0.0193	0.0064	0.00028	<0.0011	0.00029	<0.000053	0.00121	512	2	2	<0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	11-Sep-14	11:00	9:15	0.66	Dry Flow	0	0	0	5.5	100	11.9	6.43	0.31	1.3	0.42	2.67	3.1	0.43	0.018	0.017		0.036	0.0039	0.00033	<0.0011	0.0031	<0.000053	0.00108	317		10				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	25-Jun-15	9:35	14:31	5.7	Dry Flow	0	0	0	33	70	9.4	6.21	0.292	0.9	0.27	3.89	5.54	1.65	0.025	0.017		0.043	0.0035	0.00074	<0.0011	0.00179	<0.000053	0.00092	884		345				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	28-Aug-15	12:02	6:15	4.81	Dry High Flow	0	0	0.5	58					10.8															630		100				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	09-Sep-15	16:10	17:21	4.6	Dry Moderate Flow	0	0	2.5	46					18															538		10				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	19-Jan-16	10:42	17:57	0.5	Dry Flow	0	0	0	54.5	100	16.3	6.42	0.322	6.4	0.2	3	6.14	3.14	0.063	0.043		0.028	0.0088	0.00064	<0.0011	0.0029	<0.000053	0.00111	7746		614				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	04-May-16	10:05	5:20	1.32	Dry Flow	0	0	0	11.5	80	14.5	6.44	0.301	3.4	0.26	2.61	3.83	1.22	0.03	0.023		0.024	0.0025	0.00031	0.00046	0.0017	<0.00005	0.0012	3300		63				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	24-May-16	10:15	9:26	15	Dry Flow	0	3	18.5	76					89															2419		49				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	27-Jun-16	16:15	13:08	1.25	Dry Flow	0	0	0	19					1.6															2098		402				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	28-Apr-12	0:01	0:11	0.3	Storm Flow	6.5	10	10	10	100	13.2	6.21	0.135	2	0.15	0.77	1.39	0.62	0.037	0.013	<0.7	0.3	0.0034	0.0023	<0.0011	0.0026	<0.000053	0.00064	5765		545	<0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	16-Jan-14	11:44	9:02	5.45	Wet Flow	0	3.5	9	50.5					0.4															1040		82				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	24-Jan-14	13:50	14:42	3	Wet Flow	0	0	22	28.5					6.8															9804		3076				
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	16-Apr-14	10:40	9:27	0.6	Storm Flow	0.5	20	20	27.5	30	14	6.4	0.161	3.7	0.16	1.09	1.66	0.57	0.045	0.03	<0.7	0.69	0.003	0.00152	<0.0011	0.0023	<0.000053	0.00064	117200		860	<0.01			
Otepuni	Ythan Street Drain (Intersection Eye Street North West Corner)	26-Jan-15	13:30	14:44	0.255	Storm Flow	5	5	5	18	85	17.6	6.49	0.032	20.8	0.11	0.24	0.96	0.72	0.031	0.042		0.27	0.0077	0.0047	<0.0011	0.0052	0.000055	0.00135	5990		315				
Waihopai	126 Gladstone Terrace (Manhole Behind)	22-Mar-12	11:00	8:41	0.65	Dry Flow	0	0	0	28.5	30	15.5	6.18	0.286	3.6	0.001	3.23	3.33	0.1	0.013	0.017	<0.7	0.179	0.0021	0.0009	<0.0011	0.00151	<0.000053	<0.00053	2586		1124	0.09			
Waihopai	126 Gladstone Terrace (Manhole Behind)	23-Mar-12	10:15	9:19	0.53	Elevated E. coli Repeat Sample	0	0.5	0.5	26																				3130		100				
Waihopai	126 Gladstone Terrace (Manhole Behind)	04-Jul-12	10:40	7:58	2.2	Dry Flow	0	0	0	42	20	9.9	5.73	0.267	0.1	0.01	3.64	3.86	0.22	0.006	0.008	<0.7	0.021	0.048	0.0054	<0.0011	0.0016	0.000101	<0.00053	31		0	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	11-Dec-12	9:15	6:33	0.67	Dry Flow	0	0	0	45.5	10	14.2	6.14	0.274	0.5	0.019	5.207	5.35	0.14	0.05	0.015	<0.7	0.0116	0.0019	0.33315	<0.0011	0.00119	<0.000053	<0.00053	231		20	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	12-Mar-13	9:35	9:06	0.16	Dry Flow	0	0	0	4	10	15.5	5.9	0.268	0.1	0.01	3.45	3.76	0.31	0.011	0.01	<0.7	0.0138	0.0013	0.00091	<0.0011	0.0011	<0.000053	<0.00053	548		4	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	21-Aug-13	10:55	7:39	1.5	Dry Flow	0	0	0	23.5	10	10.6	5.81	0.276	0.6	0.01	4.81	5.1	0.21	0.005	0.003	<0.7	0.0128	0.0025	0.00019	<0.0011	0.00148	<0.000053	0.00054	344		0	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	19-Nov-13	10:25	9:48	0.54	Dry Flow	0	0	0	3	5	15	5.98	0.274	0.2	0.01	4.14	4.54	0.4	0.024	0.019	<0.7	0.0151	0.0055	0.00059	<0.0011	0.00137	<0.000053	<0.00053	1046		10	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	10-Feb-14	10:45	5:41	0.11	Dry Flow	0	0	0	1	10	17.3	6.16	0.255	0.4	0.01	4.1	4.36	0.26	0.009	0.002	<0.7	0.0092	0.0026	<0.00011	<0.0011	0.00122	<0.000053	<0.00053	1800	440	390	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	11-Sep-14	9:25	9:15	0.66	Dry Flow	0	0	0	7	5	11.3	5.91	0.27	0.2	0.03	3.59	4.52	0.93	0.002	0.002		0.0122	0.0011	<0.00011	<0.0011	0.00122	<0.000053	<0.00053	67		26				
Waihopai	126 Gladstone Terrace (Manhole Behind)	25-Jun-15	14:10	14:31	5.7	Dry Flow	0	0	0	33.5	10	10.6	6.09	0.252	0.5	0.001	4.21	4.85	0.64	0.017	0.005		0.0184	0.00101	0.00014	<0.0011	0.0013	<0.000053	<0.00053	345		4				
Waihopai	126 Gladstone Terrace (Manhole Behind)	28-Aug-15	9:20	6:15	4.81	Dry High Flow	0	0	0.5	37.5					0.4															146		0				
Waihopai	126 Gladstone Terrace (Manhole Behind)	19-Jan-16	9:31	17:57	0.5	Dry Flow	0	0	0	44	20	15.9	5.99	0.272	0.4	0.01	4.74	5.2	0.46	0.003	0.001		0.0185	0.00196	0.00027	<0.0011	0.00131	<0.000053	<0.00053	615		0				
Waihopai	126 Gladstone Terrace (Manhole Behind)	04-May-16	9:45	5:20	1.32	Dry Flow	0	0	0	22.5	10	14.1	6.11	0.263	0.8	0.03	3.96	4.37	0.41	0.014	0.011		0.012	0.00087	0.00062	0.00011	0.00098	<0.00005	<0.0005	579		23				
Waihopai	126 Gladstone Terrace (Manhole Behind)	24-May-16	9:33	9:26	15	Dry Flow	0	2	21.5	77.5					0.8															243		5				
Waihopai	126 Gladstone Terrace (Manhole Behind)	27-Jun-16	14:32	13:08	1.25	Dry Flow	0	0	0	16.5					0.1															45		0				
Waihopai	126 Gladstone Terrace (Manhole Behind)	28-Apr-12	1:55	0:11	0.3	Storm Flow	0	7.5	7.5	8	25	14.4	5.86	0.259	0.1	0.01	3.81	4.08	0.27	0.008	0.008	<0.7	0.043	0.00122	<0.00011	<0.0011	0.00118	<0.000053	<0.00053	1553		33	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	16-Jan-14	9:38	9:02	5.45	Wet Flow	0.5	3	17	49.5					0.4															6131		218				
Waihopai	126 Gladstone Terrace (Manhole Behind)	24-Jan-14	14:18	14:42	2.95	Wet Flow	0	3.5	19	26.5					0.4															395		5				
Waihopai	126 Gladstone Terrace (Manhole Behind)	16-Apr-14	9:15	9:27	0.6	Storm Flow	0	12	12	16.5	15	12.3	5.95	0.246	3.7	0.38	3.31	3.57	0.26	0.037	0.016	<0.7	0.046	1.00166	0.00039	<0.0011	0.00143	<0.000053	0.00068	1108		5	<0.01			
Waihopai	126 Gladstone Terrace (Manhole Behind)	26-Jan-15	13:44	14:44	0.255	Storm Flow	1.5	5	5	20	15	18	6.68	0.067	21.2	0.03	0.02	0.45	0.43	0.016	0.025		0.145	0.0063	0.0024	<0.0011	0.0025	<0.000053	0.0024	24100		1467				
Waihopai	274 Talbot Street(Drain Behind)	22-Mar-12	11:55	8:41	0.65	Dry Flow	0	0	0	28.5	30	14.5	6.46	0.289	3.5	0.032	3.32	3.91	0.59	0.038	0.023	<0.7	0.102	0.002	0.00087	<0.0011	0.00082	<0.000053	<0.00053	9931		43	0.11			
Waihopai	274 Talbot Street(Drain Behind)	04-Jul-12	10:50	7:58	2.2	Dry Flow	0	0	0	42	40	9	5.56	0.269	56	0.09	3.82	4.81	0.99	0.015	0.002	<0.7	0.067	0.0119	0.0039	<0.0011	0.00177	<0.000053	<0.00053	1119		35	<0.01			
Waihopai	274 Talbot Street(Drain Behind)	11-Dec-12	8:44	6:33	0.67	Dry Flow	0	0	0	45.5	15	12.9	6.09	0.269	0.9	0.056	5.872	6.19	0.31	0.026	0.025	<0.7	0.067	0.00109	0.0019	<0.0011	0.00115	<0.000053	<0.00053	1872		0	0.01			
Waihopai	274 Talbot Street(Drain Behind)	12-Mar-13	8:55	9:06	0.16	Dry Flow	0	0	0	4	20	14.2	6.06	0.272	0.2	0.1	3	3.26	0.26	0.041	0.021	<0.7	0.103	0.0041	0.00168	<0.0011	0.00084	<0.000053	<0.00053	6200		131	<0.01			
Waihopai	274 Talbot Street(Drain Behind)	21-Aug-13	10:23	7:39	1.5	Dry Flow	0	0	0	23.5	10	10.6	6.04	0.268	2	0.02	5.65	6.03	0.38	0.008	0.019	<0.7	0.075	0.00118	0.003	<0.0011	0.00081	<0.000053	<0.00053	933		4	<0.01			
Waihopai	274 Talbot Street(Drain Behind)	19-Nov-13	9:00	9:48	0.54	Dry Flow	0	0	0	3	10	12.9	6.18	0.269	3.2	0.02	5.51	5.95	0.44	0.037	0.03	<0.7	0.069	0.00125	0.00151	<0.0011	0.00066	<0.000053	<0.00053	3244		32	<0.01			
Waihopai	274 Talbot Street(Drain Behind)	10-Feb-14	14:58	5:41	0.11	Dry Flow	0	0	0	1	10	15.3	6.11	0.245	2.4	0.04	4.86	5.32	0.46	0.07	0.021	<0.7	0.075	0.0023	0.0044	<0.0011	0.00155	<0.000053	<0.00053	4840	133	125	0.11			
Waihopai	274 Talbot Street(Drain Behind)	11-Sep-14	10:00	9:15	0.66	Dry Flow	0	0	0	7	10	11	6.13	0.274	1.1	0.01	4.56	5.45	0.89	0.006	0.005		0.079	0.0031	0.00061	<0.0011	0.00111	<0.000053	<0.00053	832		10				
Waihopai	274 Talbot Street(Drain Behind)	25-Jun-15	9:50	14:31	5.7	Dry Flow	0	0	0	33.5	10	9.5	6.24	0.256	0.1	0.03	5.15	5.69	0.54	0.031	0.01		0.054	0.00155	0.00069	<0.0011	0.00106	0.000068	<0.00053	556		10				
Waihopai	274 Talbot Street(Drain Behind)	28-Aug-15	11:34	6:15	4.81	Dry High Flow	0	0	0.5	37.5					0.4															636		40				
Waihopai	274 Talbot Street(Drain Behind)	19-Jan-16	8:56	17:57	0.5	Dry Flow	0	0	0	44	10	14.9	6.26	0.267	0.4	0.03	5.38	5.99	0.61	0.03	0.025		0.084	0.00188	0.0045	<0.0011	0.0017	<0.000053	0.00062	4611		0				
Waihopai	274 Talbot Street(Drain Behind)	04-May-16	10:27	5:20	1.32	Dry Flow	0	0	0	22.5	20	14.1	6.27	0.267	10.6	0.05	4.28	5.69	1.41	0.014	0.014		0.046	0.00077	0.00035	0.00021	0.00058	<0.00005	0.00065	3654		20				
Waihopai	274 Talbot Street(Drain Behind)	24-May-16	9:50	9:26	15	Dry Flow	0	2	21.5	77.5					2															2306		80				
Waihopai	274 Talbot Street(Drain Behind)	27-Jun-16	15:20	13:08	1.25	Dry Flow	0	0	0	16.5					11.4															1956		10				

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Flow	Sampling Event	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Suspended Solids	Ammonia	Nitrate	Total Nitrogen	Total Kjeldahl Nitrogen	Total Phosphorus	Dissolved Reactive Phosphorus	Total Petroleum Hydrocarbons	Total Zinc	Total Copper	Total Lead	Total Arsenic	Total Nickel	Total Cadmium	Total Chromium	Total Coliform	Faecal Coliform	Escherichia coli	FWA microgram/litre	Calcium	Alkalinity	Comment
1	1	1				1	mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	CFU/100ml	MPN/100ml		mg/l	mg/l as CaCO3	
Waihopai	274 Talbot Street(Drain Behind)	28-Apr-12	1:00	0:11	0.3	Storm Flow	0	7.5	7.5	8	50	12.3	6.12	0.127	9.7	0.01	0.93	1.3	0.37	0.09	0.012	<0.7	0.188	0.0029	0.0021	<0.0011	0.00108	<0.000053	0.00074			228	0.01			
Waihopai	274 Talbot Street(Drain Behind)	16-Jan-14	9:58	9:02	5.45	Wet Flow	0.5	3	17	49.5					0.4															14200		920				
Waihopai	274 Talbot Street(Drain Behind)	24-Jan-14	14:42	14:42	2.95	Wet Flow	0	3.5	19	26.5					5.6															12262		146				
Waihopai	274 Talbot Street(Drain Behind)	16-Apr-14	9:51	9:27	0.6	Storm Flow	0	12	12	16.5	20	13.5	6.37	0.164	2.3	0.03	2.23	2.67	0.44	0.091	0.025	<0.7	0.25	0.00182	0.00159	<0.0011	0.00064	<0.000053	0.00061	15531		573	<0.01			
Waihopai	274 Talbot Street(Drain Behind)	26-Jan-15	14:17	14:44	0.255	Storm Flow	1.5	5	5	20	15	17.6	6.82	0.029	7.8	0.03	0.02	0.32	0.3	0.085	0.083		0.119	0.0023	0.0032	<0.0011	0.00092	<0.000053	0.00087	10598		968				
Waihopai	61 Rosewood Drive	22-Mar-12	11:45	8:41	0.65	Dry Flow	0	0	0	28.5	10	14.5	6.15	0.29	0.5	0.001	4.4	4.49	0.09	0.012	0.012	<0.7	0.024	<0.00053	<0.00011	<0.0011	0.00066	<0.000053	<0.00053	164		5	<0.01			
Waihopai	61 Rosewood Drive	04-Jul-12	10:35	7:58	2.2	Dry Flow	0	0	0	42	40	11.9	5.51	0.256	12	0.001	6.03	6.26	0.23	0.003	0.002	<0.7	0.012	0.005	0.00091	<0.0011	0.00096	<0.000053	<0.00053	1299		1	<0.01			
Waihopai	61 Rosewood Drive	11-Dec-12	9:00	6:33	0.67	Dry Flow	0	0	0	45.5	10	12.7	5.97	0.267	0.2	0.008	7.312	7.4	0.09	0.011	0.016	<0.7	0.0078	0.00193	<0.00011	<0.0011	0.00077	<0.000053	<0.00053	41		10	<0.01			
Waihopai	61 Rosewood Drive	12-Mar-13	9:05	9:06	0.16	Dry Flow	0	0	0	4	5	14.7	5.84	0.27	0.1	0.001	4.56	4.81	0.25	0.013	0.016	<0.7	0.04	0.0183	0.00014	<0.0011	0.00083	<0.000053	<0.00053	9200		0	<0.01			
Waihopai	61 Rosewood Drive	21-Aug-13	10:30	7:39	1.5	Dry Flow	0	0	0	23.5	50	12.1	5.71	0.267	0.1	0.01	6	6.19	0.19	0.002	0.001	<0.7	0.125	0.00076	<0.00011	<0.0011	0.00081	<0.000053	<0.00053	203		0	<0.01			
Waihopai	61 Rosewood Drive	19-Nov-13	10:30	9:48	0.54	Dry Flow	0	0	0	3	5	13.1	5.94	0.266	0.3	0.01	5.86	6.12	0.26	0.036	0.028	<0.7	0.0091	0.00083	0.00022	<0.0011	0.00071	<0.000053	<0.00053	345		49	<0.01			
Waihopai	61 Rosewood Drive	10-Feb-14	14:44	5:41	0.11	Dry Flow	0	0	0	1	10	15.9	5.91	0.255	0.2	0.01	5.71	5.92	0.21	0.002	0.001	<0.7	0.0089	0.00056	<0.00011	<0.0011	0.00073	<0.000053	<0.00053	250	74	60	<0.01			
Waihopai	61 Rosewood Drive	11-Sep-14	9:40	9:15	0.66	Dry Flow	0	0	0	7	5	12	5.89	0.258	0.3	0.05	4.22	4.52	0.3	0.002	0.002		0.0098	<0.00053	<0.00011	<0.0011	0.0008	<0.000053	<0.00053	46		0				
Waihopai	61 Rosewood Drive	25-Jun-15	9:59	14:31	5.7	Dry Flow	0	0	0	33.5	10	11.4	6	0.255	1.1	0.01	4.94	5.5	0.56	0.011	0.005		0.0139	0.00074	0.00025	<0.0011	0.00101	<0.000053	<0.00053	200		5				
Waihopai	61 Rosewood Drive	28-Aug-15	11:24	6:15	4.81	Dry High Flow	0	0	0.5	37.5					4.4															293		0				
Waihopai	61 Rosewood Drive	19-Jan-16	9:05	17:57	0.5	Dry Flow	0	0	0	44	10	14	5.86	0.274	0.4	0.02	5.34	5.67	0.33	0.003	0.002		0.0115	0.00185	<0.00011	<0.0011	0.00094	<0.000053	<0.00053	129		0				
Waihopai	61 Rosewood Drive	04-May-16	10:09	5:20	1.32	Dry Flow	0	0	0	22.5	5	14.1	6.05	0.271	0.6	0.02	4.64	4.67	1.03	0.006	0.006		0.01	0.00044	0.00062	<0.0001	0.00062	<0.00005	0.00077	238		0				
Waihopai	61 Rosewood Drive	24-May-16	9:44	9:26	15	Dry Flow	0	2	21.5	77.5					0.4															480		10				
Waihopai	61 Rosewood Drive	27-Jun-16	15:10	13:08	1.25	Dry Flow	0	0	0	16.5					1.8															64		0				
Waihopai	61 Rosewood Drive	28-Apr-12	1:20	0:11	0.3	Storm Flow	0	7.5	7.5	8	30	12.3	5.78	0.252	0.2	0.001	4.68	4.92	0.24	0.013	0.011	<0.7	0.063	0.00071	<0.00011	<0.0011	0.00074	<0.000053	<0.00053	3244		26	<0.01			
Waihopai	61 Rosewood Drive	16-Jan-14	9:52	9:02	5.45	Wet Flow	0.5	3	17	49.5					1.2															1583		130				
Waihopai	61 Rosewood Drive	24-Jan-14	14:34	14:42	2.95	Wet Flow	0	3.5	19	26.5					0.8															662		5				
Waihopai	61 Rosewood Drive	16-Apr-14	9:52	9:27	0.6	Storm Flow	0	12	12	16.5	8	14	6.17	0.256	0.7	0.03	4.2	4.69	0.49	0.019	0.023	<0.7	0.052	0.00055	<0.00011	<0.0011	0.0008	<0.000053	<0.00053	866		52	<0.01			
Waihopai	61 Rosewood Drive	26-Jan-15	13:55	14:44	0.255	Storm Flow	1.5	5	5	20	10	17.5	6.18	0.032	6.8	0.01	0.02	0.37	0.35	0.064	0.039		0.102	0.0029	0.00078	<0.0011	<0.00053	<0.000053	0.00067	19663		211				Dead sheep decomposing in the discharge ditch just above discharge. Phoned Prime Range to arrange removal.
Waihopai	Prestonville Discharge	22-Mar-12	10:50	8:41	0.65	Dry Flow	0	0	0	28.5	60	13.4	6.58	0.313	3.4	0.122	1.84	2.4	0.56	0.09	0.017	<0.7	0.045	0.0025	0.00048	0.0015	0.0038	<0.000053	<0.00053	4100		545	0.03	13	47	
Waihopai	Prestonville Discharge	04-Jul-12	9:50	7:58	2.2	Dry Flow	0	0	0	42	80	9	6.11	0.326	11	0.17	2.07	2.58	0.51	0.111	0.005	<0.7	0.03	0.0197	0.00196	0.0013	0.0047	<0.000053	<0.00053	959		86	<0.01	11	37	
Waihopai	Prestonville Discharge	11-Dec-12	9:30	6:33	0.67	Dry Flow	0	0	0	45.5	80	13.1	6.29	0.314	8.2	0.1	3.074	3.35	0.28	0.007	0.02	<0.7	0.025	0.00185	0.00032	<0.0011	0.0042	<0.000053	<0.00053	1467		146	<0.01	14	47	
Waihopai	Prestonville Discharge	12-Mar-13	9:55	9:06	0.16	Dry Flow	0	0	0	4	40	13.8	6.13	0.416	2.2	0.14	1.84	2.26	0.42	0.052	0.019	<0.7	0.024	0.00143	0.00035	<0.0011	0.0037	<0.000053	<0.00053	17329		325	<0.01	12	44	
Waihopai	Prestonville Discharge	21-Aug-13	8:35	7:39	1.5	Dry Flow	0	0	0	23.5	80	9.8	6.13	0.325	9.3	0.11	2.76	3.13	0.37	0.042	0.004	<0.7	0.028	0.00154	0.00086	<0.0011	0.0044	<0.000053	<0.00053	839		75	<0.01	18.8	50	
Waihopai	Prestonville Discharge	19-Nov-13	9:50	9:48	0.54	Dry Flow	0	0	0	3	100	15.2	6.24	0.335	9	0.07	1.88	2.64	0.76	0.035	0.026	<0.7	0.0179	0.00153	0.00053	<0.0011	0.0063	<0.000053	<0.00053	1188		466	<0.01	15.2	52	
Waihopai	Prestonville Discharge	10-Feb-14	13:49	5:41	0.11	Dry Flow	0	0	0	1	40	16.5	6.33	0.246	2.8	0.06	2.41	2.76	0.35	0.029	0.015	<0.7	0.0119	0.00077	0.00018	<0.0011	0.0025	<0.000053	<0.00053	946	40	30	<0.01	12.9	48	
Waihopai	Prestonville Discharge	11-Sep-14	8:55	9:15	0.66	Dry Flow	0	0	0	7	90	10.6	6.2	0.383	10.1	0.1	2.1	2.51	0.41	0.069	0.002		0.026	0.00118	0.0005	0.0012	0.0044	<0.000053	<0.00053	590		20		13.1	44	
Waihopai	Prestonville Discharge	25-Jun-15	10:28	14:31	5.7	Dry Flow	0	0	0	33.5	50	9.3	6.34	1.012	7.7	0.15	2.15	2.98	0.83	0.087	0.007		0.033	0.00184	0.00129	<0.0011	0.0045	0.00054	0.0006	1008		104		22	54	
Waihopai	Prestonville Discharge	28-Aug-15	9:37	6:15	4.81	Dry High Flow	0	0	0.5	37.5					10															3745		740				
Waihopai	Prestonville Discharge	19-Jan-16	9:48	17:57	0.5	Dry Flow	0	0	0	44	60	14.2	6.31	0.318	10.8	0.17	2.93	3.57	0.64	0.158	0.06		0.027	0.00132	0.00074	0.0013	0.0041	<0.000053	<0.00053	10935		945		18	55	
Waihopai	Prestonville Discharge	04-May-16	9:23	5:20	1.32	Dry Flow	0	0	0	22.5	90	12.6	6.42	0.315	14	0.13	2.2	2.46	0.26	0.077	0.016		0.027	0.0016	0.00089	0.0012	0.0034	<0.00005	0.00079	8080		545		19	57	
Waihopai	Prestonville Discharge	24-May-16	8:22	9:26	15	Dry Flow	0	2	21.5	77.5					4.4															3170		630				
Waihopai	Prestonville Discharge	27-Jun-16	14:50	13:08	1.25	Dry Flow	0	0	0	16.5					5.6															11235		790				
Waihopai	Prestonville Discharge	28-Apr-12	2:25	0:11	0.3	Storm Flow	0	7.5	7.5	8	40	10.7	6.42	0.149	4.5	0.05	3.54	3.92	0.38	0.038	0.023	<0.7	0.05	0.0028	0.00106	<0.0011	0.00167	<0.000053	0.00059	49200		2160	0.04	9	27	
Waihopai	Prestonville Discharge	16-Jan-14	8:58	9:02	5.45	Wet Flow	0.5	3	17	49.5					24															25994		976				
Waihopai	Prestonville Discharge	24-Jan-14	14:00	14:42	2.95	Wet Flow	0	3.5	19	26.5					11.6															12910		1077				
Waihopai	Prestonville Discharge	16-Apr-14	9:00	9:27	0.6	Storm Flow	0	12	12	16.5	100	12	6.26	0.189	14.3	0.09	0.99	1.81	0.85	0.224	0.043	<0.7	0.134	0.0036	0.00107	<0.0011	0.0032	<0.000053	0.00081	17820		1580	<0.01	12.4	38	
Waihopai	Prestonville Discharge	26-Jan-15	13:20	14:44	0.255	Storm Flow	1.5	5	5	20	95	16.5	6.37	0.083	51	0.16	0.18	1.14	0.96	0.159	0.074		0.167	0.0089	0.0065	0.0015	0.0055	<0.000053	0.0023	77655		19365		14	37	
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	22-Mar-12	11:35	8:41	0.65	Dry Flow	0	0	0	28.5	20	15.4	7.05	0.233	1	0.3	3.96	4.58	0.62	0.27	0.198	<0.7	0.131	0.0051	0.00064	<0.0011	0.00094	<0.000053	<0.00053	48385		3106	5.9			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	23-Mar-12	15:20	9:19	0.53	Elevated E. coli Repeat Sample	0	0.5	0.5	26																				48840		1072				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	04-Jul-12	10:20	7:58	2.2	Dry Flow	0	0	0	42	40	9.2	6.81	0.27	0.9	0.49	4.99	6.07	1.08	0.134	0.124	<0.7	0.087	0.0135	0.00105	<0.0011	0.00105	<0.000053	0.00053	32550		4730	0.08			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	05-Jul-12	14:30	8:49	1.7	Elevated E. coli Repeat Sample	0	0	0	36.5																				21300		5200				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	11-Dec-12	8:27	6:33	0.67	Dry Flow	0	0	0	45.5	30	14.3	7.09	0.217	4.7	3.31	3.933	9.95	6.02	1.175	0.966	<0.7	0.065	0.0089	0.00139	<0.0011	0.00102	<0.000053	<0.00053	1986280		1046240	0.98			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	12-Dec-12	14:00	7:29	0.45	Elevated E. coli Repeat Sample	0	0	0	11																				198900		172300				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	12-Mar-13	9:25	9:06	0.16	Dry Flow	0	0	0	4	10	15.5	6.8	0.198	0.5	0.15	3.95	4.21	0.26	0.374	0.333	<0.7	0.073	0.0036	0.00089	<0.0011	0.00122	<0.000053	<0.00053	63700		3100	0.37			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	13-Mar-13	15:50	9:50	0.2	Elevated E. coli Repeat Sample	0	0	0.5	3.5																				15770		4000				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	21-Aug-13	10:50	7:39	1.5	Dry Flow	0	0	0	23.5	10	10.5	6.73	0.285	2	2.97	5.816	8.66	2.76	0.381	0.386	<0.7	0.073	0.0058	0.00064	<0.0011	0.00094	<0.000053	<0.00053	86640		46110	0.06			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	19-Nov-13	10:20	9:48	0.54	Dry Flow	0	0	0	3	20	14	6.85	0.234	1.2	0.8	5.53	6.42	0.89	0.346	0.266	<0.7	0.088	0.0068	0.00079	<0.0011	0.00118	<0.000053	<0.00053	1000		980	0.35			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	10-Feb-14	14:30	5:41	0.11	Dry Flow	0	0	0	1	20	18	6.57	0.203	1.2	1.97	4.93	7.07	2.14	0.486	0.437	<0.7	0.057	0.0085	0.00114	<0.0011	0.00119	<0.000053	<0.00053	18500	13400	13100	1.12			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	11-Sep-14	9:50	9:15	0.66	Dry Flow	0	0	0	7	10	11	6.68	0.22	1.6	5.04	2.07	7.14	5.07	0.488	0.399		0.05	0.0127	0.0066	<0.0011	0.00108	<0.000053	0.00121	2909000		1723000				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	25-Jun-15	10:06	14:31	5.7	Dry Flow	0	0	0	33.5	20	8.5	6.7	1.029	0.1	0.38	3.68	4.73	1.05	0.096	0.062		0.039	0.0023	0.00034	<0.0011	0.00091	<0.000053	<0.00053	155310		23820				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	28-Aug-15	11:40	6:15	4.81	Dry High Flow	0	0	0.5	37.5					0.8															7670		4260				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	19-Jan-16	9:15	17:57	0.5	Dry Flow	0	0	0	44	30	15.4	6.97	0.25	0.4	0.48	4.53	5.78	1.25	0.24	0.228		0.06	0.0056	0.00057	<0.0011	0.00092	<0.000053	<0.00053	166900		93300				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	04-May-16	10:45	5:20	1.32	Dry Flow	0	0	0	22.5	20	14.1	6.81	0.244	1.8	0.6	4.38	5.54	1.16	0.206	0.174		0.053	0.0029	0.00076	0.00026	0.00066	<0.00005	0.00067	163280		5240				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	24-May-16	10:02	9:26	15	Dry Flow	0	2	21.5	77.5					0.1															124050		89250				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	27-Jun-16	15:33	13:08	1.25	Dry Flow	0	0	0	16.5					4.2															866435		706800				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	28-Apr-12	1:35	0:11	0.3	Storm Flow	0	7.5	7.5	8	50	12	6.46	0.103	1	0.11	1.55	1.96	0.41	0.153	0.101	<0.7	0.175	0.0067	0.00153	<0.0011	0.00102	<0.000053	<0.00053	81640		9080	0.22			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	16-Jan-14	9:38	9:02	5.45	Wet Flow	0.5	3	17	49.5					1.2															1986280		866400				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	24-Jan-14	14:28	14:42	2.95	Wet Flow	0	3.5	19	26.5					2.8															523100		363500				
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	16-Apr-14	9:36	9:27	0.6	Storm Flow	0	12	12	16.5	30	14.3	6.64	0.186	4.5	3.51	1.86	5.81	3.95	0.657	0.578	<0.7	0.152	0.0076	0.00161	<0.0011	0.00096	<0.000053	<0.00053	19863000		12033000	0.61			
Waihopai	Queens Drive Bridge (Manhole 450m South of Bridge)	26-Jan-15	13:49	14:44	0.255	Storm Flow	1.5	5	5	20	10	17.7	6.21	0.027	29.2	0.03	0.02	0.85	0.83	0.27	0.053		0.153	0.0091	0.0058	<0.0011	0.000182	<0.000053	0.0013	12200		3100				
Waihopai	Russell Street (Discharge to Waihopai)	22-Mar-12	9:20	8:41	0.65	Dry Flow	0	0	0	28.5	35	15	6.36	0.274	1.2	0.064	2.79	3.05	0.26	0.071	0.039	<0.7	0.047	0.00182	0.00037	<0.0011	0.00094	<0.000053	<0.00053	5226		378	0.5			
Waihopai	Russell Street (Discharge to Waihopai)	04-Jul-12	9:20	7:58	2.2	Dry Flow	0	0	0	42	40	10	6.56	0.339	0.1	0.06	3.72	4.16	0.44	0.044	0.037	<0.7	0.061	0.00054	0.00121	<0.0011	0.00123	<0.000053	0.00058	4410		3590	0.01			
Waihopai	Russell Street (Discharge to Waihopai)	05-Jul-12	8:45	8:49	1.8	Elevated E. coli Repeat Sample	0	0	0	36.5																				6840		5040				
Waihopai	Russell Street (Discharge to Waihopai)	11-Dec-12	9:22	6:33	0.67	Dry Flow	0	0	0	45.5	30	13.8	6.32	0.244	1.1	0.174	3.268	3.83	0.56	0.073	0.061	<0.7	0.053	0.00054	0.00144	<0.0011	0.00135	<0.000053	<0.00053	6240		970	0.04			
Waihopai	Russell Street (Discharge to Waihopai)	12-Mar-13	9:40	9:06	0.16	Dry Flow	0	0	0	4	20	15.5	6.24	0.937	0.7	0.04	2.82	3.08	0.26	0.084	0.074	<0.7	0.05	0.00175	0.00024	<0.0011	0.00089	<0.000053	<0.00053	2590		100	0.09			
Waihopai	Russell Street (Discharge to Waihopai)	21-Aug-13	8:05	7:39	1.5	Dry Flow	0	0	0	23.5	20	10.2	6.09	0.257	0.5	0.02	2.83	4.12	0.29	0.044	0.031	<0.7	0.057	0.0024	0.00046	<0.0011	0.00046	0.00088	0.00054	2481		448	0.02			
Waihopai	Russell Street (Discharge to Waihopai)	19-Nov-13	9:24	9:48	0.54	Dry Flow	0	0	0	3	20	14.1	6.22	0.225	0.5	0.08	2.3	2.82	0.52	0.05	0.035	<0.7	0.033	0.00195	0.00067	<0.0011	0.00096	<0.000053	<0.00053	400		100	0.02			
Waihopai	Russell Street (Discharge to Waihopai)	10-Feb-14	16:01	5:41	0.11	Dry Flow	0	0	0	1	20	17.8	6.79	0.201	0.4	0.2	2.22	2.52	0.3	0.132	0.079	<0.7	0.034	0.00177	0.00073	<0.0011	0.00074	<0.000053	<0.00053	64985	52100	48700	0.21			
Waihopai	Russell Street (Discharge to Waihopai)	11-Sep-14	9:15	9:15	0.66	Dry Flow	0	0	0	7	15	11	6.19	0.286	0.7	0.09	3.12	3.28	0.26	0.066	0.044		0.054	0.00161	0.00021	<0.0011	0.00109	<0.000053	<0.00053	13540		100				
Waihopai	Russell Street (Discharge to Waihopai)	25-Jun-15	14:15	14:31	5.7	Dry Flow	0	0	0	33.5	20	11.1	6.19	0.257	0.1	0.1	2.81	3.41	0.6	0.037	0.026		0.052	0.002	0.00031	<0.0011	0.00112	<0.000053	<0.00053	9675		3415				
Waihopai	Russell Street (Discharge to Waihopai)	28-Aug-15	9:23	6:15	4.81	Dry High Flow	0	0	0.5	37.5					0.1															70680		30655				
Waihopai	Russell Street (Discharge to Waihopai)	19-Jan-16	15:35	17:57	0.5	Dry Flow	0	0	0	44	80	14.5	6.4	0.23	0.8	0.08	3.07	4.28	1.21	0.049	0.049		0.044	0.00172	0.00034	<0.0011	0.00108	<0.000053	<0.00053	198628		97080				
Waihopai	Russell Street (Discharge to Waihopai)	04-May-16	9:07	5:20	1.32	Dry Flow	0	0	0	22.5	10	13.6	6.49	0.217	0.2	0.1	2.54	3.17	0.63	0.058	0.023		0.03	0.0016	0.00023	0.00039	0.00071	<0.00005	0.00055	7695		430				
Waihopai	Russell Street (Discharge to Waihopai)	24-May-16	9:30	9:26	15	Dry Flow	0	2	21.5	77.5					4															19350		13540				
Waihopai	Russell Street (Discharge to Waihopai)	27-Jun-16	14:40	13:08	1.25	Dry Flow	0	0	0	16.5					0.6															10080		1680				
Waihopai	Russell Street (Discharge to Waihopai)	28-Apr-12	2:00	0:11	0.3	Storm Flow	0	7.5	7.5	8	100	11.9	6.16	0.097	2.3	0.16	0.76	1.47	0.71	0.132	0.069	<0.7	0.173	0.00078	0.0021	<0.0011	0.00174	<0.000053	<0.00053			24420	0.13			
Waihopai	Russell Street (Discharge to Waihopai)	16-Jan-14	9:23	9:02	5.45	Wet Flow	0.5	3	17	49.5					1.6															1930		620				
Waihopai	Russell Street (Discharge to Waihopai)	24-Jan-14	14:16	14:42	2.95	Wet Flow	0	3.5	19	26.5					0.4															7230		630				
Waihopai	Russell Street (Discharge to Waihopai)	16-Apr-14	9:12	9:27	0.6	Storm Flow	0	12	12	16.5	10	12.6	6.3	0.069	0.7	0.05	0.46	0.94	0.48	0.059	0.038	<0.7	0.152	0.0035	0.00136	<0.0011	0.00058	<0.000053	<0.00053	38800		1000	0.03			
Waihopai	Russell Street (Discharge to Waihopai)	26-Jan-15	13:38	14:44	0.255	Storm Flow	1.5	5	5	20	30	17.2	6.15	0.044	15.4	0.05	0.02	0.66	0.64	0.107	0.052		0.155	0.0096	0.0039	<0.0011	0.00139	<0.000053	0.00093	25994		2708				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	22-Mar-12	11:12	8:41	0.65	Dry Flow	0	0	0	28.5		12.9																		925		293				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	04-Jul-12	10:10	7:58	2.2	Dry Flow	0	0	0	42																				749		80				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	11-Dec-12	9:02	6:33	0.67	Dry Flow	0	0	0	45.5																				1553		171				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	12-Mar-13	9:08	9:06	0.16	Dry Flow	0	0	0	4																				1259		199				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	21-Aug-13	8:49	7:39	1.5	Dry Flow	0	0	0	23.5																				820		85				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	19-Nov-13	9:10	9:48	0.54	Dry Flow	0	0	0	3	10	15.2																		2755		187				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	10-Feb-14	14:08	5:41	0.11	Dry Flow	0	0	0	1																				1650	965	90				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	11-Sep-14	9:30	9:15	0.66	Dry Flow	0	0	0	7																				316		21				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	25-Jun-15	10:11	14:31	5.7	Dry Flow	0	0	0	33.5																				329		61				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	28-Aug-15	9:43	6:15	4.81	Dry High Flow	0	0	0.5	37.5					0.8															205		10				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	19-Jan-16	9:18	17:57	0.5	Dry Flow	0	0	0	44																				960		270				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	04-May-16	9:48	5:20	1.32	Dry Flow	0	0	0	22.5		14	6.11																	5475		11				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	24-May-16	9:38	9:26	15	Dry Flow	0	2	21.5	77.5					3															5000		96				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	27-Jun-16	15:03	13:08	1.25	Dry Flow	0	0	0	16.5					0.6															338		5				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	28-Apr-12	1:37	0:11	0.3	Storm Flow	0	7.5	7.5	8																				6980		485				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	16-Jan-14	9:32	9:02	5.45	Wet Flow	0.5	3	17	49.5					2															798		75				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	24-Jan-14	14:22	14:42	2.95	Wet Flow	0	3.5	19	26.5					2.8															738		40				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	16-Apr-14	9:20	9:27	0.6	Storm Flow	0	12	12	16.5																				3130		200				
Waihopai	Thomsons Bush Discharge (Discharge from Backwash)	26-Jan-15	14:03	14:44	0.255	Storm Flow	1.5	5	5	20																				2238		590				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	22-Mar-12	11:15	8:41	0.65	Dry Flow	0	0	0	28.5	60	12.6	6.42	0.271	1.8	0.098	1.08	1.6	0.52	0.035	0.056	<0.7	0.0109	0.00108	0.00013	<0.0011	0.0023	<0.000053	<0.00053	1426		173	0.14			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	04-Jul-12	10:05	7:58	2.2	Dry Flow	0	0	0	42	60	9.1	5.86	0.255	2.7	0.11	2.09	2.67	0.58	0.018	0.028	<0.7	0.0145	0.0052	0.0009	<0.0011	0.003	<0.000053	0.00059	420		20	<0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	11-Dec-12	9:06	6:33	0.67	Dry Flow	0	0	0	45.5	50	12.9	6.22	0.257	2.1	0.078	1.302	1.75	0.45	0.047	0.009	<0.7	0.0077	0.00095	0.00014	<0.0011	0.0024	<0.000053	<0.00053	2247		0	0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	12-Mar-13	9:10	9:06	0.16	Dry Flow	0	0	0	4	120	14.3	6.23	0.262	3.2	0.15	1.12	1.54	0.42	0.054	0.037	<0.7	0.074	0.00088	0.00025	<0.0011	0.0022	<0.000053	<0.00053	5794		121	<0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	21-Aug-13	8:53	7:39	1.5	Dry Flow	0	0	0	23.5	20	8.6	6.08	0.26	3.4	0.05	2.538	3.21	0.67	0.003	0.002	<0.7	0.0084	0.00093	<0.00011	<0.0011	0.0021	<0.000053	<0.00053	512		52	<0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	19-Nov-13	9:16	9:48	0.54	Dry Flow	0	0	0	3	45	13.6	6.09	0.256	1	0.08	1.35	1.91	0.56	0.019	0.011	<0.7	0.0089	0.00116	0.020022	<0.0011	0.0025	<0.000053	<0.00053	6887		120	<0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	10-Feb-14	14:20	5:41	0.11	Dry Flow	0	0	0	1	5	17	6.34	0.251	2.9	0.06	1.82	2.71	0.89	0.01	0.002	<0.7	0.0064	0.00181	0.00014	<0.0011	0.0023	<0.000053	<0.00053	3448	61	54	<0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	11-Sep-14	9:35	9:15	0.66	Dry Flow	0	0	0	7	60	8.9	6.19	0.252	3.9	0.06	1.9	3.1	1.2	0.019	0.008		0.013	0.0019	0.00032	<0.0011	0.0026	<0.000053	0.00161	1607		202				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	25-Jun-15	10:15	14:31	5.7	Dry Flow	0	0	0	33.5	30	5.5	6.15	0.986	1.2	0.05	1.81	3.42	1.61	0.028	0.01		0.0147	0.00118	<0.00011	<0.0011	0.0024	<0.000053	0.00054	329		94				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	28-Aug-15	9:45	6:15	4.81	Dry High Flow	0	0	0.5	37.5					1.2															2391		104				

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Flow	Sampling Event	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Suspended Solids	Ammonia	Nitrate	Total Nitrogen	Total Kjeldahl Nitrogen	Total Phosphorus	Dissolved Reactive Phosphorus	Total Petroleum Hydrocarbons	Total Zinc	Total Copper	Total Lead	Total Arsenic	Total Nickel	Total Cadmium	Total Chromium	Total Coliform	Faecal Coliform	Escherichia coli	FWA microgram/litre	Calcium	Alkalinity mg/l as CaCO3	Comment
1	1	1				1	mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	CFU/100ml	MPN/100ml		mg/l		
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	19-Jan-16	9:22	17:57	0.5	Dry Flow	0	0	0	44	50	14.5	6.23	0.261	2.8	0.03	2.38	2.88	0.5	0.03	0.01		0.0112	0.00088	0.00014	<0.0011	0.0025	<0.000053	<0.00053	4564		82				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	04-May-16	10:00	5:20	1.32	Dry Flow	0	0	0	22.5	40	10.1	6.27	0.254	2.6	0.08	1.15	2.47	1.32	0.025	0.019		0.0086	0.0011	<0.0001	0.00029	0.0018	<0.00005	0.00085	2143		41				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	24-May-16	9:40	9:26	15	Dry Flow	0	2	21.5	77.5					2.8															410		100				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	27-Jun-16	15:06	13:08	1.25	Dry Flow	0	0	0	16.5					1															778		62				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	28-Apr-12	1:40	0:11	0.3	Storm Flow	0	7.5	7.5	8	120	11.5	6.27	0.221	2.6	0.15	1.02	1.49	0.47	0.066	0.049	<0.7	0.034	0.00097	0.00034	<0.0011	0.0015	<0.000053	<0.00053	7765		550	0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	16-Jan-14	9:34	9:02	5.45	Wet Flow	0.5	3	17	49.5					0.4															6131		556				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	24-Jan-14	14:24	14:42	2.95	Wet Flow	0	3.5	19	26.5					0.4															2492		194				
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	16-Apr-14	9:27	9:27	0.6	Storm Flow	0	12	12	16.5	50	11.5	6.51	0.216	2.5	0.1	0.57	1.1	0.53	0.064	0.029	<0.7	0.057	0.00109	0.0008	<0.0011	0.00193	<0.000053	0.00054	15380		550	<0.01			
Waihopai	Thomsons Bush Inflow (Discharge to Backwash)	26-Jan-15	14:06	14:44	0.255	Storm Flow	1.5	5	5	20	55	17.8	6.2	0.038	45	0.13	0.02	0.59	0.57	0.066	0.022		0.132	0.005	0.0022	<0.0011	0.0022	<0.000053	0.00126	9768		2224				
Waikiwi	Discharge to Waikiwi Stream	21-Mar-12	13:55	20:22	0.79	Dry Flow	0	0	0	34	55	13	6.61	0.227	6.7	0.208	0.79	1.26	0.47	0.073	0.04	<0.7	0.045	0.0023	0.00053	0.0045	0.00155	<0.000053	0.00135			308	0.57			
Waikiwi	Discharge to Waikiwi Stream	04-Jul-12	10:15	7:58	2.2	Dry Flow	0	0	0	42	40	2.9	6.42	0.283	12	0.36	2.63	3.41	0.78	0.029	0.012	<0.7	0.064	0.00151	0.00094	0.015	0.00135	<0.000053	0.00083	1072		5	<0.01			
Waikiwi	Discharge to Waikiwi Stream	22-Nov-12	11:30	16:12	0.89	Dry Flow	0	0	0	14.5	80	15.5	6.75	0.26	5.2	0.49	0.71	1.32	0.83	0.15	0.025	<0.7	0.059	0.0035	0.0035	0.0065	0.0034	<0.000053	0.0035	4604		984	0.05			
Waikiwi	Discharge to Waikiwi Stream	12-Mar-13	10:20	9:06	0.16	Dry Flow	0	0	0	4	110	13.3	6.44	0.251	0.9	0.03	0.12	0.84	0.72	0.088	0.044	<0.7	0.028	0.00155	0.00098	0.0046	0.00127	<0.000053	<0.00053	6488		31	0.01			
Waikiwi	Discharge to Waikiwi Stream	21-Aug-13	13:20	7:39	1.5	Dry Flow	0	0	0	23.5	30	9.3	6.62	0.29	2.6	0.06	2.87	3.11	0.24	0.078	0.015	<0.7	0.067	0.00169	0.00047	0.0013	0.00139	<0.000053	0.00106	448		10	<0.01			
Waikiwi	Discharge to Waikiwi Stream	14-Nov-13	11:05	5:59	0.535	Dry Flow	0	0	0	2.5	50	14.1	6.48	0.254	11	0.01	1.14	1.65	0.51	0.03	0.021	<0.7	0.042	0.0032	0.00059	0.0019	0.00133	<0.000053	0.00068	1124		144	<0.01			
Waikiwi	Discharge to Waikiwi Stream	10-Feb-14	9:11	5:11	0.11	Dry Flow	0	0	0	1	60	14	6.41	0.188	5	0.01	0.24	0.54	0.3	0.049	0.01	<0.7	0.032	0.00095	0.00028	0.0038	0.0011	<0.000053	0.00097	340	10	9	0.01			
Waikiwi	Discharge to Waikiwi Stream	11-Sep-14	13:00	9:15	0.66	Dry Flow	0	0	0	7	60	11.5	6.58	0.258	1.7	0.04	0.89	2.56	1.67	0.031	0.023		0.069	0.00193	0.00027	0.0019	0.022	<0.000053	0.001	723		74				
Waikiwi	Discharge to Waikiwi Stream	26-Jan-15	10:14	14:44	0.257	Dry Flow	0	0	0	15	110	15.6	6.42	0.211	67.6	0.13	0.64	1.6	0.96	0.251	0.119		0.089	0.0022	0.00071	0.023	0.0044	<0.000053	0.0022	12976		82				
Waikiwi	Discharge to Waikiwi Stream	28-Aug-15	11:16	6:15	4.81	Dry High Flow	0	0	0.5	37.5					1.2															1187		0				
Waikiwi	Discharge to Waikiwi Stream	14-Sep-15	13:53	8:25	2.9	Dry High Flow	0	0	5.5	36.5					3															487		2				
Waikiwi	Discharge to Waikiwi Stream	02-Dec-15	9:13	8:37	0.71	Dry Flow	0	0	0	23.5	70	15.9	6.45	0.282	3.8	0.05	0.85	1.84	0.99	0.074	0.017		0.062	0.0023	0.00054	0.0054	0.0033	<0.000053	0.00191	2306		133				
Waikiwi	Discharge to Waikiwi Stream	19-Jan-16	9:10	17:57	0.5	Dry Flow	0	0	0	44	100	14.2	6.43	0.255	4	0.03	0.48	1.49	1.01	0.057	0.039		0.045	0.0021	0.0003	0.0041	0.0024	<0.000053	0..00185	1725		52				
Waikiwi	Discharge to Waikiwi Stream	24-May-16	9:00	9:26	15	Dry Flow	0	2	21.5	77.5					7.6															2460		740				
Waikiwi	Discharge to Waikiwi Stream	27-Jun-16	13:55	13:08	1.25	Dry Flow	0	0	0	16.5					22.9															5794		576				
Waikiwi	Discharge to Waikiwi Stream	28-Apr-12	3:30	0:11	0.3	Storm Flow	0	7.5	7.5	8	55	11	6.36	0.161	5.7	0.47	0.48	1.15	0.67	0.073	0.039	<0.7	0.043	0.0032	0.00093	0.0045	0.00134	<0.000053	0.0028	28272		610	0.03			
Waikiwi	Discharge to Waikiwi Stream	16-Jan-14	8:53	9:02	5.45	Wet Flow	0.5	3	17	49.5					0.4															6131		110				
Waikiwi	Discharge to Waikiwi Stream	24-Jan-14	13:42	14:42	3	Wet Flow	0	3.5	19	26.5					0.4															3683		197				
Waikiwi	Discharge to Waikiwi Stream	05-May-14	11:23	12:20	1.9	Storm Flow	0.5	7.5	7.5	47	50	12.6	6.36	0.126	30.2	0.05	0.9	1.73	0.83	0.14	0.023	<0.7	0.077	0.0054	0.00127	0.0046	0.0052	<0.000053	0.0082	6510		1552	0.01			
Waikiwi	Discharge to Waikiwi Stream	26-Jan-15	16:10	14:44	0.255	Storm Flow	1.5	5.5	5.5	20.5	100	17	6.46	0.14	15.4	0.14	0.58	1.76	1.18	0.098	0.077		0.066	0.004	0.0017	0.0109	0.0046	<0.000053	0.0024	39706		5510				

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Sampling Event	Flow	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Dissolved Oxygen	Suspended Solids	Dissolved Reactive Phosphorus	Total Phosphorus	Ammonia	Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Coliform MPN/100	Faecal Coliform CFU/100	Escherichia coli MPN/100	SHMAK	Chlorophyll a	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Nickel	Total Zinc	Total Petroleum Hydrocarbons	Comment
1	1	1			1		mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	ml	ml	ml	cm	mg/m3	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Clifton	Bain Street East	22-Mar-12	8:03	8:41	Dry Flow	0.67	0	0	0	36.5	100	11.5	6.77	0.283	7.59	13.1	0.025	0.059	0.442	0.525	0.86	1.39	7701		2909	58	1.5	<0.0011	<0.000053	0.00109	0.0022	0.00045	0.00176	0.0185	<0.7	Dry weather sample
Clifton	Bain Street East	23-Mar-12	14:58	9:19	Elevated E. coli Repeat Sample	0.52	0	1	1	33													7765		467											
Clifton	Bain Street East	05-Jul-12	9:20	8:49	Dry Flow	1.8	0	0	0	31.5	60	6.5	6.45	0.278	9.83	2.8	0.014	0.024	0.26	1.21	0.86	2.07	16640		1080	83	0.44	<0.0011	<0.000053	0.00101	0.0025	0.0003	0.00138	0.0174	<0.7	Dry weather sample
Clifton	Bain Street East	06-Jul-12	16:00	22:02	Elevated E. coli Repeat Sample	1.88	0	0	0	24													816		727											
Clifton	Bain Street East	22-Nov-12	14:30	16:12	Dry Flow	0.89	0	0	0.5	15.5	90	16.1	6.41	0.278	6.47	7.8	0.075	0.168	2.68	0.54	3.57	4.11	45695		34465	58	8.89	<0.0011	<0.000053	0.00099	0.00163	0.00026	0.00187	0.0098	<0.7	Dry weather sample
Clifton	Bain Street East	23-Nov-12	14:00	17:09	Elevated E. coli Repeat Sample	0.85	0	0.5	0.5	15.5													2980		1580											
Clifton	Bain Street East	13-Mar-13	10:30	9:50	Dry Flow	0.2	0	0	0.5	3.5	140	14	6.55	0.285	5.45	2.9	0.07	0.142	0.08	0.79	0.37	1.16	12180		3513	66	1.56	<0.0011	<0.000053	0.00066	0.00123	0.00035	0.00137	0.0074	<0.7	Dry weather sample
Clifton	Bain Street East	14-Mar-13	15:15	10:33	Elevated E. coli Repeat Sample	0.2	0	0	0	2													4800		410											
Clifton	Bain Street East	21-Aug-13	8:30	7:39	Dry Flow	1.5	0	0	0	32	100	8.6	6.28	0.26	8.6	24.7	0.201	0.252	0.45	1.23	1.04	2.27	1187		738	80	3.43	<0.0011	<0.000053	0.00147	0.0025	0.0007	0.0023	0.0161	<0.7	Dry weather sample
Clifton	Bain Street East	14-Nov-13	8:28	5:59	Dry Flow	0.535	0	0	0	9.5	120	12	6.26	0.242	6.75	3.7	0.026	0.072	0.04	0.75	0.74	1.49	4374		746	75	3.99	<0.0011	<0.000053	0.00106	0.00197	0.00151	0.0019	0.0097	<0.7	Dry weather sample
Clifton	Bain Street East	11-Feb-14	7:45	6:32	Dry Flow	0.1	0	0	0	1	160	13.8	6.08	0.236	4.45	11.5	0.023	0.105	0.46	4.27	0.77	5.04	8070	2900	2600	62	4.25	<0.0011	<0.000053	0.00085	0.00101	0.00038	0.00149	0.0065	<0.7	Dry weather sample
Clifton	Bain Street East	11-Sep-14	9:45	9:15	Dry Flow	0.66	0	0	0	5.5	90	9.5	6.33	0.252	9.15	4.3	0.023	0.039	0.18	0.78	0.53	1.31	23055		945	65	1.48	<0.0011	<0.000053	0.00097	0.00165	0.00031	0.00189	0.0085		Dry weather sample
Clifton	Bain Street East	26-Jan-15	11:15	14:44	Dry Flow	0.257	0	0	0	12	160	16.5	6.72	0.299	5.37	4	0.05	0.086	2.24	0.11	2.25	2.36	27375		1705	75	3.21	<0.0011	<0.000053	0.0008	0.00133	0.00041	0.0022	0.0104		Dry weather sample
Clifton	Bain Street East	28-Aug-15	8:37	6:15	Dry High Flow	4.81	0	0	0.5	58						3.6							12910		250											Dry High Flow
Clifton	Bain Street East	14-Sep-15	9:30	8:25	Dry Moderate Flow	2.9	0	0	5.5	36.5						3.2							2755		148											Dry Moderate Flow
Clifton	Bain Street East	02-Dec-15	15:06	8:37	Dry	0.71	0	0	0	42	120	19	6.88	0.256	8.25	6.2	0.002	0.036	0.09	0.32	2.87	3.19	3912		576	77.8	2.26	<0.0011	<0.000053	0.00107	0.00145	0.00026	0.0028	0.0094		Dry weather sample
Clifton	Bain Street East	19-Jan-16	13:40	17:57	Dry Flow	0.5	0	0	0	54.5	90	16	6.54	0.266	6.19	15.2	0.05	0.131	0.09	1.39	1.23	2.62	10950		862	46	5.7	<0.0011	<0.000053	0.00102	0.00168	0.00055	0.0024	0.0108		Dry weather sample
Clifton	Bain Street East	24-May-16	11:25	9:26	Dry Flow	15	0	3	18.5	76						4.4							2224		192											
Clifton	Bain Street East	27-Jun-16	14:43	13:08	Dry	1.25	0	0	0	19						5.7							5510		350											
Clifton	Bain Street East	27-Apr-12	22:02	0:11	Storm Flow	0.3	6.5	9	9	9	230	12	6.59	0.237	7.87	44.3	0.116	0.615	1.33	0.71	0.61	1.32	86645		46040	17	5.12	<0.0011	<0.000053	0.00178	0.0033	0.0021	0.0029	0.041	<0.7	
Clifton	Bain Street East	16-Jan-14	8:26	9:02	Wet Flow	5.45	1.5	3.5	9	50.5						8.8							21760		4285											
Clifton	Bain Street East	24-Jan-14	13:00	14:42	Wet Flow	3	0	0	22	28.5						13.2							31062		3340											
Clifton	Bain Street East	05-May-14	13:20	12:20	Storm Flow	1.9	0.5	9.5	9.5	43	110	12.3	6.25	0.242	8.81	11.3	0.023	0.171	0.08	0.61	1.88	2.49	14200		1450	64	4.98	<0.0011	<0.000053	0.00166	0.0061	0.00074	0.0027	0.021	<0.7	
Clifton	Bain Street East	26-Jan-15	14:30	14:44	Storm Flow	0.255	3.5	9	9	21	120	15.4	6.8	0.296	5.94	12.8	0.159	0.299	2.42	0.74	2.39	3.13	218100		38505	39	4.15	<0.0011	<0.000053	0.00054	0.00156	0.00055	0.00185	0.025		
Clifton	Wicklow Street East	22-Mar-12	8:12	8:41	Dry Flow	0.67	0	0	0	36.5	100	11.9	6.55	0.299	2.77	33	0.02	0.031	0.021	0.487	0.62	1.11	2909		52	71	1.65	<0.0011	<0.000053	0.0007	0.00165	0.00029	0.00183	0.027	<0.7	Dry weather sample
Clifton	Wicklow Street East	05-Jul-12	9:25	8:49	Dry Flow	1.8	0	0	0	31.5	65	5.8	6.14	0.291	7.76	0.4	0.012	0.02	0.05	1.65	0.66	2.31	740		100	100	0.43	<0.0011	<0.000053	0.00092	0.00197	0.0002	0.002	0.038	<0.7	Dry weather sample
Clifton	Wicklow Street East	22-Nov-12	14:35	16:12	Dry Flow	0.89	0	0	0.5	15.5	110	15.1	6.32	0.268	4.39	1.8	0.025	0.031	0.07	0.03	0.77	0.8	368		5	82	2.55	<0.0011	<0.000053	0.00093	0.00142	0.00012	0.0023	0.023	<0.7	Dry weather sample
Clifton	Wicklow Street East	13-Mar-13	10:35	9:50	Dry Flow	0.2	0	0	0.5	3.5	140	14	6.43	0.277	1.25	3.4	0.027	0.041	0.17	0.06	0.79	0.85	2063		20	69	1.44	<0.0011	<0.000053	0.00064	<0.00053	<0.00011	0.00094	0.0019	<0.7	Dry weather sample
Clifton	Wicklow Street East	21-Aug-13	8:35	7:39	Dry Flow	1.5	0	0	0	32	60	8.6	6.25	0.279	6.72	2.8	0.052	0.059	0.03	2.01	1.19	3.2	855		63	29	2.25	<0.0011	<0.000053	0.00101	0.0018	0.00018	0.0021	0.024	<0.7	Dry weather sample
Clifton	Wicklow Street East	14-Nov-13	8:20	5:59	Dry Flow	0.535	0	0	0	9.5	120	14	6.18	0.252	3.63	3	0.02	0.035	0.04	0.48	0.76	1.24	1724		286	65	4.16	<0.0011	<0.000053	0.00093	0.0027	0.00131	0.002	0.022	<0.7	Dry weather sample
Clifton	Wicklow Street East	11-Feb-14	7:52	6:32	Dry Flow	0.1	0	0	0	1	280	14	6.15	0.266	3.73	3.5	0.007	0.062	0.05	4.12	1.71	5.83	170	47	45	54	2.89	<0.0011	<0.000053	0.00091	0.00112	0.00058	0.002	0.0186	<0.7	Dry weather sample
Clifton	Wicklow Street East	11-Sep-14	9:55	9:15	Dry Flow	0.66	0	0	0	5.5	90	10	6.46	0.267	12.18	4.4	0.017	0.031	0.06	1.16	1.12	2.28	3654		933	79	5.58	<0.0011	<0.000053	0.00083	0.00138	0.00029	0.00172	0.021		Dry weather sample
Clifton	Wicklow Street East	26-Jan-15	11:20	14:44	Dry Flow	0.257	0	0	0	12	160	18	7.02	0.267	7.64	9.2	0.031	0.082	0.06	0.19	1.09	1.28	14540		350	45	2.64	<0.0021	<0.00011	0.0014	0.006	0.00124	0.0026	0.037		Dry weather sample
Clifton	Wicklow Street East	28-Aug-15	8:33	6:15	Dry High Flow	4.81	0	0	0.5	58						0.4							10950		148											Dry High Flow
Clifton	Wicklow Street East	14-Sep-15	9:34	8:25	Dry Moderate Flow	2.9	0	0	5.5	36.5						0.6							171		20											Dry Moderate Flow
Clifton	Wicklow Street East	02-Dec-15	15:12	8:37	Dry	0.71	0	0	0	42	90	16.2	6.68	0.285	3.98	2.2	0.002	0.019	0.01	0.62	3.08	3.7	11199		545	100	1.02	<0.0011	<0.000053	0.00088	0.00122	0.00017	0.0024	0.035		Dry weather sample
Clifton	Wicklow Street East	19-Jan-16	13:50	17:57	Dry Flow	0.5	0	0	0	54.5	75	15.1	6.44	0.273	2.15	7.2	0.038	0.021	0.02	1.15	0.79	1.94	8664		20	83	1.8	<0.0011	<0.000053	0.00084	0.00187	0.0005	0.0022	0.0188		Dry weather sample
Clifton	Wicklow Street East	24-May-16	11:19	9:26	Dry Flow	15	0	3	18.5	76						0.1							1300		76											
Clifton	Wicklow Street East	27-Jun-16	14:47	13:08	Dry	1.25	0	0	0	19						2.6							296		10											
Clifton	Wicklow Street East	27-Apr-12	22:19	0:11	Storm Flow	0.3	6.5	9	9	9	35	12	6.59	0.035	9.98	16	0.019	0.099	0.15	0.2	0.14	0.34	43320		6545	55	3.76	<0.0011	<0.000053	0.00134	0.0054	0.0061	0.0026	0.125	<0.7	
Clifton	Wicklow Street East	16-Jan-14	8:22	9:02	Wet Flow	5.45	1.5	3.5	9	50.5						0.8							9590		790											
Clifton	Wicklow Street East	24-Jan-14	13:03	14:42	Wet Flow	3	0	0	22	28.5						6.4							10344		456											
Clifton	Wicklow Street East	05-May-14	13:13	12:20	Storm Flow	1.9	0.5	9.5	9.5	43	80	12.6	6.23	0.189	6.46	1.5	0.016	0.043	0.02	0.67	0.58	2.25	2752		264	78	1.51	<0.0011	<0.000053	0.00074	0.00184	0.00059	0.0012	0.078	<0.7	
Clifton	Wicklow Street East	26-Jan-15	14:35	14:44	Storm Flow	0.255	3.5	9	9	21	110	17.5	6.58	0.087	8.14	21.4	0.014	0.098	0.11	0.74	0.96	1.7	136500		14136	44	2.75	<0.0011	<0.000053	0.00091	0.0031	0.0024	0.0022	0.091		
Clifton	Bluff Highway West (Lake Street)	22-Mar-12	8:17	8:41	Dry Flow	0.67	0	0	0	36.5	90	12	6.72	0.303	3.21	3	0.019	0.035	0.047	1.277	0.62	1.9	6488		221	79	1.34	<0.0011	<0.000053	0.00065	0.00151	0.00053	0.00177	0.047	<0.7	Dry weather sample
Clifton	Bluff Highway West (Lake Street)	05-Jul-12	8:28	8:49	Dry Flow	1.8	0	0	0	31.5	65	5.8	6.3	0.298	8.84	2.6	0.005	0.096	0.07	2.09	0.45	2.54	880		97	78	0.44	<0.0011	<0.000053	0.00076	0.0032	0.00053	0.00182	0.045	<0.7	Dry weather sample
Clifton	Bluff Highway West (Lake Street)	22-Nov-12	15:05	16:12	Dry Flow	0.89	0	0	0.5	15.5	100	16.8	6.48	0.291	8.36	6.2	0.011	0.057	0.03	0.95	0.81	1.76	7270		295	63	6.68	<0.0011	<0.000053	0.00076	0.00178	0.00094	0.0023	0.035	<0.7	Dry weather sample
Clifton	Bluff Highway West (Lake Street)	13-Mar-13	10:40	9:50	Dry Flow	0.2	0	0	5	3.5	45	13.3	6.62	0.318	4.91	0.2	0.027	0.032	0.02	0.92	0.4	1.32	6983		5	90	0.88	<0.0011	<0.000053	<0.00053	0.00123	0.00025	0.00101	0.062	<0.7	Dry weather sample
Clifton	Bluff Highway West (Lake Street)	21-Aug-13	8:40	7:39	Dry Flow	1.5	0	0	0	32	60	8.6	6.19	0.269	7.39	2.3	0.016	0.025	0.01	1.54	0.96	2.5	985		132	85	1.94	<0.0011	<0.000053	0.00104	0.00186	0.00036	0.002	0.032	<0.7	Dry weather sample
Clifton	Bluff Highway West (Lake Street)	14-Nov-13	8:15	5:59	Dry Flow	0.535	0	0	0	9.5	100	13.5	6.24	0.279	4.79	5.5	0.014	0.041	0.01	1.4	0.69	2.09	1937		120	78	4.01	<0.0011	<0.000053	0.00076	0.0024	0.0013	0.00189	0.027	<0.7	Dry weather sample
Clifton	Bluff Highway West (Lake Street)	11-Feb-14	7:57	6:32	Dry Flow	0.1	0	0	0	1	200	15	6.16	0.271	3.02	16.4	0.002	0.058	0.05	3.28	1.04	4.32	300	33	31	66	2.21	<0.0011	<0.000053	0.0008	0.00169	0.00097	0.00181	0.03	<0.7	Dry weather sample
Clifton	Bluff Highway West (Lake Street)	11-Sep-14	10:05	9:15	Dry Flow	0.66	0	0	0	5.5	90	10	6.52	0.312	11.26	5.3	0.017	0.025	0.1	1.52	0.5	2.02	1725		187	71	3.72	<0.0011	<0.000053	0.00094	0.00148	0.00053	0.0018	0.031		Dry weather sample
Clifton	Bluff Highway West (Lake Street)	26-Jan-15	11:35	14:44	Dry Flow	0.257	0	0	0	12	120	18.2	7.03	0.592	7.83	21.2	0.027	0.069	2.03	1.24	1.07	2.31	16500		40	30	2.33	<0.0011	<0.000053	0.00116	0.0026	0.0013	0.0021	0.041		Dry weather sample
Clifton	Bluff Highway West (Lake Street)	28-Aug-15	8:30	6:15	Dry High Flow	4.81	0	0	0.5	58						0.8							1340		40											Dry High Flow
Clifton	Bluff Highway West (Lake Street)	14-Sep-15	9:36	8:25	Dry Moderate Flow	2.9	0	0	5.5	36.5						0.8							669		2											Dry Moderate Flow
Clifton	Bluff Highway West (Lake Street)	02-Dec-15	15:18	8:37	Dry	0.71	0	0	0	42	90	19.2	6.67	0.283	7.36	3.8	0.005	0.022	0.01	1.34	3.97	2.95	12098		287	88.5	2.63	<0.0011	<0.000053	0.00085	0.00154	0.00056	0.0022	0.037		Dry weather sample
Clifton	Bluff Highway West (Lake Street)	19-Jan-16	13:54	17:57	Dry Flow	0.5	0	0	0	54.5	70	14.2	6.52	0.281	7.15	22.8	0.025	0.027	0.03	1.57	1.16	2.73	14136		520	59	2.92	<0.0011	<0.000053	0.00109	0.00179	0.00151	0.0025	0.04		Dry weather sample
Clifton	Bluff Highway West (Lake Street)	24-May-16	11:28	9:26	Dry Flow	15	0	3	18.5	76						0.8							768		10											
Clifton	Bluff Highway West (Lake Street)	27-Jun-16	15:00	13:08	Dry	1.25	0	0	0	19						1.9							1610		62											
Clifton	Bluff Highway West (Lake Street)	28-Apr-12	0:57	0:11	Storm Flow	0.3	6.5	9	9	9	200	12	6.59	0.282	7.19	3.2	0.037	0.099	0.07	0.63	0.18	0.81	86645		995	66	4.27	<0.0011	<0.000053	0.00067	0.00146	0.00058	0.00141	0.0128	<0.7	
Clifton	Bluff Highway West (Lake Street)	16-Jan-14	8:20	9:02	Wet Flow	5.45	1.5	3.5	9	50.5						1.6							13775		1725											
Clifton	Bluff Highway West (Lake Street)	24-Jan-14	13:05	14:42	Wet Flow	3	0	0	22	28.5						0.4							6896		544											
Clifton	Bluff Highway West (Lake Street)	05-May-14	13:05	12:20	Storm Flow	1.9	0.5	9.5	9.5	43	60	12	6.28	0.172	7.35	3.3	0.023	0.112	0.01	0.47	0.54	1.01	2668		240	84	1.28	<0.0011	<0.000053	0.00077	0.0031	0.00061	0.00129	0.074	<0.7	Pumping from Prestonville
Clifton	Bluff Highway West (Lake Street)	26-Jan-15	14:45	14:44	Storm Flow	0.255	3.5	9	9	21	90	17.5	6.53	0.105	8.03	24	0.035	0.082	0.08	0.89	0.81	1.7	151000		8664	46	2.79	<0.0011	<0.000053	0.001	0.0036	0.0029	0.0023	0.1		
Kingswell	Chesney Street (Up Stream)	22-Mar-12	8:25	8:41	Dry Flow	0.67	0	0	0	36.5	90	11.9	6.69	0.308	5.57	2.4	0.032	0.059	0.066	1.371	1	2.15	12095		207	79	2.62	<0.0011	<0.000053	0.0009	0.00184	0.00026	0.00126	0.0115	<0.7	Storm Sample
Kingswell	Chesney Street (Up Stream)	05-Jul-12	9:13	8:49	Dry Flow	1.8	0	0	0	31.5	90	6.3	6.16	0.304	11.08	8.1	0.009	0.057	0.18	3.1	0.73	3.83	3076		601	71	1.36	<0.0011	<0.000053	0.00093	0.00195	0.00028	0.00124	0.016	<0.7	Storm Sample
Kingswell	Chesney Street (Up Stream)	22-Nov-12	14:18	16:12	Dry Flow	0.89	0	0	0	15.5	110	16.5	7.05	0.277	14.91	2.8	0.021	0.062	0.01	2.09	0.88	2.97	3080		863	76	9.83	<0.0011	<0.000053	0.00109	0.00179	0.00017	0.00148	0.0066	<0.7	Storm Sample
Kingswell	Chesney Street (Up Stream)	13-Mar-13	10:20	9:50	Dry Flow	0.2	0	0	0.5	3.5	280	14.2	6.64	0.331	3.28	4	0.12	0.199	0.09	0.42	0.66	1.08	15531		7270	56	6.42	<0.0011	<0.000053	0.00081	0.00155	0.00058	0.00108	0.046	<0.7	Storm Sample
Kingswell	Chesney Street (Up Stream)	14-Mar-13	15:50	10:33	Elevated E. coli Repeat Sample	0.2	0	0	0	2													4320		980											Pumping from Prestonville

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Sampling Event	Flow	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Dissolved Oxygen	Suspended Solids	Dissolved Reactive Phosphorus	Total Phosphorus	Ammonia	Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Coliform MPN/100 ml	Faecal Coliform CFU/100 ml	Escherichia coli MPN/100 ml	SHMAK	Chlorophyll a	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Nickel	Total Zinc	Total Petroleum Hydrocarbons	Comment
1	1	1			1		mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l as N	mg/l as N	mg/l	mg/l				cm	mg/m3	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Kingswell	Chesney Street (Up Stream)	21-Aug-13	8:05	7:39	Dry Flow	1.5	0	0	0	32	80	8.6	6.22	0.279	8.89	3.1	0.018	0.018	0.03	2.03	0.93	2.96	1291		173	75	1.87	<0.0011	<0.000053	0.00108	0.00189	0.00019	0.00151	0.0095	<0.7	Wet weather extra sampling
Kingswell	Chesney Street (Up Stream)	14-Nov-13	8:15	5:59	Dry Flow	0.535	0	0	0	9.5	140	12.9	6.41	0.275	6.94	2.2	0.02	0.046	0.01	1.02	0.75	1.77	5600		507	71	5.89	<0.0011	<0.000053	0.00084	0.00194	0.00086	0.00151	0.0105	<0.7	Wet weather extra sampling
Kingswell	Chesney Street (Up Stream)	10-Feb-14	11:25	5:41	Dry Flow	0.11	0	0	0	1	150	15.6	6.68	0.291	6.93	3.1	0.023	0.091	0.02	0.17	1.17	1.34	1100	180	150	86	4.57	<0.0011	<0.000053	0.00079	0.00151	0.00015	0.00163	0.0056	<0.7	Wet weather extra sampling
Kingswell	Chesney Street (Up Stream)	11-Sep-14	9:40	9:15	Dry Flow	0.66	0	0	0	5.5	100	8.6	6.49	0.286	9.97	4.2	0.023	0.071	0.05	1.7	0.96	2.66	3282		754	63	3.62	<0.0011	<0.000053	0.00099	0.00196	0.00026	0.00163	0.0092		Wet weather extra sampling
Kingswell	Chesney Street (Up Stream)	26-Jan-15	11:05	14:44	Dry Flow	0.257	0	0	0	12	200	17	6.71	0.345	3.32	3.4	0.072	0.153	0.04	0.59	1.62	2.21	31.62		462	65	5.56	<0.0011	<0.000053	0.00099	0.0026	0.00052	0.0034	0.0115		Wet weather extra sampling
Kingswell	Chesney Street (Up Stream)	28-Aug-15	8:40	6:15	Dry High Flow	4.81	0	0	0.5	58						2.4							3978		2548											
Kingswell	Chesney Street (Up Stream)	14-Sep-15	9:11	8:25	Dry Moderate Flow	2.9	0	0	5.5	36.5						2.2							2382		1396											
Kingswell	Chesney Street (Up Stream)	02-Dec-15	15:00	8:37	Dry	0.71	0	0	0	42	150	19.1	6.73	0.286	10.33	3.8	0.074	0.027	0.03	1.06	0.94	2	4082		429	62.5	6.56	<0.0011	<0.000053	0.000114	0.0023	0.00024	0.0023	0.0106		
Kingswell	Chesney Street (Up Stream)	19-Jan-16	13:40	17:57	Dry Flow	0.5	0	0	0	54.5	180	15	6.56	0.295	5.86	5.2	0.047	0.065	0.02	1.59	1.24	2.83	14136		122	73	1.9	<0.0011	<0.000053	0.00101	0.0028	0.0005	0.0023	0.024		
Kingswell	Chesney Street (Up Stream)	24-May-16	11:14	9:26	Dry Flow	15	0	3	18.5	76						6							3316		486											
Kingswell	Chesney Street (Up Stream)	27-Jun-16	14:35	13:08	Dry	1.25	0	0	0	19						3.5							2518		596											
Kingswell	Chesney Street (Up Stream)	27-Apr-12	21:10	0:01	Storm Flow	0.3	6.5	9	9	9	180	12	6.61	0.319	4.35	4.5	0.048	0.141	0.14	1.14	0.51	1.66	16410		610	64	5.59	<0.0011	<0.000053	0.00093	0.0022	0.0004	0.00153	0.0099	<0.7	
Kingswell	Chesney Street (Up Stream)	16-Jan-14	8:29	9:02	Wet Flow	5.45	1.5	3.5	9	50.5						0.4							13734		738											
Kingswell	Chesney Street (Up Stream)	24-Jan-14	12:58	14:42	Wet Flow	3	0	1	22	28.5						3.2							48392		9222											
Kingswell	Chesney Street (Up Stream)	05-May-14	13:05	12:20	Storm Flow	1.9	0.5	9.5	9.5	43	100	12.5	6.29	0.257	6.68	4.7	0.035	0.08	0.06	1.58	0.92	2.5	4564		1112	66	3.33	<0.0011	<0.000053	0.00115	0.0028	0.00025	0.00195	0.0168	<0.7	
Kingswell	Chesney Street (Up Stream)	26-Jan-15	14:25	14:44	Storm Flow	0.255	3.5	9	9	21	160	16	6.66	0.347	3.18	13	0.084	0.208	0.03	0.37	1.41	1.78	102500		14136	42	6.95	<0.0011	<0.000053	0.00081	0.0023	0.00043	0.0031	0.0103		Not pumping from Prestonville
Kingswell	Bluff Road (Down Stream)	22-Mar-12	8:15	8:41	Dry Flow	0.67	0	0	0	36.5	90	13.1	6.78	1.29	5.03	3.5	0.025	0.067	0.01	0.145	0.66	2.03			55	82	4.25	<0.0011	<0.000053	0.00089	0.0021	0.00049	0.00182	0.029	<0.7	Repeat Sampling due to E.coli >1000 22/3/12
Kingswell	Bluff Road (Down Stream)	05-Jul-12	8:23	8:49	Dry Flow	1.8	0	0	0	31.5	80	6	6.45	0.352	10.78	4.1	0.008	0.048	0.11	3.07	0.82	3.89	1296		620	68	1.34	<0.0011	<0.000053	0.00091	0.0024	0.00063	0.00142	0.037	<0.7	Repeat Sampling due to E.coli >1000 5/7/12
Kingswell	Bluff Road (Down Stream)	22-Nov-12	15:34	16:12	Dry Flow	0.89	0	0	0	15.5	110	19.6	7.14	0.336	12.54	1.8	0.019	0.044	0.04	1.09	0.82	1.91	2306		945	78	4.74	<0.0011	<0.000053	0.00073	0.0018	0.00047	0.00139	0.0166	<0.7	Repeat Sampling due to E.coli >1000 22/11/12
Kingswell	Bluff Road (Down Stream)	13-Mar-13	10:50	9:50	Dry Flow	0.2	0	0	0.5	3.5	90	16	6.95	2.59	7.49	3.1	0.039	0.06	0.16	0.31	0.86	1.17	9600		43	79	3.48	<0.0011	<0.00011	<0.0011	<0.0011	0.00028	0.0013	0.0176	<0.7	Repeat Sampling due to E.coli >1000 13/03/13
Kingswell	Bluff Road (Down Stream)	21-Aug-13	8:05	7:39	Dry Flow	1.5	0	0	0	32	80	8.9	6.47	0.378	9.46	3.1	0.007	0.006	0.09	2.52	0.81	3.33	2755		388	77	1.97	<0.0011	<0.000053	0.00097	0.002	0.00038	0.00151	0.0022	<0.7	Storm Sample
Kingswell	Bluff Road (Down Stream)	14-Nov-13	8:09	5:59	Dry Flow	0.535	0	0	0	9.5	140	13.8	6.51	0.296	4.34	1	0.046	0.047	0.02	1.42	0.65	2.07	1724		248	84	5.69	<0.0011	<0.000053	0.00081	0.0023	0.00084	0.00156	0.02	<0.7	Storm Sample
Kingswell	Bluff Road (Down Stream)	10-Feb-14	13:20	5:41	Dry Flow	0.11	0	0	0	1	80	18.1	6.92	0.281	10.21	1.2	0.005	0.078	0.01	0.27	0.83	1.1	1560	40	35	90	1.9	<0.0011	<0.000053	0.0006	0.00163	0.00038	0.00137	0.021	<0.7	Storm Sample
Kingswell	Bluff Road (Down Stream)	11-Sep-14	10:00	9:15	Dry Flow	0.66	0	0	0	5.5	100	10	6.53	0.407	9.94	2.2	0.028	0.044	0.08	1.95	0.94	2.89	3873		842	74	2.16	<0.0011	<0.000053	0.00078	0.0031	0.0004	0.0018	0.033		Storm Sample
Kingswell	Bluff Road (Down Stream)	26-Jan-15	11:30	14:44	Dry Flow	0.257	0	0	0	12	80	19.7	6.77	1.416	1.36	5.2	0.026	0.055	0.09	0.09	2.09	2.18	5750		60	82	1.77	0.0012	0.000146	<0.00053	0.00196	0.0006	0.00182	0.0032		Storm Sample
Kingswell	Bluff Road (Down Stream)	28-Aug-15	8:47	6:15	Dry High Flow	4.81	0	0	0.5	58						3.2							1816		1112											
Kingswell	Bluff Road (Down Stream)	14-Sep-15	9:05	8:25	Dry Moderate Flow	2.9	0	0	5.5	36.5						1.2							2481		583											
Kingswell	Bluff Road (Down Stream)	02-Dec-15	15:23	8:37	Dry	0.71	0	0	0	42	120	21.2	6.72	0.299	12.92	2.4	0.049	0.014	0.03	1.36	1.04	2.4	9930		390	81	3.74	<0.0011	<0.000053	0.00093	0.0037	0.0006	0.003	0.028		
Kingswell	Bluff Road (Down Stream)	19-Jan-16	14:05	17:57	Dry Flow	0.5	0	0	0	54.5	100	15.4	6.66	0.323	6.38	6.8	0.036	0.06	0.02	1.66	1	2.66	21430		395	86	2.72	<0.0011	<0.000053	0.00077	0.0023	0.00052	0.00168	0.037		
Kingswell	Bluff Road (Down Stream)	24-May-16	10:51	9:26	Dry Flow	15	0	3	18.5	76						4.4							2420		492											
Kingswell	Bluff Road (Down Stream)	27-Jun-16	14:58	13:08	Dry	1.25	0	0	0	19						2.9							1772		928											
Kingswell	Bluff Road (Down Stream)	28-Apr-12	0:00	0:11	Storm Flow	0.3	6.5	9	9	9	50	11	6.65	0.075	6.86	5.9	0.019	0.121	0.12	0.44	0.2	0.64	27375		1405	17	5.75	<0.0011	<0.000053	<0.00053	0.0023	0.00094	0.0009	0.086	<0.7	
Kingswell	Bluff Road (Down Stream)	16-Jan-14	8:40	9:02	Wet Flow	5.45	1.5	3.5	9	50.5						3.6							22397		1434											
Kingswell	Bluff Road (Down Stream)	24-Jan-14	12:50	14:42	Wet Flow	3	0	1	22	28.5						0.4							31062		4494											
Kingswell	Bluff Road (Down Stream)	05-May-14	13:15	12:20	Storm Flow	1.9	0.5	9.5	9.5	43	90	15	6.37	0.147	9.24	4	0.02	0.086	0.05	0.72	0.75	1.47	9222		4564	63	1.57	<0.0011	<0.000053	0.00114	0.003	0.00095	0.00177	0.103	<0.7	
Kingswell	Bluff Road (Down Stream)	26-Jan-15	14:40	14:44	Storm Flow	0.255	3.5	9	9	21	100	17.6	6.5	0.097	5.95	29	0.058	0.094	0.05	0.03	0.73	0.76	29650		1234	46	1.29	<0.0011	<0.000053	0.00104	0.0067	0.0029	0.0037	0.06		
Otepuni	Rockdale Road East (Up Stream)	22-Mar-12	9:20	8:41	Dry Flow	0.66	0	0	0	36.5	70	11.4	6.77	0.296	8.09	5.6	0.023	0.054	0.009	1.092	0.63	1.72	6867		663	81	3.69	<0.0011	<0.000053	0.00068	0.0022	0.00018	0.00194	0.0114	<0.7	Wet weather extra sampling
Otepuni	Rockdale Road East (Up Stream)	05-Jul-12	9:06	8:49	Dry Flow	1.8	0	0	0	31.5	90	6.3	6.22	0.277	10.75	2.6	0.012	0.022	0.07	2.57	0.76	3.33	4106		262	76	0.056	<0.0011	<0.000053	0.00065	0.0022	0.00023	0.00186	0.0156	<0.7	
Otepuni	Rockdale Road East (Up Stream)	11-Dec-12	9:50	6:33	Dry Flow	0.67	0	0	0	47	100	13	6.67	0.245	9.33	3	0.016	0.034	0.032	1.108	0.94	2.05	3076		238	70	13.97	<0.0011	<0.000053	0.00062	0.00161	0.00011	0.0025	0.0065	<0.7	
Otepuni	Rockdale Road East (Up Stream)	14-Mar-13	10:40	10:33	Dry Flow	0.2	0	0	0	2	140	13.5	6.62	0.266	7.42	3.3	0.059	0.063	0.07	0.18	0.37	0.55	3441		393	66	10.06	<0.0011	<0.000053	<0.00053	0.0009	0.00025	0.00161	0.0025	<0.7	
Otepuni	Rockdale Road East (Up Stream)	21-Aug-13	7:15	7:39	Dry Flow	1.5	0	0	0	32	80	8.3	6.26	0.257	10.19	5.9	0.009	0.012	0.03	2.87	0.69	3.56	443		86	72	2.98	<0.0011	<0.000053	0.00095	0.00196	0.00021	0.0022	0.0087	<0.7	
Otepuni	Rockdale Road East (Up Stream)	19-Nov-13	8:32	9:48	Dry Flow	0.54	0	0	0	9.5	135	14	6.43	0.268	8.95	2.1	0.025	0.096	0.04	0.61	0.43	1.04			1241	81	18.34	<0.0011	<0.000053	0.00061	0.002	0.00032	0.0025	0.0078	<0.7	
Otepuni	Rockdale Road East (Up Stream)	11-Feb-14	8:40	6:32	Dry Flow	0.1	0	0	0	1	100	15.1	6.43	0.244	5.99	5.6	0.009	0.051	0.05	0.18	0.87	1.05	1100	360	340	71	11.06	<0.0011	<0.000053	0.00057	0.00119	0.00024	0.00182	0.0028	<0.7	
Otepuni	Rockdale Road East (Up Stream)	11-Sep-14	8:30	9:15	Dry Flow	0.66	0	0	0	5.5	100	8	6.46	0.275	10.48	7.1	0.012	0.033	0.03	1.15	0.33	1.58	8164		60	60	5.08	<0.0011	<0.000053	0.00075	0.00168	0.00037	0.0025	0.0085		
Otepuni	Rockdale Road East (Up Stream)	25-Jun-15	13:50	14:31	Dry Flow	5.7	0	0	0	33	100	7	6.22	0.257	10.81	8.8	0.017	0.073	0.098	3.02	5.39	8.41	1210		104	59	2.63	<0.0011	<0.000053	0.00078	0.00183	0.00024	0.002	0.0097		
Otepuni	Rockdale Road East (Up Stream)	28-Aug-15	9:10	6:15	Dry High Flow	4.81	0	0	0.5	58						7.6								1498	320											
Otepuni	Rockdale Road East (Up Stream)	09-Sep-15	14:50	17:21	Dry Moderate Flow	4.6	0	0	2.5	46						12.8								836	350											
Otepuni	Rockdale Road East (Up Stream)	19-Jan-16	13:50	17:57	Dry Flow	0.5	0	0	0	54.5	160	15	6.7	0.255	9.71	6.8	0.049	0.055	0.06	2.19	0.88	3.07		9804	799	60	5.98	<0.0011	<0.000053	0.00086	0.0025	0.00029	0.0023	0.0071		
Otepuni	Rockdale Road East (Up Stream)	04-May-16	9:20	5:20	Dry Flow	1.32	0	0	0	11.5	70	10.5	6.93	0.246	8.71	3	0.015	0.055	0.09	1.01	1.17	1.1		2481	327	79	3.25	0.00028	<0.00005	0.0013	0.0016	0.00012	0.0019	0.0084		
Otepuni	Rockdale Road East (Up Stream)	24-May-16	10:45	9:26	Dry Flow	15	0	3	18.5	76						4								2344	406											
Otepuni	Rockdale Road East (Up Stream)	27-Jun-16	14:25	13:08	Dry Flow	1.25	0	0	0	19						4.2								1968	264											
Otepuni	Rockdale Road East (Up Stream)	27-Apr-12	23:16	0:11	Storm Flow	0.3	6.5	10	10	10	90	11.5	6.77	0.264	8.22	2.5	0.018	0.042	0.04	0.29	0.58	0.87	99315		5215	77	6.47	<0.0011	<0.000053	<0.00053	0.00098	0.00016	0.00174	0.0037	<0.7	
Otepuni	Rockdale Road East (Up Stream)	16-Jan-14	10:10	9:02	Wet Flow	5.45	0	3.5	9	50.5						0.4							10344		1816											
Otepuni	Rockdale Road East (Up Stream)	24-Jan-14	13:30	14:42	Wet Flow	3	0	0	22	28.5						2.4							39726		8704											
Otepuni	Rockdale Road East (Up Stream)	16-Apr-14	10:06	9:27	Storm Flow	0.6	0.5	20	20	27.5	120	11.5	6.42	0.234	8.97	6.9	0.04	0.129	0.07	0.83	0.34	1.17	240960		17328	57	4.81	<0.0011	<0.000053	0.00082	0.0025	0.00038	0.0029	0.0124	<0.7	
Otepuni	Rockdale Road East (Up Stream)	26-Jan-15	12:45	14:44	Storm Flow	0.255	5	5	5	18	280	17	6.62	0.269	5.37	5.4	0.056	0.106	0.17	0.72	2.13	2.84	740		300	50	11.6	<0.0011	<0.000053	0.00062	0.00144	0.00047	0.0021	0.0047		

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Sampling Event	Flow	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Dissolved Oxygen	Suspended Solids	Dissolved Reactive Phosphorus	Total Phosphorus	Ammonia	Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Coliform	Faecal Coliform	Escherichia coli	SHMAK	Chlorophyll a	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Nickel	Total Zinc	Total Petroleum Hydrocarbons	Comment
1	1	1			1		mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	MPN/100 ml	CFU/100 ml	MPN/100 ml	cm	mg/m3	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	22-Mar-12	9:10	8:41	Dry Flow	0.66	0	0	0	36.5	70	12.2	6.79	0.268	7.69	1.4	0.023	0.052	0.01	1.162	0.57	1.73	5172		256	79	4.44	<0.0011	<0.000053	0.00066	0.0028	0.00044	0.0021	0.027	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	05-Jul-12	8:58	8:49	Dry Flow	1.8	0	0	0	31.5	80	6.2	6.41	0.272	10.17	3.2	0.017	0.026	0.06	2.2	0.93	3.13	2359		256	72	0.09	<0.0011	<0.000053	0.00099	0.0023	0.00043	0.0019	0.0197	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	11-Dec-12	9:40	6:33	Dry Flow	0.67	0	0	0	47	100	13	6.81	0.246	11.65	1.7	0.02	0.034	0.019	1.108	0.67	1.78	1539		108	83	7.79	<0.0011	<0.000053	0.00059	0.002	0.00028	0.0024	0.021	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	14-Mar-13	10:50	10:33	Dry Flow	0.2	0	0	0	2	60	15.5	6.63	0.268	5.19	0.7	0.036	0.061	0.16	0.63	0.35	0.98	24200		52	92	1.8	<0.0011	<0.000053	<0.00053	0.00144	0.00028	0.00143	0.027	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	21-Aug-13	7:26	7:39	Dry Flow	1.5	0	0	0	32	60	8.6	6.41	0.254	9.83	2.8	0.041	0.042	0.03	2.58	0.53	3.11	1172		180	56	2.31	<0.0011	<0.000053	0.00085	0.002	0.00042	0.002	0.0143	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	19-Nov-13	8:58	9:48	Dry Flow	0.54	0	0	0	9.5	100	14.6	6.64	0.256	9.54	0.7	0.019	0.055	0.02	0.7	0.38	1.08			788	82	8.92	<0.0011	<0.000053	0.00067	0.0022	0.00042	0.0023	0.019	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	11-Feb-14	8:35	6:32	Dry Flow	0.1	0	0	0	1	60	16.9	6.4	0.242	3.31	1.1	0.011	0.024	0.03	1.06	0.68	1.74	1130	113	105	84	3.23	<0.0011	<0.000053	<0.00053	0.00159	0.00035	0.00162	0.021	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	11-Sep-14	8:50	9:15	Dry Flow	0.66	0	0	0	5.5	90	8.6	6.56	0.257	10.26	2.1	0.011	0.037	0.03	1.29	0.29	1.58	9804		73	73	3.59	<0.0011	<0.000053	0.00056	0.00179	0.00027	0.0023	0.0171		
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	25-Jun-15	14:00	14:31	Dry Flow	5.7	0	0	0	33	100	7	6.35	0.251	10.58	0.8	0.017	0.034	0.092	2.82	1.3	4.12	2472		456	58	1.99	<0.0011	<0.000053	0.00085	0.00199	0.00025	0.002	0.0137		
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	28-Aug-15	9:05	6:15	Dry High Flow	4.81	0	0	0.5	58						0.1								48392	2092											
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	09-Sep-15	15:02	17:21	Dry Moderate Flow	4.6	0	0	2.5	46						3.2								820	296											
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	19-Jan-16	13:55	17:57	Dry Flow	0.5	0	0	0	54.5	120	15.6	6.83	0.258	11.29	2	0.05	0.055	0.02	2.58	0.85	3.43		8664	426	83	3.25	<0.0011	<0.000053	0.00068	0.0022	0.00035	0.002	0.0172		
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	04-May-16	9:45	5:20	Dry Flow	1.32	0	0	0	11.5	90	10.6	6.7	0.248	9.93	2.4	0.019	0.041	0.07	0.98	1.03	1.05		2104	464	88	2.58	0.00036	<0.00005	0.00084	0.0018	0.00018	0.0019	0.012		
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	24-May-16	10:35	9:26	Dry Flow	15	0	3	18.5	76						6.8								3000	924											
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	27-Jun-16	14:12	13:08	Dry Flow	1.25	0	0	0	19						2.9								4494	990											
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	27-Apr-12	23:41	0:11	Storm Flow	0.3	6.5	10	10	10	80	12.4	6.58	0.062	8.78	16.8	0.04	0.066	0.13	0.42	0.73	1.15	23055		800	42	6.96	0.0012	<0.000053	0.00116	0.0058	0.0036	0.0027	0.137	<0.7	
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	16-Jan-14	10:22	9:02	Wet Flow	5.45	0	3.5	9	50.5						0.8							13734		1974											
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	24-Jan-14	13:38	14:42	Wet Flow	3	0	0	22	28.5						2							31062		13976											
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	16-Apr-14	10:24	9:27	Storm Flow	0.6	0.5	20	20	27.5	50	12.5	6.54	0.155	8.83	5	0.039	0.069	0.12	0.86	0.39	1.25	9222		3214	64	1.77	<0.0011	<0.000053	0.00071	0.0032	0.00107	0.00189	0.154	<0.7	Not pumping from Prestonville
Otepuni	Lindisfarne Street West (5m Down Stream of South Outfall)	26-Jan-15	13:15	14:44	Storm Flow	0.255	5	5	5	18	120	17.4	6.57	0.141	7.25	22	0.047	0.149	0.03	0.4	2.21	2.61	8625		2640	22	2.3	0.0012	<0.000053	0.001	0.0079	0.0041	0.0024	0.164		
Otepuni	Mersey Street Bridge East	22-Mar-12	8:50	8:41	Dry Flow	0.66	0	0	0	36.5	70	12.7	7.03	0.296	8.26	7.9	0.029	0.048	0.015	1.371	0.46	1.83	9804		441	70	3.89	<0.0011	<0.000053	0.00079	0.0028	0.00076	0.00193	0.037	<0.7	
Otepuni	Mersey Street Bridge East	05-Jul-12	8:45	8:49	Dry Flow	1.8	0	0	0	31.5	80	6.4	6.5	0.269	10.15	6	0.009	0.048	0.08	3.02	0.84	3.86	2613		488	70	1	<0.0011	<0.000053	0.00079	0.0029	0.00082	0.0025	0.029	<0.7	
Otepuni	Mersey Street Bridge East	11-Dec-12	9:30	6:33	Dry Flow	0.67	0	0	0	47	70	13.3	6.91	0.343	10.07	5	0.023	0.05	0.02	1.108	1.05	2.16	2909		426	66	9.52	<0.0011	<0.000053	0.00073	0.0028	0.00079	0.0025	0.035	<0.7	
Otepuni	Mersey Street Bridge East	14-Mar-13	12:05	10:33	Dry Flow	0.2	0	0	0	2	70	17.5	7.14	5.43	10.01	16.6	0.025	0.123	0.13	1.16	0.54	1.7	12997		691	47	12.58	<0.0053	<0.00027	<0.0027	<0.0027	0.00142	<0.0027	0.03	<0.7	
Otepuni	Mersey Street Bridge East	21-Aug-13	7:50	7:39	Dry Flow	1.5	0	0	0	32	40	8.9	6.56	0.277	9.49	14.3	0.036	0.042	0.04	2.62	0.44	3.06	1500		395	63	2.19	<0.0011	<0.000053	0.00088	0.0023	0.00042	0.0021	0.0193	<0.7	
Otepuni	Mersey Street Bridge East	19-Nov-13	9:25	9:48	Dry Flow	0.54	0	0	0	9.5	100	15.6	6.75	0.842	8.54	3.4	0.03	0.068	0.03	1.11	0.42	1.53			742	76	11.68	<0.0011	<0.000053	0.00057	0.0023	0.00076	0.0022	0.032	<0.7	
Otepuni	Mersey Street Bridge East	11-Feb-14	8:25	6:32	Dry Flow	0.1	0	0	0	1	60	17.1	6.62	0.85	5.35	10.8	0.014	0.084	0.04	0.48	0.64	1.12	12300	620	590	31	13.24	<0.0011	<0.000053	0.00082	0.0024	0.00107	0.00188	0.027	<0.7	
Otepuni	Mersey Street Bridge East	11-Sep-14	9:15	9:15	Dry Flow	0.66	0	0	0	5.5	90	9	6.74	1.289	10.07	1.1	0.033	0.069	0.07	1.4	0.58	1.98	3130		70	70	2.84	<0.0011	<0.000053	0.00081	0.0023	0.0007	0.0028	0.034		
Otepuni	Mersey Street Bridge East	25-Jun-15	14:10	14:31	Dry Flow	5.7	0	0	0	33	100	7	6.46	0.261	11.64	2.1	0.014	0.102	0.095	2.97	1.43	4.4	1920		466	52	2.41	<0.0011	<0.000053	0.00082	0.034	0.00095	0.0024	0.23		
Otepuni	Mersey Street Bridge East	28-Aug-15	9:00	6:15	Dry High Flow	4.81	0	0	0.5	58						4.4								1866	426											
Otepuni	Mersey Street Bridge East	09-Sep-15	17:00	17:21	Dry Moderate Flow	4.6	0	0	2.5	46						3.2								1956	487											
Otepuni	Mersey Street Bridge East	19-Jan-16	15:45	17:57	Dry Flow	0.5	0	0	0	54.5	60	15.8	7.13	1.156	11.25	31.6	0.057	0.183	0.03	2.07	2.91	4.98		12033	990	32	13.8	<0.0011	<0.000053	0.00176	0.0051	0.00179	0.0035	0.036		
Otepuni	Mersey Street Bridge East	04-May-16	8:55	5:20	Dry Flow	1.32	0	0	0	11.5	90	10.4	6.76	0.272	9.81	4.4	0.016	0.077	0.09	1.34	1.13	1.43		2909	313	79	3.02	0.0004	<0.00005	0.0012	0.0018	0.00037	0.0019	0.016		
Otepuni	Mersey Street Bridge East	24-May-16	8:50	9:26	Dry Flow	15	0	3	18.5	76						10.4								1976	456											
Otepuni	Mersey Street Bridge East	27-Jun-16	13:55	13:08	Dry Flow	1.25	0	0	0	19						4.1								3870	900											
Otepuni	Mersey Street Bridge East	28-Apr-12	0:13	0:11	Storm Flow	0.3	6.5	10	10	10	140	12.3	6.82	0.664	8.61	19.8	0.021	0.049	0.09	0.76	0.68	1.44	43320		1405	32	9.48	0.0014	<0.000053	0.00164	0.0051	0.0027	0.0028	0.143	<0.7	
Otepuni	Mersey Street Bridge East	16-Jan-14	10:32	9:02	Wet Flow	5.45	0	3.5	9	50.5						6.8							32500		6152											
Otepuni	Mersey Street Bridge East	24-Jan-14	13:58	14:42	Wet Flow	3	0	0	22	28.5						5.6							48392		12262											
Otepuni	Mersey Street Bridge East	16-Apr-14	8:40	9:27	Storm Flow	0.6	0.5	20	2	27.5	30	12.4	6.64	0.097	8.59	2.3	0.018	0.045	0.06	0.29	0.31	0.6	6896		2366	63	1.03	<0.0011	<0.000053	0.00064	0.0026	0.00111	0.00129	0.116	<0.7	
Otepuni	Mersey Street Bridge East	26-Jan-15	13:40	14:44	Storm Flow	0.255	5	5	5	18	100	18	6.68	0.247	7.12	181	0.034	0.648	0.06	0.5	1.86	2.36	805		805	10	15.2	0.0044	0.000092	0.0081	0.02	0.0153	0.015	0.27		
Waihopai	Racecourse Road 50m Upstream	22-Mar-12	9:40	8:41	Dry Flow	0.66	0	0	0	28.5	60	13.1	6.77	0.218	8.47	2.5	0.025	0.038	0.04	1.746	0.48	2.23	5231		620	83	2.98	<0.0011	<0.000053	<0.00053	0.0063	0.00033	0.00119	0.0063	<0.7	
Waihopai	Racecourse Road 50m Upstream	05-Jul-12	9:30	8:49	Dry Flow	1.8	0	0	0	36.5	40	5	6.43	0.23	11.81	8.2	0.017	0.02	0.07	3.98	0.39	4.37	3076		354	75	1.02	<0.0011	<0.000053	<0.00053	0.0063	0.00058	0.00116	0.0069	<0.7	
Waihopai	Racecourse Road 50m Upstream	11-Dec-12	10:10	6:33	Dry Flow	0.67	0	0	0	45.5	50	14.5	6.97	0.201	11.43	3.2	0.019	0.032	0.02	1.91	0.57	2.48	644		256	84	5.49	<0.0011	<0.000053	<0.00053	0.00097	0.00012	0.00151	0.0029	<0.7	
Waihopai	Racecourse Road 50m Upstream	12-Mar-13	8:45	9:06	Dry Flow	0.16	0	0	0	4	40	14.7	6.48	0.196	6.92	1.3	0.021	0.043	0.03	1.14	0.25	1.39	4082		386	84	6.42	<0.0011	<0.000053	<0.00053	0.00015	0.00012	0.0012	0.0031	<0.7	
Waihopai	Racecourse Road 50m Upstream	21-Aug-13	9:03	7:39	Dry Flow	1.5	0	0	0	23.5	30	9	6.29	0.222	9.4	3	0.004	0.017	0.01	4.38	0.38	4.76	1092		282	98	2.43	<0.0011	<0.000053	<0.00053	0.00095	0.00012	0.00117	0.005	<0.7	
Waihopai	Racecourse Road 50m Upstream	19-Nov-13	8:48	9:48	Dry Flow	0.54	0	0	0	3	35	15.7	6.71	0.205	9.73	4	0.014	0.02	0.02	1.47	0.56	2.03	3066		480	88	9	<0.0011	<0.000053	<0.00053	0.0014	0.00026	0.00141	0.0043	<0.7	
Waihopai	Racecourse Road 50m Upstream	10-Feb-14	10:35	5:41	Dry Flow	0.11	0	0	0	1	40	16.1	6.88	0.19	11.13	1.6	0.002	0.045	0.02	0.98	0.56	1.54	490	150	129	84	4.62	<0.0011	<0.000053	<0.00053	0.00087	<0.00011	0.00112	0.0016	<0.7	
Waihopai	Racecourse Road 50m Upstream	11-Sep-14	10:08	9:15	Dry Flow	0.66	0	0	0	7	40	10.2	6.8	0.203	12.15	7.7	0.011	0.015	0.02	1.46	0.28	1.74	1723		1246	77	2.28	<0.0011	<0.000053	<0.00053	0.00128	0.00017	0.00143	0.0074		
Waihopai	Racecourse Road 50m Upstream	25-Jun-15	13:55	14:31	Dry Flow	5.7	0	0	0	33.5	40	7.6	6.46	0.233	10.91	0.8	0.019	0.071	0.05	3.75	0.58	4.33	3873		108	54	1.65	<0.0011	<0.000053	<0.00053	0.00099	0.00019	0.00111	0.007		

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Sampling Event	Flow	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Dissolved Oxygen	Suspended Solids	Dissolved Reactive Phosphorus	Total Phosphorus	Ammonia	Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Coliform MPN/100 ml	Faecal Coliform CFU/100 ml	Escherichia coli MPN/100 ml	SHMAK	Chlorophyll a	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Nickel	Total Zinc	Total Petroleum Hydrocarbons	Comment
1	1	1			1		mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l as N	mg/l as N	mg/l	mg/l				cm	mg/m3	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Waihopai	Racecourse Road 50m Upstream	28-Aug-15	9:50	6:15	Dry High Flow	4.81	0	0	0.5	37.5						7.2							1578		654											
Waihopai	Racecourse Road 50m Upstream	19-Jan-16	15:25	17:57	Dry Flow	0.5	0	0	0	44	30	16	6.91	0.221	10.7	2.8	0.038	0.039	0.03	3.05	0.9	3.95	2909		246	93	2.45	<0.0011	<0.000053	<0.00053	0.00125	0.00013	0.00143	0.0038		
Waihopai	Racecourse Road 50m Upstream	04-May-16	10:20	5:20	Dry Flow	1.32	0	0	0	22.5	40	11	6.75	0.219	10.85	3.2	0.012	0.041	0.05	2.84	0.91	3.75	3441		262	100	2.09	0.00021	<0.00005	0.0011	0.00091	<0.0001	0.00095	0.0037		
Waihopai	Racecourse Road 50m Upstream	27-Jun-16	15:25	13:08	Dry Flow	1.25	0	0	0	16.5						2.8							1274		246											
Waihopai	Racecourse Road 50m Upstream	28-Apr-12	0:50	0:11	Storm Flow	0.3	0	7.5	7.5	8	50	11.3	6.76	0.202	9.56	2.3	0.023	0.024	0.01	1.45	0.53	1.98	3870		1166	82	6.27	<0.0011	<0.000053	<0.00053	0.00107	0.00011	0.00104	0.0038	<0.7	
Waihopai	Racecourse Road 50m Upstream	16-Jan-14	10:04	9:02	Wet Flow	5.45	0.5	3	17	49.5						5							10462		1201											
Waihopai	Racecourse Road 50m Upstream	24-Jan-14	14:48	14:42	Wet Flow	2.95	0	3.5	19	26.5						5.6							39726		14540											
Waihopai	Racecourse Road 50m Upstream	16-Apr-14	10:00	9:27	Storm Flow	0.6	0	12	12	16.5	30	12.8	6.69	0.19	9.76	7	0.014	0.095	0.02	1.2	0.36	1.56	9222		728	66	2.55	<0.0011	<0.000053	0.00148	0.00138	0.00015	0.00166	0.0064	<0.7	
Waihopai	Racecourse Road 50m Upstream	26-Jan-15	14:25	14:44	Storm Flow	0.255	1.5	5	5	20	80	18	6.84	0.201	7.44	2.6	0.022	0.02	0.05	0.94	1.62	2.56	2446		524	85	3.54	<0.0011	<0.000053	<0.00053	0.00167	0.00021	0.00145	0.0025		
Waihopai	Racecourse Road 50m Upstream	24-May-16	9:57	9:26	Wet Flow	15	0	2	21.5	77.5						16							4028		544											
Waihopai	Queens Drive 50m Down Stream	22-Mar-12	9:30	8:41	Dry Flow	0.66	0	0	0	28.5	60	13	6.73	0.213	8.31	3	0.031	0.045	0.05	1.611	0.8	2.41	4604		480	89	2.31	<0.0011	<0.000053	<0.00053	0.00128	0.00013	0.00116	0.0054	<0.7	
Waihopai	Queens Drive 50m Down Stream	05-Jul-12	9:17	8:49	Dry Flow	1.8	0	0	0	36.5	40	5	6.43	0.23	11.88	10.1	0.019	0.053	0.06	2.67	0.44	3.11	4352		411	76	0.9	<0.0011	<0.000053	<0.00053	0.0036	0.00046	0.00127	0.0067	<0.7	
Waihopai	Queens Drive 50m Down Stream	11-Dec-12	10:05	6:33	Dry Flow	0.67	0	0	0	45.5	50	14.8	6.93	0.203	10.93	2.6	0.022	0.026	0.01	2.05	0.49	2.54	1793		744	75	4.9	<0.0011	<0.000053	<0.00053	0.0018	0.00035	0.00158	0.0072	<0.7	
Waihopai	Queens Drive 50m Down Stream	12-Mar-13	9:10	9:06	Dry Flow	0.16	0	0	0	4	40	14.8	6.49	0.2	6.71	1.1	0.021	0.047	0.03	1.32	0.28	1.6	1827		335	86	4.74	<0.0011	<0.000053	<0.00053	0.00094	0.00016	0.00116	0.0064	<0.7	
Waihopai	Queens Drive 50m Down Stream	21-Aug-13	8:45	7:39	Dry Flow	1.5	0	0	0	23.5	25	8.9	6.39	0.222	10.55	1.8	0.001	0.02	0.01	3.73	0.31	4.04	2481		448	95	1.89	<0.0011	<0.000053	<0.00053	0.00104	<0.00011	0.00124	0.006	<0.7	
Waihopai	Queens Drive 50m Down Stream	19-Nov-13	9:09	9:48	Dry Flow	0.54	0	0	0	3	40	15.9	6.78	0.203	10.46	1.8	0.014	0.019	0.01	2.34	0.26	2.6	2897		349	91	4.72	<0.0011	<0.000053	<0.00053	0.00137	0.00023	0.0014	0.0035	<0.7	
Waihopai	Queens Drive 50m Down Stream	10-Feb-14	10:35	5:41	Dry Flow	0.11	0	0	0	1	40	16.1	6.89	0.189	10.95	2.6	0.007	0.027	0.01	1.15	0.29	1.44	550	160	136	80	4.14	<0.0011	<0.000053	<0.00053	0.00092	0.00027	0.00107	0.0023	<0.7	
Waihopai	Queens Drive 50m Down Stream	11-Sep-14	9:28	9:15	Dry Flow	0.66	0	0	0	7	40	9.8	6.74	0.203	11.18	2.6	0.02	0.031	0.03	2.53	1.08	3.61	6488		4106	75	1.26	<0.0011	<0.000053	0.00188	0.0077	0.0003	0.00142	0.0064		
Waihopai	Queens Drive 50m Down Stream	25-Jun-15	14:03	14:31	Dry Flow	5.7	0	0	0	33.5	40	6.7	6.45	0.234	11.88	0.6	0.014	0.11	0.05	4.21	0.89	5.1	11200		122	66	1.31	<0.0011	<0.000053	<0.00053	0.00101	0.00023	0.00118	0.0076		
Waihopai	Queens Drive 50m Down Stream	28-Aug-15	9:41	6:15	Dry High Flow	4.81	0	0	0.5	37.5						7.2							1714		544											
Waihopai	Queens Drive 50m Down Stream	19-Jan-16	15:33	17:57	Dry Flow	0.5	0	0	0	44	30	15.4	7.06	0.227	11.34	0.4	0.025	0.031	0.01	2.36	1.02	2.38	6488		547	95	1.89	<0.0011	<0.000053	<0.00053	0.0011	<0.00011	0.00129	0.0041		
Waihopai	Queens Drive 50m Down Stream	04-May-16	9:44	5:20	Dry Flow	1.32	0	0	0	22.5	30	10.8	6.73	0.221	11.07	2.2	0.012	0.03	0.04	2.54	0.11	2.65	17329		759	100	1.9	0.00027	<0.00005	0.0006	0.00082	<0.0001	0.00094	0.0046		
Waihopai	Queens Drive 50m Down Stream	27-Jun-16	14:58	13:08	Dry Flow	1.25	0	0	0	16.5						4.7							13000		748											
Waihopai	Queens Drive 50m Down Stream	28-Apr-12	1:45	0:11	Storm Flow	0.3	0	7.5	7.5	8	60	11.4	6.7	0.153	8.99	1.7	0.003	0.024	0.04	1.32	0.45	1.77	48392		7746	80	4.66	<0.0011	<0.000053	<0.00053	0.00191	0.00048	0.00094	0.029	<0.7	
Waihopai	Queens Drive 50m Down Stream	16-Jan-14	9:30	9:02	Wet Flow	5.45	0.5	3	17	49.5						2							15402		4374											
Waihopai	Queens Drive 50m Down Stream	24-Jan-14	14:21	14:42	Wet Flow	2.95	0	3.5	19	26.5						3.2							31062		12262											
Waihopai	Queens Drive 50m Down Stream	16-Apr-14	9:24	9:27	Storm Flow	0.6	0	12	12	16.5	25	11.9	6.61	0.176	8.21	2.6	0.014	0.041	0.03	1.16	0.47	1.63	9768		2900	84	2.12	<0.0011	<0.000053	0.0006	0.0026	0.00032	0.0014	0.022	<0.7	Pumping from Prestonville
Waihopai	Queens Drive 50m Down Stream	26-Jan-15	14:00	14:44	Storm Flow	0.255	1.5	5	5	20	80	17.9	6.7	0.081	7.59	5.6	0.016	0.035	0.03	0.4	1.77	2.17	20924		3030	58	1.99	<0.0011	<0.000053	0.00071	0.0044	0.00132	0.00127	0.072		
Waihopai	Queens Drive 50m Down Stream	24-May-16	9:35	9:26	Wet Flow	15	0	2	21.5	77.5						14.2							4196		550											
Waihopai	Prestonville 50m Upstream	22-Mar-12	9:05	8:41	Dry Flow	0.66	0	0	0	28.5	50	13.1	6.75	0.214	8	2.5	0.028	0.042	0.04	1.591	0.56	2.15	3635		218	89	2.4	<0.0011	<0.000053	<0.00053	0.00171	0.00017	0.00124	0.0061	<0.7	
Waihopai	Prestonville 50m Upstream	05-Jul-12	9:00	8:49	Dry Flow	1.8	0	0	0	36.5	50	4.9	6.44	0.231	11.91	11.2	0.008	0.042	0.08	3.45	0.54	3.99	1789		323	75	1.22	<0.0011	<0.000053	<0.00053	0.0047	0.00056	0.00145	0.0083	<0.7	
Waihopai	Prestonville 50m Upstream	11-Dec-12	9:40	6:33	Dry Flow	0.67	0	0	0	45.5	50	14.9	6.91	0.205	10.96	3.3	0.016	0.028	0.01	1.41	0.53	1.91	1019		246	72	7.33	<0.0011	<0.000053	<0.00053	0.0035	0.00017	0.00149	0.0046	<0.7	
Waihopai	Prestonville 50m Upstream	12-Mar-13	10:00	9:06	Dry Flow	0.16	0	0	0	4	50	14.8	6.57	0.204	6.82	1.1	0.037	0.035	0.04	1.04	0.36	1.39	1628		101	83	5.42	<0.0011	<0.000053	<0.00053	0.00114	0.00017	0.00122	0.0045	<0.7	
Waihopai	Prestonville 50m Upstream	21-Aug-13	8:25	7:39	Dry Flow	1.5	0	0	0	23.5	25	8.7	6.39	0.224	10.53	1.6	0.001	0.02	0.01	3.62	0.37	3.99	1670		269	95	2.5	<0.0011	<0.000053	<0.00053	0.00125	<0.00011	0.00123	0.0055	<0.7	
Waihopai	Prestonville 50m Upstream	19-Nov-13	10:00	9:48	Dry Flow	0.54	0	0	0	3	25	16.6	6.97	0.205	12.39	3.6	0.016	0.026	0.01	1.81	0.38	2.19	1455		307	77	6.1	<0.0011	<0.000053	<0.00053	0.0025	0.0003	0.00137	0.0037	<0.7	
Waihopai	Prestonville 50m Upstream	10-Feb-14	13:55	5:41	Dry Flow	0.11	0	0	0	1	40	18	7.62	0.187	12.93	1	0.013	0.043	0.01	1.03	0.47	1.5	620	270	210	78	3.13	<0.0011	<0.000053	<0.00053	0.00089	0.00011	0.00107	0.0025	<0.7	
Waihopai	Prestonville 50m Upstream	11-Sep-14	9:00	9:15	Dry Flow	0.66	0	0	0	7	40	9.9	6.71	0.208	11.09	2.3	0.005	0.027	0.02	1.17	0.85	2.02	2987		2382	78	1.58	<0.0011	<0.000053	<0.00053	0.0085	0.00053	0.00162	0.0145		
Waihopai	Prestonville 50m Upstream	25-Jun-15	14:33	14:31	Dry Flow	5.7	0	0	0	33.5	40	6.5	6.52	0.233	10.93	1	0.01	0.044	0.05	3.45	2.53	5.98	10460		86	64	1.53	<0.0011	<0.000053	<0.00053	0.0013	0.00021	0.00113	0.0083		
Waihopai	Prestonville 50m Upstream	28-Aug-15	9:33	6:15	Dry High Flow	4.81	0	0	0.5	37.5						6							960		530											
Waihopai	Prestonville 50m Upstream	19-Jan-16	15:43	17:57	Dry Flow	0.5	0	0	0	44	30	15.7	7.15	0.226	11.61	1.2	0.033	0.037	0.03	2.25	1.24	3.49	4601		259	95	2.12	<0.0011	<0.000053	<0.00053	0.00147	0.00014	0.0014	0.0045		
Waihopai	Prestonville 50m Upstream	04-May-16	9:30	5:20	Dry Flow	1.32	0	0	0	22.5	40	10.5	6.66	0.22	9.77	0.2	0.009	0.022	0.03	2.81	1.2	4.01	3255		185	100	5.71	0.00024	<0.00005	0.00069	0.00081	<0.0001	0.00086	0.0048		
Waihopai	Prestonville 50m Upstream	27-Jun-16	14:18	13:08	Dry Flow	1.25	0	0	0	16.5						6							1904		145											
Waihopai	Prestonville 50m Upstream	28-Apr-12	2:15	0:11	Storm Flow	0.3	0	7.5	7.5	8	50	11.1	6.66	0.163	7.98	11.9	0.006	0.055	0.03	1.06	0.67	1.73			2582	55	5.05	<0.0011	<0.000053	<0.00053	0.0027	0.00077	0.00133	0.021	<0.7	
Waihopai	Prestonville 50m Upstream	16-Jan-14	9:05	9:02	Wet Flow	5.45	0.5	3	17	49.5						4							7746		2100											
Waihopai	Prestonville 50m Upstream	24-Jan-14	14:02	14:42	Wet Flow	2.95	0	3.5	19	26.5						4							34685		18416											
Waihopai	Prestonville 50m Upstream	16-Apr-14	9:00	9:27	Storm Flow	0.6	0	12	12	16.5	30	12	6.62	0.164	7.92	1.6	0.026	0.026	0.03	0.63	0.74	1.37	5818		1466	100	1.17	<0.0011	<0.000053	<0.00053	0.00128	0.0002	0.00092	0.0122	<0.7	
Waihopai	Prestonville 50m Upstream	26-Jan-15	13:25	14:44	Storm Flow	0.255	1.5	5	5	20	75	18.1	6.71	0.207	4.9	5.8	0.014	0.061	0.14	0.52	1.57	2.09	3000		82	77	2.67	<0.0011	<0.000053	<0.00053	0.00107	0.0002	0.00139	0.0055		
Waihopai	Prestonville 50m Upstream	24-May-16	8:22	9:26	Wet Flow	15	0	2	21.5	77.5						16.8							2828		636											
Waihopai	Prestonville 60m Downstream	22-Mar-12	9:10	8:41	Dry Flow	0.66	0	0	0	28.5	50	13	6.94	0.214	7.99	2	0.022	0.027	0.03	1.553	0.49	2.04	2586		232	88	2.43	<0.0011	<0.000053	<0.00053	0.0017	0.00017	0.00136	0.0045	<0.7	

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Sampling Event	Flow	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Dissolved Oxygen	Suspended Solids	Dissolved Reactive Phosphorus	Total Phosphorus	Ammonia	Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Coliform MPN/100 ml	Faecal Coliform CFU/100 ml	Escherichia coli MPN/100 ml	SHMAK	Chlorophyll a	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Nickel	Total Zinc	Total Petroleum Hydrocarbons	Comment
1	1	1			1		mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	ml	ml	ml	cm	mg/m3	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Waihopai	Prestonville 60m Downstream	05-Jul-12	9:05	8:49	Dry Flow	1.8	0	0	0	36.5	50	5	6.48	0.231	11.82	9.4	0.006	0.02	0.07	2.81	0.55	3.36	3448		496	78	1	<0.0011	0.00007	<0.00053	0.022	0.00194	0.00142	0.0086	<0.7	
Waihopai	Prestonville 60m Downstream	11-Dec-12	9:45	6:33	Dry Flow	0.67	0	0	0	45.5	50	14.5	6.81	0.215	10.17	2.7	0.018	0.035	0.03	1.72	0.41	2.12	633		168	81	4.51	<0.0011	<0.000053	<0.00053	0.0031	0.00014	0.00151	0.0048	<0.7	
Waihopai	Prestonville 60m Downstream	12-Mar-13	10:05	9:06	Dry Flow	0.16	0	0	0	4	50	14.8	6.56	0.203	6.77	0.8	0.02	0.03	0.02	1.12	0.18	1.3	3066		121	82	5.28	<0.0011	<0.000053	<0.00053	0.00095	0.00013	0.00114	0.0048	<0.7	
Waihopai	Prestonville 60m Downstream	21-Aug-13	8:15	7:39	Dry Flow	1.5	0	0	0	23.5	30	8.6	6.41	0.221	10.23	2.4	0.003	0.017	0.01	3.95	0.46	4.41	1137		216	95	2.3	<0.0011	<0.000053	<0.00053	0.00095	<0.00011	0.00125	0.0062	<0.7	
Waihopai	Prestonville 60m Downstream	19-Nov-13	10:05	9:48	Dry Flow	0.54	0	0	0	3	35	16.6	6.83	0.211	11.39	4.5	0.007	0.019	0.02	1.74	0.33	2.07	3635		455	77	4.73	<0.0011	<0.000053	<0.00053	0.0014	0.00023	0.0013	0.0041	<0.7	
Waihopai	Prestonville 60m Downstream	10-Feb-14	13:58	5:41	Dry Flow	0.11	0	0	0	1	40	18	7.52	0.187	13.08	1.1	0.007	0.023	0.01	1.01	0.51	1.52	550	220	195	78	3.23	<0.0011	<0.000053	<0.00053	0.0008	<0.00011	0.00114	0.0022	<0.7	
Waihopai	Prestonville 60m Downstream	11-Sep-14	9:05	9:15	Dry Flow	0.66	0	0	0	7	40	9.9	6.71	0.209	10.49	2.1	0.023	0.046	0.01	1.38	0.69	2.07	1782		1396	78	1.54	<0.0011	<0.000053	<0.00053	0.001	0.00011	0.00145	0.00061		
Waihopai	Prestonville 60m Downstream	25-Jun-15	14:33	14:31	Dry Flow	5.7	0	0	0	33.5	40	6.5	6.53	0.232	11.82	1.3	0.01	0.048	0.05	4	0.64	4.64	14136		84	66	1.63	<0.0011	<0.000053	<0.00053	0.00109	0.00031	0.00142	0.024		
Waihopai	Prestonville 60m Downstream	28-Aug-15	9:35	6:15	Dry High Flow	4.81	0	0	0.5	37.5						8.4							1162		402											Not Pumping from Prestonville
Waihopai	Prestonville 60m Downstream	19-Jan-16	15:47	17:57	Dry Flow	0.5	0	0	0	44	30	15.7	7.14	0.225	11.49	0.4	0.035	0.037	0.01	2.25	0.85	3.1	3873		259	95	3.35	<0.0011	<0.000053	<0.00053	0.00149	<0.00011	0.00152	0.0054		
Waihopai	Prestonville 60m Downstream	04-May-16	9:35	5:20	Dry Flow	1.32	0	0	0	22.5	40	10.9	6.66	0.226	9.87	2.4	0.012	0.033	0.04	2.67	0.76	3.43	5794		354	96	2.11	0.00025	<0.00005	0.00056	0.00077	<0.0001	0.001	0.0056		
Waihopai	Prestonville 60m Downstream	27-Jun-16	14:22	13:08	Dry Flow	1.25	0	0	0	16.5						5.4							1421		187											
Waihopai	Prestonville 60m Downstream	28-Apr-12	2:17	0:11	Storm Flow	0.3	0	7.5	7.5	8	50	11.1	6.64	0.159	8.45	2	0.009	0.051	0.04	1.14	0.65	1.79			2252	69	4.77	<0.0011	<0.000053	0.00055	0.003	0.00109	0.00179	0.054	<0.7	
Waihopai	Prestonville 60m Downstream	16-Jan-14	9:00	9:02	Wet Flow	5.45	0.5	3	17	49.5						4							10344		1666											
Waihopai	Prestonville 60m Downstream	24-Jan-14	14:04	14:42	Wet Flow	2.95	0	3.5	19	26.5						4.4							39726		14540											
Waihopai	Prestonville 60m Downstream	16-Apr-14	9:04	9:27	Storm Flow	0.6	0	12	12	16.5	30	12	6.62	0.165	8.08	1.7	0.014	0.031	0.04	0.7	0.74	1.44	9222		1060	100	1.38	<0.0011	<0.000053	<0.00053	0.0028	0.00036	0.0012	0.024	<0.7	
Waihopai	Prestonville 60m Downstream	26-Jan-15	13:28	14:44	Storm Flow	0.255	1.5	5	5	20	40	18	6.61	0.144	6.08	18.8	0.071	0.153	0.08	0.67	2.04	2.71	36500		5510	50	1.63	<0.0011	<0.000053	0.00101	0.0043	0.0026	0.0031	0.101		
Waihopai	Prestonville 60m Downstream	24-May-16	8:25	9:26	Wet Flow	15	0	2	21.5	77.5						18.8							3338		690											
Waihopai	North Road Bridge Downstream	22-Mar-12	9:00	8:41	Dry Flow	0.66	0	0	0	28.5	40	13.1	6.77	0.22	7.74	3.3	0.022	0.029	0.03	1.529	0.42	1.95	3435		171	78	2.86	<0.0011	<0.000053	<0.00053	0.00187	0.00037	0.00129	0.0084	<0.7	
Waihopai	North Road Bridge Downstream	05-Jul-12	8:38	8:49	Dry Flow	1.8	0	0	0	36.5	50	5.5	6.4	0.234	11.22	28	0.005	0.052	0.08	3.32	0.56	3.88	1669		132	34	1.9	<0.0011	<0.000053	0.00075	0.0049	0.00082	0.00196	0.0136	<0.7	
Waihopai	North Road Bridge Downstream	11-Dec-12	9:55	6:33	Dry Flow	0.67	0	0	0	45.5	50	15	6.81	0.213	10.48	5.9	0.018	0.043	0.01	1.33	0.44	1.77	1607		364	73	8.07	<0.0011	<0.000053	<0.00053	0.0021	0.00038	0.00178	0.0085	<0.7	
Waihopai	North Road Bridge Downstream	12-Mar-13	9:45	9:06	Dry Flow	0.16	0	0	0	4	60	14.9	6.71	1.005	7.39	20	0.041	0.124	0.04	1.17	0.35	1.52	7068		214	39	55.8	<0.0011	<0.000053	0.00096	0.0027	0.00083	0.0021	0.0013	<0.7	
Waihopai	North Road Bridge Downstream	21-Aug-13	7:50	7:39	Dry Flow	1.5	0	0	0	23.5	20	8.6	6.42	0.23	9.52	8.7	0.001	0.009	0.07	3.93	0.32	4.25	938		134	68	3.2	<0.0011	<0.000053	<0.00053	0.00128	<0.00011	0.00143	0.0097	<0.7	
Waihopai	North Road Bridge Downstream	19-Nov-13	9:36	9:48	Dry Flow	0.54	0	0	0	3	40	16.3	6.84	0.214	10.61	5.2	0.01	0.04	0.01	1.95	0.49	2.44	1827		155	83	10.01	<0.0011	<0.000053	<0.00053	0.00161	0.00047	0.00151	0.0083	<0.7	
Waihopai	North Road Bridge Downstream	10-Feb-14	13:30	5:41	Dry Flow	0.11	0	0	0	1	45	19.4	8.02	0.188	12.16	7.3	0.013	0.058	0.02	1.2	0.43	1.63	690	210	170	72	4.13	<0.0011	<0.000053	<0.00053	0.00111	0.00038	0.00127	0.0042	<0.7	
Waihopai	North Road Bridge Downstream	11-Sep-14	8:45	9:15	Dry Flow	0.66	0	0	0	7	40	9	6.68	0.275	10.08	3.9	0.006	0.039	0.04	0.8	0.85	1.65	1281		1106	75	2.16	<0.0011	<0.000053	<0.00053	0.00146	0.00022	0.00155	0.0105		
Waihopai	North Road Bridge Downstream	25-Jun-15	14:46	14:31	Dry Flow	5.7	0	0	0	33.5	40	6.6	6.55	0.228	10.56	2.6	0.01	0.025	0.04	4.12	0.99	5.11	10462		122	67	1.73	<0.0011	<0.000053	<0.00053	0.00189	0.00043	0.0015	0.0122		
Waihopai	North Road Bridge Downstream	28-Aug-15	9:26	6:15	Dry High Flow	4.81	0	0	0.5	37.5						6.8							1096		466											
Waihopai	North Road Bridge Downstream	19-Jan-16	15:52	17:57	Dry Flow	0.5	0	0	0	44	40	16.4	6.98	0.229	9.57	57.2	0.038	0.067	0.04	2.34	1.08	3.42	4684		282	22	5.67	<0.0011	<0.000053	0.00178	0.0027	0.0021	0.0029	0.0179		
Waihopai	North Road Bridge Downstream	04-May-16	9:15	5:20	Dry Flow	1.32	0	0	0	22.5	30	11.4	6.72	0.228	9.98	14	0.012	0.085	0.05	2.54	1.94	4.48	5475		187	59	4.62	0.00036	<0.00005	0.00054	0.0011	0.00021	0.0012	0.0065		
Waihopai	North Road Bridge Downstream	27-Jun-16	14:10	13:08	Dry Flow	1.25	0	0	0	16.5						34.3							1872		288											
Waihopai	North Road Bridge Downstream	28-Apr-12	2:10	0:11	Storm Flow	0.3	0	7.5	7.5	8	80	11.1	6.76	0.602	9.13	28.6	0.012	0.222	0.08	1.29	0.72	2.01	28272		1526	22	7.26	0.0017	<0.000053	0.003	0.0052	0.0032	0.0045	0.056	<0.7	No pumping from Prestonville
Waihopai	North Road Bridge Downstream	16-Jan-14	9:14	9:02	Wet Flow	5.45	0.5	3	17	49.5						14.8							13734		3720											
Waihopai	North Road Bridge Downstream	24-Jan-14	14:12	14:42	Wet Flow	2.95	0	3.5	19	26.5						12.4							28272		15402											
Waihopai	North Road Bridge Downstream	16-Apr-14	8:52	9:27	Storm Flow	0.6	0	12	12	16.5	35	12	6.56	0.158	8.17	11.2	0.022	0.071	0.04	0.42	0.63	1.05	17328		2966	76	2.4	<0.0011	<0.000053	<0.00053	0.00181	0.00058	0.00129	0.03	<0.7	
Waihopai	North Road Bridge Downstream	26-Jan-15	13:13	14:44	Storm Flow	0.255	1.5	5	5	20	40	18	6.68	0.519	4.62	75.6	0.019	0.35	0.13	0.62	1.98	2.6	5510		974	17	67.61	0.0017	<0.000053	0.002	0.0051	0.0028	0.0045	0.067		
Waihopai	North Road Bridge Downstream	24-May-16	8:15	9:26	Wet Flow	15	0	2	21.5	77.5						18							5510		778											
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	21-Mar-12	14:00	20:22	Dry Flow	0.79	0	0	0	34	50	15.4	6.89	0.221	11.08	11.3	0.026	0.061	0.026	3.029	0.45	3.48			921	70	3.15	<0.0011	<0.000053	<0.00053	0.00126	0.00037	0.00106	0.0052	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	05-Jul-12	9:50	8:49	Dry Flow	1.8	0	0	0	36.5	40	6.7	6.38	0.223	8.35	8.5	0.008	0.033	0.06	5.09	0.44	5.53	1576		106	70	1.55	<0.0011	<0.000053	<0.00053	0.00092	0.00022	0.00119	0.006	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	22-Nov-12	11:20	16:12	Dry Flow	0.89	0	0	0	14.5	30	13.6	7.09	0.2	12.12	1.2	0.01	0.053	0.01	2.12	0.53	2.65	4839		689	83	6.97	<0.0011	<0.000053	<0.00053	0.00082	0.00011	0.001	0.0021	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	12-Mar-13	10:15	9:06	Dry Flow	0.16	0	0	0	4	40	14.8	6.46	0.199	8.19	0.8	0.019	0.03	0.03	2.04	0.55	2.59	1355		216	84	7.44	<0.0011	<0.000053	<0.00053	<0.00053	<0.00011	0.00072	0.0021	<0.7	Pumping from Prestonville
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	21-Aug-13	13:10	7:39	Dry Flow	1.5	0	0	0	23.5	30	9	6.64	0.213	11.46	3.2	0.004	0.051	0.01	4.48	0.28	4.76	1274		677	77	2.65	<0.0011	<0.000053	<0.00053	0.00093	0.00011	0.00111	0.0045	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	14-Nov-13	11:10	5:59	Dry Flow	0.535	0	0	0	2.5	35	14.4	6.64	0.207	9.27	0.7	0.03	0.045	0.01	3.29	0.43	3.72	3065		2175	98	4.16	<0.0011	<0.000053	<0.00053	0.0022	0.00048	0.00095	0.0022	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	10-Feb-14	9:10	5:41	Dry Flow	0.11	0	0	0	1	60	10.5	6.58	0.191	5.88	3.9	0.013	0.052	0.02	1.69	0.44	2.13	1050	810	760	79	6.37	<0.0011	<0.000053	<0.00053	0.0015	0.00016	0.00087	0.0028	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	11-Sep-14	13:05	9:15	Dry Flow	0.66	0	0	0	7	40	13	6.94	0.205	12.62	3.4	0.012	0.039	0.02	2.29	0.6	2.89	1145		512	80	2.39	<0.0011	<0.000053	<0.00053	0.00094	0.00012	0.00099	0.0035		

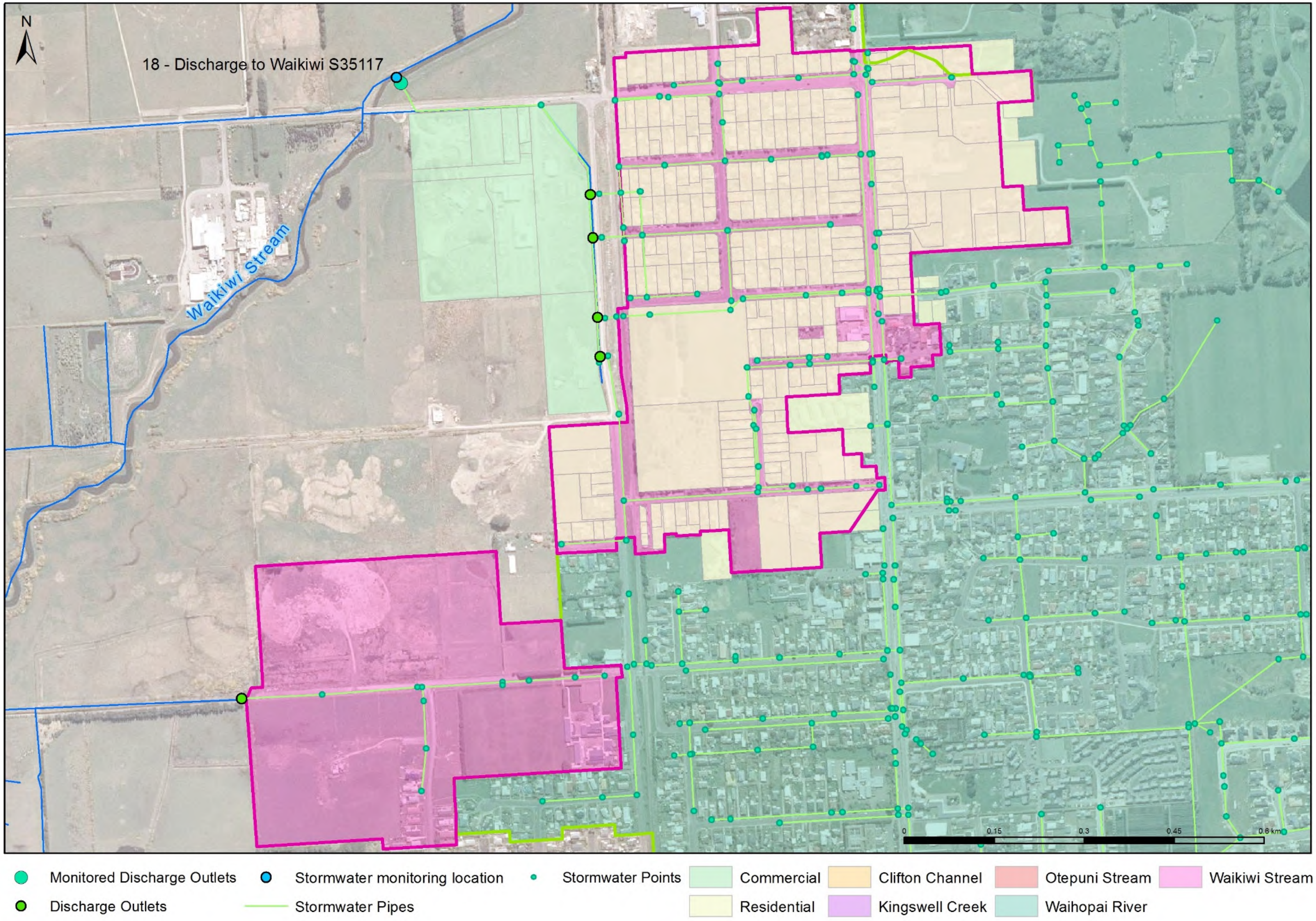
Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Sampling Event	Flow	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Dissolved Oxygen	Suspended Solids	Dissolved Reactive Phosphorus	Total Phosphorus	Ammonia	Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Coliform MPN/100 ml	Faecal Coliform CFU/100 ml	Escherichia coli MPN/100 ml	SHMAK	Chlorophyll a	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Nickel	Total Zinc	Total Petroleum Hydrocarbons	Comment
1	1	1			1		mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l as N	mg/l as N	mg/l	mg/l	ml	ml	ml	cm	mg/m3	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	26-Jan-15	10:10	14:44	Dry Flow	0.257	0	0	0	15	40	19.8	6.25	0.21	3.71	4.4	0.016	0.059	0.09	0.99	2.36	3.35	19863		880	67	4.35	<0.0011	<0.000053	<0.00053	0.00163	0.00028	0.00114	0.0038		No pumping from Prestonville
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	28-Aug-15	11:14	6:15	Dry High Flow	4.81	0	0	0.5	37.5						1.4							798		126											
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	14-Sep-15	13:50	8:25	Dry Moderate Flow	2.9	0	0	5.5	36.5						10.2							712		187											
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	02-Dec-15	9:13	8:37	Dry Flow	0.71	0	0	0	23.5	35	15.2	6.46	0.21	7.58	1	0.002	0.025	0.02	2.05	0.69	2.74	4604		553	100	6.17	<0.0011	<0.000053	0.00055	0.00141	0.00081	0.00128	0.042		
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	19-Jan-16	9:05	17:57	Dry Flow	0.5	0	0	0	44	50	15	6.71	0.217	7.14	2	0.033	0.035	0.02	1.85	0.62	2.47	2602		218	97	3.62	<0.0011	<0.000053	<0.00053	0.00109	<0.00011	0.00119	0.0069		
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	24-May-16	9:02	9:26	Dry Flow	15	0	2	21.5	77.5						16							6872		820											
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	27-Jun-16	13:56	13:08	Dry Flow	1.25	0	0	0	16.5						6							369		10											
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	28-Apr-12	3:25	0:11	Storm Flow	0.3	0	7.5	7.5	8	50	11	6.76	0.211	9.14	6.1	0.013	0.059	0.069	2.35	0.67	3.02	8164		521	78	5.44	<0.0011	<0.000053	<0.00053	0.00161	0.00024	0.00086	0.0062	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	16-Jan-14	8:45	9:02	Wet Flow	5.45	0.5	3	17	49.5						1.2							12300		959											
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	24-Jan-14	13:44	14:42	Wet Flow	3	0	3.5	19	26.5						5.2							5510		2152											
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	05-May-14	11:27	12:20	Storm Flow	1.9	0.5	7.5	7.5	47	60	12	6.45	0.208	9.81	4.8	0.025	0.061	0.05	3.1	1.04	4.14	2448		598	74	2.14	<0.0011	<0.000053	<0.00053	0.00141	0.00016	0.00129	0.0073	<0.7	
Waikiwi	Waikiwi Stream 50m Upstream of Stormwater Outfall	26-Jan-15	16:05	14:44	Storm Flow	0.255	1.5	5.5	5.5	20.5	45	17.5	6.75	0.207	5.99	4.4	0.014	0.047	0.1	0.44	1.64	1.64	25994		2187	45	4.44	<0.0011	<0.000053	<0.00053	0.00147	<0.00011	0.00079	0.0025		
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	21-Mar-12	14:05	20:22	Dry Flow	0.79	0	0	0	34	50	15.5	6.91	0.218	11.16	15	0.037	0.056	0.037	3.255	0.52	3.78			980	70	3.06	<0.0011	<0.000053	<0.00053	0.00127	0.00025	0.00095	0.0065	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	05-Jul-12	9:54	8:49	Dry Flow	1.8	0	0	0	36.5	40	6.7	6.36	0.221	8.83	10.7	0.008	0.05	0.06	4.49	0.48	4.97	1674		108	65	1.02	<0.0011	<0.000053	<0.00053	0.00112	0.0002	0.00122	0.0083	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	22-Nov-12	11:25	16:12	Dry Flow	0.89	0	0	0	14.5	30	13.7	7.07	0.199	12.15	1.8	0.006	0.06	0.02	2.21	0.53	2.74	4443		597	83	7.26	<0.0011	<0.000053	<0.00053	0.00077	<0.00011	0.00106	0.0019	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	12-Mar-13	10:10	9:06	Dry Flow	0.16	0	0	0	4	40	14.8	6.45	0.2	8.15	0.4	0.027	0.028	0.04	2.19	0.61	2.8	1198		199	87	6.85	<0.0011	<0.000053	<0.00053	0.00054	<0.00011	0.00068	0.0014	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	21-Aug-13	13:05	7:39	Dry Flow	1.5	0	0	0	23.5	35	9	6.62	0.215	11.42	3.2	0.006	0.053	0.02	4.5	0.31	4.81	1145		487	77	2.89	<0.0011	<0.000053	<0.00053	0.00102	0.00012	0.00116	0.0052	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	14-Nov-13	11:15	5:59	Dry Flow	0.535	0	0	0	2.5	35	14.4	6.66	0.208	9.28	0.9	0.034	0.049	0.01	3.25	0.41	3.66	2740		1937	98	4.84	<0.0011	<0.000053	<0.00053	0.00167	0.00044	0.00099	0.00167	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	10-Feb-14	9:20	5:41	Dry Flow	0.11	0	0	0	1	40	10.5	6.57	0.19	5.87	3	0.009	0.023	0.01	1.58	0.4	1.98	1010	820	770	79	5.32	<0.0011	<0.000053	<0.00053	0.00158	<0.00011	0.00088	0.0044	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	11-Sep-14	12:55	9:15	Dry Flow	0.66	0	0	0	7	40	13	6.95	0.205	12.6	3.4	0.011	0.039	0.03	3.01	0.58	3.59	1334		620	80	2.63	<0.0011	<0.000053	<0.00053	0.00097	0.00012	0.00095	0.0042		No pumping from Prestonville
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	26-Jan-15	10:08	14:44	Dry Flow	0.257	0	0	0	15	40	19.8	6.28	0.21	3.85	2.7	0.01	0.037	0.08	0.96	0.85	1.81	17329		637	84	2.53	<0.0011	<0.000053	<0.00053	0.00121	<0.00011	0.00093	0.0032		
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	28-Aug-15	11:20	6:15	Dry High Flow	4.81	0	0	0.5	37.5						1.6							728		126											
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	14-Sep-15	13:55	8:25	Dry Moderate Flow	2.9	0	0	5.5	36.5						8.4							538		134											
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	02-Dec-15	9:23	8:37	Dry Flow	0.71	0	0	0	23.5	35	15.2	6.48	0.21	7.45	0.8	0.002	0.03	0.03	2.13	0.65	2.78	5231		657	100	7.27	<0.0011	<0.000053	<0.00053	0.0012	<0.00011	0.0012	0.0043		
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	19-Jan-16	9:00	17:57	Dry Flow	0.5	0	0	0	44	50	15	6.7	0.218	7.11	1.6	0.03	0.038	0.02	2.09	0.65	2.74	3448		249	97	4.31	<0.0011	<0.000053	<0.00053	0.00091	<0.00011	0.00125	0.0056		
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	24-May-16	9:05	9:26	Dry Flow	15	0	2	21.5	77.5						11							8212		619											
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	27-Jun-16	13:57	13:08	Dry Flow	1.25	0	0	0	16.5						6							479		20											

Catchment	Sample	Date	Time	Low Tide (Closest to Sample Time)	Sampling Event	Flow	Rain Last 2 hr	Rain Last 24 hr	Rain Last 72 hr	Rain Last 10 day	Colour	Temperature	pH	Conductivity	Dissolved Oxygen	Suspended Solids	Dissolved Reactive Phosphorus	Total Phosphorus	Ammonia	Nitrate	Total Kjeldahl Nitrogen	Total Nitrogen	Total Coliform MPN/100 ml	Faecal Coliform CFU/100 ml	Escherichia coli MPN/100 ml	SHMAK	Chlorophyll a	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Nickel	Total Zinc	Total Petroleum Hydrocarbons	Comment
1	1	1			1		mm	mm	mm	mm	Hazen	Celcius		mS/cm	mg/l	mg/l	mg/l	mg/l	mg/l as N	mg/l as N	mg/l	mg/l				cm	mg/m3	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	28-Apr-12	3:27	0:11	Storm Flow	0.3	0	7.5	7.5	8	50	11	7.65	0.208	8.85	8	0.018	0.046	0.098	2.07	0.65	2.72	9208		857	41	6.97	<0.0011	<0.000053	0.00136	0.0023	0.00103	0.00176	0.02	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	16-Jan-14	8:50	9:02	Wet Flow	5.45	0.5	3	17	49.5						1.6							12997		933											
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	24-Jan-14	13:45	14:42	Wet Flow	3	0	3.5	19	26.5						2							7746		1976											
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	05-May-14	11:30	12:20	Storm Flow	1.9	0.5	7.5	7.5	47	50	12	6.44	0.201	9.8	6.5	0.02	0.056	0.04	3.08	0.99	4.07	3444		838	74	1.68	<0.0011	<0.000053	0.00142	0.00189	0.00028	0.00171	0.0148	<0.7	
Waikiwi	Waikiwi Stream 50m Downstream of Stormwater Outfall (West Plains Rd Bridge)	26-Jan-15	16:00	14:44	Storm Flow	0.255	1.5	5.5	5.5	20.5	50	17.5	6.64	0.181	5.82	6.4	0.013	0.043	0.16	0.41	0.76	0.76	34658		3255	55	2.99	0.0024	<0.000053	0.00082	0.00195	0.00054	0.0028	0.013		

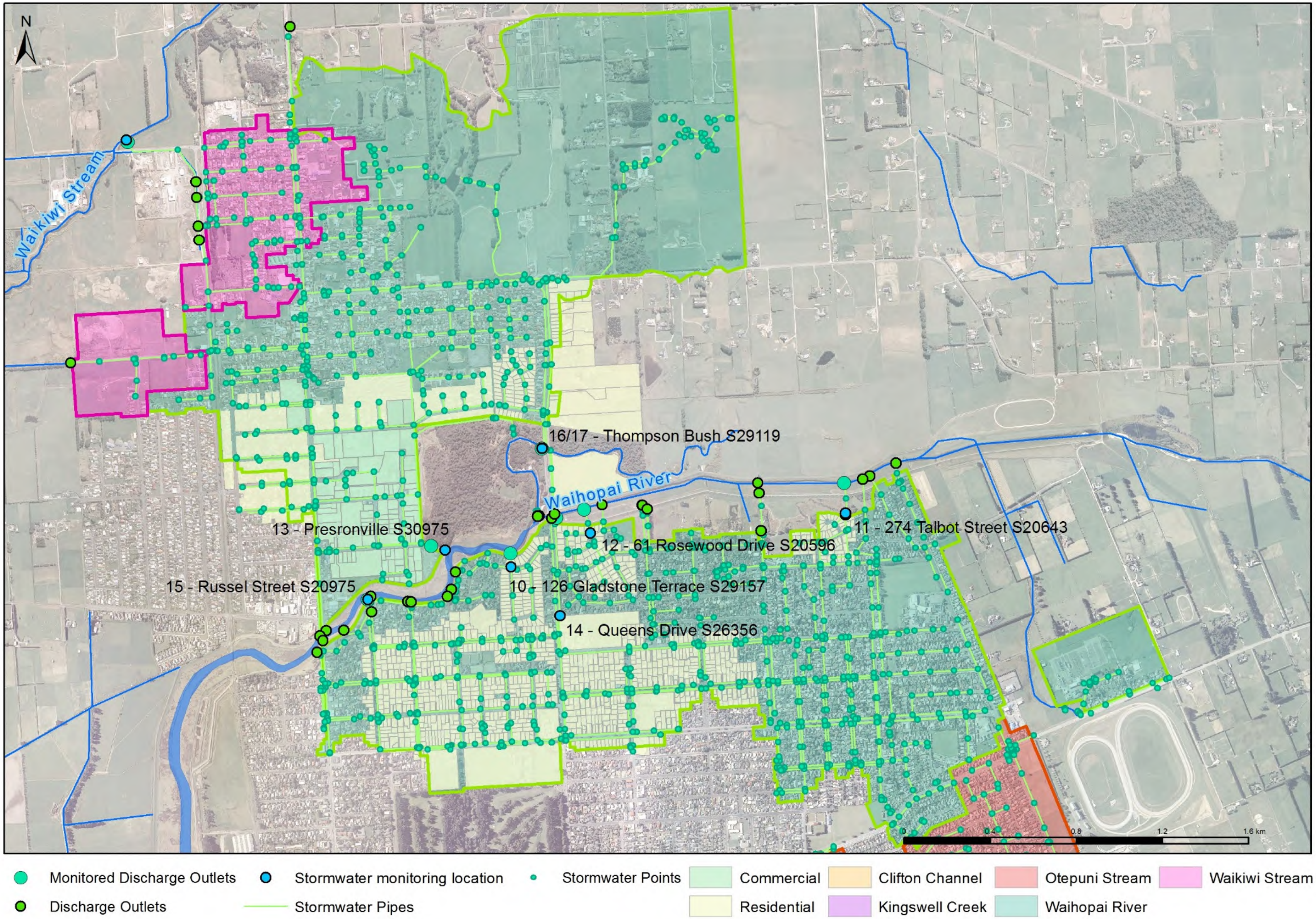
Catchment	Sample	Sequence	Date	Time	Dry Matter as received g/100g	Total Organic Carbon g/100g dry wt	Total Zinc mg/kg dry wt	Total Copper mg/kg dry wt	Total Lead mg/kg dry wt	Total Arsenic mg/kg dry wt	Total Nickel mg/kg dry wt	Total Cadmium mg/kg dry wt	Total Chromium mg/kg dry wt	Total Tin mg/kg dry wt	Total Silver mg/kg dry wt	Total Selenium mg/kg dry wt	Total Mercury mg/kg dry wt
1	1	0					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
2	ISQG-low						200	65	50	20	21	1.5	80		1		0.15
3	ISQG-high						410	270	220	70	52	10	370		3.7		1
Clifton	Clifton Channel @ Lake Street	1	13-Mar-12	14:00	51	2.2	230	14	34	4	14	0.1	12	<1.0	<0.4	<20	<0.10
Clifton	Clifton Channel @ Lake Street	1	01-Mar-13	16:00	64	1.38	81	8	12.3	3	10	<0.10	10	<1.0	1.4	<20	<0.10
Clifton	Clifton Channel @ Lake Street	1	26-Mar-14	11:40	67	1.76	260	12	22	3	11	0.21	11	<1.0	<0.4	<20	<0.10
Clifton	Clifton Channel @ Lake Street	1	12-Mar-15	14:25	65	1.16	200	8	23	4	10	<0.10	11	1.1	<0.4	<20	<0.10
Clifton	Clifton Channel @ Lake Street	1	12-Apr-16	14:00	53	1.53	360	11	27	5	16	0.11	12	5.1	<0.4	<20	<0.10
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	1	02-Apr-12	15:50	61	1.08	75	8	12.2	3	11	<0.10	11	<1.0	<0.4	<20	<0.10
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	1	01-Mar-13	14:30	76	0.83	65	6	12.6	2	7	<0.10	9	<1.0	<0.4	<20	<0.10
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	1	28-Mar-14	8:15	73	0.9	68	7	9.6	3	9	<0.10	8	<1.0	<0.4	<20	<0.10
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	1	12-Mar-15	14:00	69	1.24	83	9	13.2	4	11	<0.10	11	<1.0	<0.4	<20	<0.10
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	1	12-Apr-16	14:10	67	0.95	68	7	11.4	3	10	<0.10	9	<1.0	<0.4	<20	<0.10
Otepuni	Otepuni Upstream of Rockdale Road	1	14-May-12	16:10	77	0.35	22	4	3.1	<2	4	<0.10	5	<1.0	<0.4	<20	<0.10
Otepuni	Otepuni Upstream of Rockdale Road	1	01-Mar-13	14:45	48	1.96	47	7	6.2	<2	7	<0.10	9	<1.0	<0.4	<20	<0.10
Otepuni	Otepuni Upstream of Rockdale Road	1	21-Mar-14	14:00	71	0.59	22	4	3.2	<2	4	<0.10	5	<1.0	<0.4	<20	<0.10
Otepuni	Otepuni Upstream of Rockdale Road	1	12-Mar-15	14:40	72	0.35	21	4	3.1	<2	2	<0.10	6	<1	<0.4	<20	<0.10
Otepuni	Otepuni Upstream of Rockdale Road	1	06-Apr-16	11:40	76	0.24	21	4	2.7	<2	4	<0.10	5	<1	<0.4	<20	<0.10
Otepuni	Otepuni Downstream of Lindisfarne Bridge	2	14-May-12	15:30	76	0.84	161	28	44	2	23	0.14	12	1.2	<0.4	<20	<0.10
Otepuni	Otepuni Downstream of Lindisfarne Bridge	2	28-Feb-13	11:40	64	2.1	136	11	45	3	24	0.12	11	<1.0	<0.4	<20	<0.10
Otepuni	Otepuni Downstream of Lindisfarne Bridge	2	21-Mar-14	14:15	73	1.51	77	10	16.9	<2	11	0.11	10	<1.0	0.8	<20	<0.10
Otepuni	Otepuni Downstream of Lindisfarne Bridge	2	12-Mar-15	14:56	67	1.59	80	7	11.7	<2	8	0.11	18	<1	<0.4	<20	<0.10
Otepuni	Otepuni Downstream of Lindisfarne Bridge	2	06-Apr-16	11:55	75	0.98	141	11	29	2	37	0.12	14	<1	<0.4	<20	<0.10
Otepuni	Otepuni Upstream of Mersey Street Bridge	3	02-Apr-12	16:05	64	2.7	370	63	72	5	40	0.35	25	8.9	0.8	<20	0.16
Otepuni	Otepuni Upstream of Mersey Street Bridge	3	28-Feb-13	11:15	74	1.36	270	42	72	3	26	0.27	21	24	0.9	<20	<0.10
Otepuni	Otepuni Upstream of Mersey Street Bridge	3	25-Mar-14	16:05	49	4.2	440	49	84	5	40	0.38	29	12	1.9	<20	0.21
Otepuni	Otepuni Upstream of Mersey Street Bridge	3	12-Mar-15	15:09	75	1.29	210	38	50	4	26	0.19	17	9.5	<0.4	<20	<0.10
Otepuni	Otepuni Upstream of Mersey Street Bridge	3	19-Apr-16	8:20	73	2.2	330	41	63	4	36	0.3	17	50	2.1	<20	<0.10
Otepuni	Otepuni Outfall to Waihopai River	4	02-Apr-12	16:15	41	2.9	250	33	24	12	37	0.17	38	1.6	<0.4	<20	<0.10
Otepuni	Otepuni Outfall to Waihopai River	4	28-Feb-13	11:00	51	3.2	230	29	33	8	37	0.21	35	1.7	<0.4	<20	<0.10
Otepuni	Otepuni Outfall to Waihopai River	4	25-Mar-14	16:15	40	2.5	230	30	22	11	36	0.18	39	1.9	1.4	<20	0.11
Otepuni	Otepuni Outfall to Waihopai River	4	12-Mar-15	15:15	58	1.82	270	29	45	9	35	0.26	31	8.8	0.4	<20	<0.10
Otepuni	Otepuni Outfall to Waihopai River	4	19-Apr-16	8:08	41	2.6	220	30	22	11	34	0.18	36	1.3	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Racecourse Road	1	14-May-12	14:15	58	0.94	39	7	4.5	<2	7	0.11	7	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Racecourse Road	1	28-Feb-13	9:30	81	0.52	24	4	3.4	<2	3	<0.10	5	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Racecourse Road	1	21-Mar-14	14:30	70	0.3	21	4	2.5	<2	4	<0.10	5	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Racecourse Road	1	24-Mar-15	10:40	75	0.22	19	4	2.9	<2	3	<0.10	4	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Racecourse Road	1	18-Apr-16	15:55	52	0.35	22	4	2.7	<2	4	<0.10	4	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream Queens Drive Bridge	2	16-May-12	14:30	38	3.5	157	20	18.3	3	18	0.28	16	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream Queens Drive Bridge	2	01-Mar-13	11:30	35	5.1	270	29	30	3	20	0.34	18	1.7	<0.4	<20	<0.10
Waihopai	Waihopai Downstream Queens Drive Bridge	2	21-Mar-14	14:45	53	2.1	102	13	11.6	<2	12	0.13	10	<1.0	1	<20	<0.10
Waihopai	Waihopai Downstream Queens Drive Bridge	2	24-Mar-15	11:00	54	1.55	73	8	8.1	<2	9	<0.10	7	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream Queens Drive Bridge	2	18-Apr-16	16:10	68	1.39	67	8	8.35	<2	8	<0.10	6	1.3	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Prestonville	3	14-May-12	14:45	63	0.94	65	8	7.2	<2	8	0.15	9	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Prestonville	3	28-Feb-13	10:00	58	2	64	10	7.6	3	10	0.13	13	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Prestonville	3	25-Mar-14	15:25	57	2.6	115	14	11.7	3	15	0.3	14	<1.0	1.2	<20	<0.10
Waihopai	Waihopai Upstream of Prestonville	3	24-Mar-15	11:09	60	1.17	56	96	8.5	9	15	<0.10	19	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Upstream of Prestonville	3	18-Apr-16	16:20	50	1.94	85	12	10.2	3	12	0.19	13	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream of Prestonville	4	14-May-12	14:55	75	1.05	113	20	23	4	18	0.22	13	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream of Prestonville	4	28-Feb-13	10:00	72	1.95	85	11	13.7	5	15	0.1	14	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream of Prestonville	4	25-Mar-14	15:35	67	0.95	51	12	6.3	7	18	<0.10	25	<1.0	0.9	<20	<0.10
Waihopai	Waihopai Downstream of Prestonville	4	24-Mar-15	11:18	62	2.2	121	21	17.5	6	21	0.16	17	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream of Prestonville	4	18-Apr-16	16:25	63	0.9	53	12	6.1	8	21	<0.10	24	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai Downstream of North Road	5	14-May-12	15:15	46	2.1	188	21	32	8	27	0.15	22	13.6	<0.4	<20	<0.10
Waihopai	Waihopai Downstream of North Road	5	28-Feb-13	10:20	60	2.7	112	21	66	8	23	0.1	28	21	0.5	<20	<0.10
Waihopai	Waihopai Downstream of North Road	5	25-Mar-14	15:45	63	1.07	89	18	12	2	16	<0.10	23	<1.0	0.5	<20	<0.10
Waihopai	Waihopai Downstream of North Road	5	24-Mar-15	11:30	64	1.34	133	14	15.2	4	18	0.18	14	2.3	<0.4	<20	<0.10
Waihopai	Waihopai Downstream of North Road	5	19-Apr-16	8:50	48	2.6	210	28	28	11	38	0.21	38	2.2	<0.4	<20	<0.10
Waihopai	Waihopai 20 metres above Railway Bridge	6	02-Apr-12	16:30	58	1.28	118	16	14.6	5	19	0.13	20	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai 20 metres above Railway Bridge	6	28-Feb-13	10:40	46	2.9	200	26	23	9	29	0.23	33	1.5	<0.4	<20	<0.10
Waihopai	Waihopai 20 metres above Railway Bridge	6	25-Mar-14	15:55	42	2.9	220	28	21	8	32	0.23	35	1.5	0.6	<20	<0.10
Waihopai	Waihopai 20 metres above Railway Bridge	6	24-Mar-15	11:40	36	2.5	210	25	19.2	9	30	0.26	30	<1.0	<0.4	<20	<0.10
Waihopai	Waihopai 20 metres above Railway Bridge	6	19-Apr-16	8:40	38	3	250	33	23	11	36	0.24	39	1.9	<0.4	<20	<0.10
Waikiwi	Waikiwi West Plains Road Bridge	1	16-May-12	14:00	52	1.49	71	10	8.5	3	10	0.22	12	<1.0	<0.4	<20	<0.10
Waikiwi	Waikiwi West Plains Road Bridge	1	01-Mar-13	12:00	64	1.74	53	8	8.4	<2	7	0.13	11	<1.0	<0.4	<20	<0.10
Waikiwi	Waikiwi West Plains Road Bridge	1	25-Mar-14	15:10	60	2.5	70	9	8.1	2	11	0.22	12	<1.0	<1.0	<20	<0.10
Waikiwi	Waikiwi West Plains Road Bridge	1	31-Mar-15	13:45	46	3.2	97	14	15.3	5	12	0.25	18	<1.0	<0.4	<20	<0.10
Waikiwi	Waikiwi West Plains Road Bridge	1	06-Apr-16	11:15	44	3.5	81	14	9.7	5	13	0.25	17	<1.0	<0.4	<20	<0.10

Catchment	Sample	Date	Acenaphthene mg/kg dry wt	Acenaphthylene mg/kg dry wt	Anthracene mg/kg dry wt	Benzo(a)anthracene mg/kg dry wt	Benzo(a)pyrene (BAP) mg/kg dry wt	Benzo(b)fluoranthene + Benzo(j)fluoranthene mg/kg dry wt	Benzo(g,h,i)perylene mg/kg dry wt	Benzo(k)fluoranthene mg/kg dry wt	Chrysene mg/kg dry wt	Dibenzo(a,h)anthracene mg/kg dry wt	Fluoranthene mg/kg dry wt	Fluorene mg/kg dry wt	Indeno(1,2,3-c,d)pyrene mg/kg dry wt	Naphthalene mg/kg dry wt	Phenanthrene mg/kg dry wt	Pyrene mg/kg dry wt	Comment
1	1		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
2	ISQG-low		0.016	0.044	0.085	0.261	0.43				0.384	0.063	0.6	0.019		0.16	0.24	0.665	
3	ISQG-high		0.5	0.64	1.1	1.6	1.6				2.8	0.26	5.1	0.54		2.1	1.5	2.6	
Clifton	Clifton Channel @ Lake Street	13-Mar-12	<0.05	0.06	<0.05	0.14	0.18	0.36	0.2	0.12	0.14	<0.05	0.32	<0.05	0.13	<0.3	0.15	0.35	First sediment sample taken from 5 replicates of Clifton Channel around the Bluff Railway line on Lake Street.
Clifton	Clifton Channel @ Lake Street	01-Mar-13	<0.08	<0.08	<0.08	0.13	0.14	0.15	0.11	0.09	0.14	<0.08	0.38	<0.08	0.12	<0.4	0.32	0.34	Second sediment sample taken from 5 replicates of Clifton Channel around the Bluff Railway line on Lake Street.
Clifton	Clifton Channel @ Lake Street	26-Mar-14	<0.07	<0.07	<0.07	0.1	0.12	0.16	0.1	0.07	0.09	<0.07	0.15	<0.07	0.1	<0.4	0.1	0.17	Third sediment sample taken from 5 replicates of Clifton Channel around the Bluff Railway line on Lake Street.
Clifton	Clifton Channel @ Lake Street	12-Mar-15	<0.04	<0.04	<0.04	<0.04	<0.04	0.04	<0.04	<0.04	<0.04	<0.04	0.07	<0.04	<0.04	<0.17	<0.04	0.06	Fourth sediment sample taken from 5 replicates of Clifton Channel around the Bluff Railway line on Lake Street.
Clifton	Clifton Channel @ Lake Street	12-Apr-16	<0.08	0.32	0.13	0.99	1.28	1.53	0.61	0.62	0.82	0.18	0.9	<0.08	0.7	<0.04	0.16	0.84	Fifth sediment sample taken from 5 replicates of Clifton Channel around the Bluff Railway line on Lake Street.
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	02-Apr-12	<0.04	<0.04	<0.04	0.04	<0.04	0.05	0.04	0.04	0.05	<0.04	0.04	<0.04	<0.04	<0.18	<0.04	0.06	First sediment sample taken from 5 replicates of Kingswell Creek West of Bluff Road
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	01-Mar-13	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.4	<0.07	<0.07	Second sediment sample taken from 5 replicates of Kingswell Creek West of Bluff Road
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	28-Mar-14	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.3	<0.06	0.06	Third sediment sample taken from 5 replicates of Kingswell Creek West of Bluff Road
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	12-Mar-15	<0.04	<0.04	<0.04	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.16	<0.04	<0.04	Fourth sediment sample taken from 5 replicates of Kingswell Creek West of Bluff Road
Kingswell	Kingswell Creek 150m West of Bluff Road @ Walking Track Bridge	12-Apr-16	<0.04	<0.04	<0.04	<0.04	0.04	0.04	<0.04	<0.04	<0.04	<0.04	0.04	<0.04	<0.04	<0.17	<0.04	<0.03	Fifth sediment sample taken from 5 replicates of Kingswell Creek West of Bluff Road
Otepuni	Otepuni Upstream of Rockdale Road	14-May-12	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.15	<0.03	<0.03	
Otepuni	Otepuni Upstream of Rockdale Road	01-Mar-13	<0.10	<0.10	<0.10	0.14	0.1	0.12	<0.10	<0.10	0.13	<0.10	0.4	<0.10	<0.10	<0.5	0.34	0.34	
Otepuni	Otepuni Upstream of Rockdale Road	21-Mar-14	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.16	<0.04	<0.04	
Otepuni	Otepuni Upstream of Rockdale Road	12-Mar-15	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.15	<0.03	<0.03	
Otepuni	Otepuni Upstream of Rockdale Road	06-Apr-16	<0.08	<0.06	>0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.3	<0.06	<0.06	
Otepuni	Otepuni Downstream of Lindisfarne Bridge	14-May-12	0.07	0.21	0.4	1.32	1.03	1.31	0.66	0.53	1.01	0.13	2.5	0.14	0.69	<0.16	1.28	2.5	
Otepuni	Otepuni Downstream of Lindisfarne Bridge	28-Feb-13	<0.07	<0.07	0.15	0.53	0.63	0.7	0.4	0.37	0.61	<0.07	1.43	<0.07	0.54	<0.4	0.63	1.31	
Otepuni	Otepuni Downstream of Lindisfarne Bridge	21-Mar-14	<0.06	<0.06	<0.06	0.29	0.31	0.45	0.23	0.22	0.34	<0.06	0.81	<0.06	0.26	<0.3	0.61	0.79	
Otepuni	Otepuni Downstream of Lindisfarne Bridge	12-Mar-15	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.08	<0.04	>0.04	<0.16	<0.04	0.12	
Otepuni	Otepuni Downstream of Lindisfarne Bridge	06-Apr-16	0.38	0.32	1.78	3.9	3.3	3.8	1.43	1.52	2.3	0.39	8.1	0.37	1.79	<0.4	5.3	6.7	
Otepuni	Otepuni Upstream of Mersey Street Bridge	02-Apr-12	<0.04	<0.04	0.05	0.28	0.36	0.4	0.29	0.17	0.32	0.06	0.65	<0.04	0.22	<0.18	0.32	0.72	
Otepuni	Otepuni Upstream of Mersey Street Bridge	28-Feb-13	<0.07	0.1	0.16	0.62	0.8	0.82	0.58	0.45	0.67	0.06	1.81	<0.07	0.8	<0.4	0.82	1.59	
Otepuni	Otepuni Upstream of Mersey Street Bridge	25-Mar-14	<0.09	0.16	0.32	1.84	1.87	2.3	1.28	0.98	1.74	0.21	3.9	0.1	1.4	<0.5	2.1	4.1	
Otepuni	Otepuni Upstream of Mersey Street Bridge	12-Mar-15	<0.03	0.03	0.03	0.26	0.39	0.38	0.24	0.12	0.22	<0.03	0.6	<0.03	0.26	<0.15	0.23	0.62	
Otepuni	Otepuni Upstream of Mersey Street Bridge	19-Apr-16	<0.03	0.12	0.15	0.81	1.07	1.24	0.62	0.46	0.73	0.12	1.8	0.05	0.64	<0.15	0.9	1.61	
Otepuni	Otepuni Outfall to Waihopai River	02-Apr-12	<0.06	<0.06	<0.06	<0.06	<0.06	0.06	<0.06	<0.06	<0.06	<0.06	0.07	<0.06	<0.06	<0.3	<0.06	0.1	
Otepuni	Otepuni Outfall to Waihopai River	28-Feb-13	<0.09	<0.09	0.09	0.22	0.26	0.28	0.2	0.14	0.21	<0.09	0.77	<0.09	0.23	<0.5	0.29	0.69	
Otepuni	Otepuni Outfall to Waihopai River	25-Mar-14	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.6	<0.11	0.13	
Otepuni	Otepuni Outfall to Waihopai River	12-Mar-15	<0.04	0.05	0.13	0.56	0.7	0.69	0.49	0.24	0.45	<0.04	1.56	<0.04	0.52	<0.19	0.46	1.64	
Otepuni	Otepuni Outfall to Waihopai River	19-Apr-16	<0.06	<0.06	<0.06	0.06	0.08	0.09	<0.06	<0.06	<0.06	<0.06	0.11	<0.06	0.05	<0.3	<0.06	0.09	
Waihopai	Waihopai Upstream of Racecourse Road	14-May-12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	
Waihopai	Waihopai Upstream of Racecourse Road	28-Feb-13	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.3	<0.06	<0.06	
Waihopai	Waihopai Upstream of Racecourse Road	21-Mar-14	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.3	<0.06	<0.06	
Waihopai	Waihopai Upstream of Racecourse Road	24-Mar-15	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.15	<0.03	<0.03	
Waihopai	Waihopai Upstream of Racecourse Road	18-Apr-16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	
Waihopai	Waihopai Downstream Queens Drive Bridge	16-May-12	<0.07	<0.07	0.1	0.23	0.18	0.21	0.14	0.09	0.2	<0.07	0.55	<0.07	0.14	<0.4	0.41	0.59	Sample taken from sediment at Southwest side of bridge due to lack of sediment downstream.
Waihopai	Waihopai Downstream Queens Drive Bridge	01-Mar-13	<0.13	<0.13	<0.13	0.25	0.2	0.3	0.16	<0.13	0.25	<0.13	0.6	<0.13	0.2	<0.7	0.4	0.52	
Waihopai	Waihopai Downstream Queens Drive Bridge	21-Mar-14	<0.08	<0.08	<0.08	0.1	0.09	0.1	0.08	<0.08	0.13	<0.08	0.24	<0.08	<0.08	<0.4	0.19	0.27	
Waihopai	Waihopai Downstream Queens Drive Bridge	24-Mar-15	<0.05	<0.05	0.15	0.38	0.33	0.39	0.22	0.17	0.39	<0.05	0.98	<0.05	0.22	<0.03	0.57	0.93	
Waihopai	Waihopai Downstream Queens Drive Bridge	18-Apr-16	<0.04	<0.04	<0.04	0.04	0.04	0.05	<0.04	<0.04	<0.04	<0.04	0.08	<0.04	<0.04	<0.16	0.04	0.07	
Waihopai	Waihopai Upstream of Prestonville	14-May-12	<0.04	<0.04	<0.04	0.06	<0.04	0.06	<0.4	<0.04	0.05	<0.04	0.09	<0.04	<0.04	<0.2	<0.04	0.11	
Waihopai	Waihopai Upstream of Prestonville	28-Feb-13	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.4	<0.08	<0.08	
Waihopai	Waihopai Upstream of Prestonville	25-Mar-14	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.4	<0.08	<0.08	
Waihopai	Waihopai Upstream of Prestonville	24-Mar-15	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.04	<0.04	<0.04	<0.18	<0.04	0.05	
Waihopai	Waihopai Upstream of Prestonville	18-Apr-16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.3	<0.05	0.05	
Waihopai	Waihopai Downstream of Prestonville	14-May-12	<0.04	0.05	0.06	0.26	0.26	0.34	0.2	0.12	0.19	<0.04	0.44	<0.04	0.19	<0.16	0.23	0.46	
Waihopai	Waihopai Downstream of Prestonville	28-Feb-13	<0.07	0.08	0.11	0.29	0.26	0.34	0.16	0.15	0.29	<0.07	0.52	<0.07	0.25	<0.4	0.24	0.45	
Waihopai	Waihopai Downstream of Prestonville	25-Mar-14	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.16	<0.04	<0.04	
Waihopai	Waihopai Downstream of Prestonville	24-Mar-15	<0.04	0.04	0.04	0.15	0.2	0.21	0.13	0.08	0.13	<0.04	0.31	<0.04	0.16	<0.18	0.23	0.31	
Waihopai	Waihopai Downstream of Prestonville	18-Apr-16	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.17	<0.04	<0.04	
Waihopai	Waihopai Downstream of North Road	14-May-12	<0.06	<0.06	<0.06	0.07	0.07	0.1	0.06	<0.06	0.06	<0.06	0.15	<0.06	<0.06	<0.3	0.08	0.17	
Waihopai	Waihopai Downstream of North Road	28-Feb-13	<0.04	0.17	0.25	0.71	0.73	0.9	0.43	0.39	0.72	0.08	2.1	0.16	0.65	<0.2	1.83	1.87	
Waihopai	Waihopai Downstream of North Road	25-Mar-14	<0.07	<0.07	<0.07	0.16	0.17	0.21	0.15	0.1	0.2	<0.07	0.34	<0.07	0.13	<0.4	0.16	0.44	
Waihopai	Waihopai Downstream of North Road	24-Mar-15	<0.04	<0.04	0.03	0.13	0.16	0.17	0.1	0.07	0.09	<0.04	0.28	<0.04	0.12	<0.17	0.12	0.28	
Waihopai	Waihopai Downstream of North Road	19-Apr-16	0.05	0.08	0.12	0.4	0.52	0.58	0.37	0.2	0.34	0.07	1.2	0.05	0.35	<0.3	0.5	1.14	
Waihopai	Waihopai 20 metres above Railway Bridge	02-Apr-12	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04	<0.19	<0.04	0.06	
Waihopai	Waihopai 20 metres above Railway Bridge	28-Feb-13	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.6	<0.11	<0.11	
Waihopai	Waihopai 20 metres above Railway Bridge	25-Mar-14	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.6	<0.11	0.13	
Waihopai	Waihopai 20 metres above Railway Bridge	24-Mar-15	<0.07	<0.07	<0.07	0.07	0.09	0.12	0.07	<0.07	0.07	<0.07	0.15	<0.07	0.09	<0.4	<0.07	0.15	
Waihopai	Waihopai 20 metres above Railway Bridge	19-Apr-16	<0.06	<0.06	<0.06	0.06	0.08	0.08	<0.06	<0.06	<0.06	<0.06	0.12	<0.06	0.06	<0.3	<0.06	0.11	
Waikiwi	Waikiwi West Plains Road Bridge	16-May-12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.3	<0.05	0.08	
Waikiwi	Waikiwi West Plains Road Bridge	01-Mar-13	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.09	<0.07	<0.07	<0.4	<0.07	0.09	
Waikiwi	Waikiwi West Plains Road Bridge	25-Mar-14	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.4	<0.08	<0.08	
Waikiwi	Waikiwi West Plains Road Bridge	31-Mar-15	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.3	<0.05	<0.05	
Waikiwi	Waikiwi West Plains Road Bridge	06-Apr-16	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.11	<0.6	<0.11	<0.11	

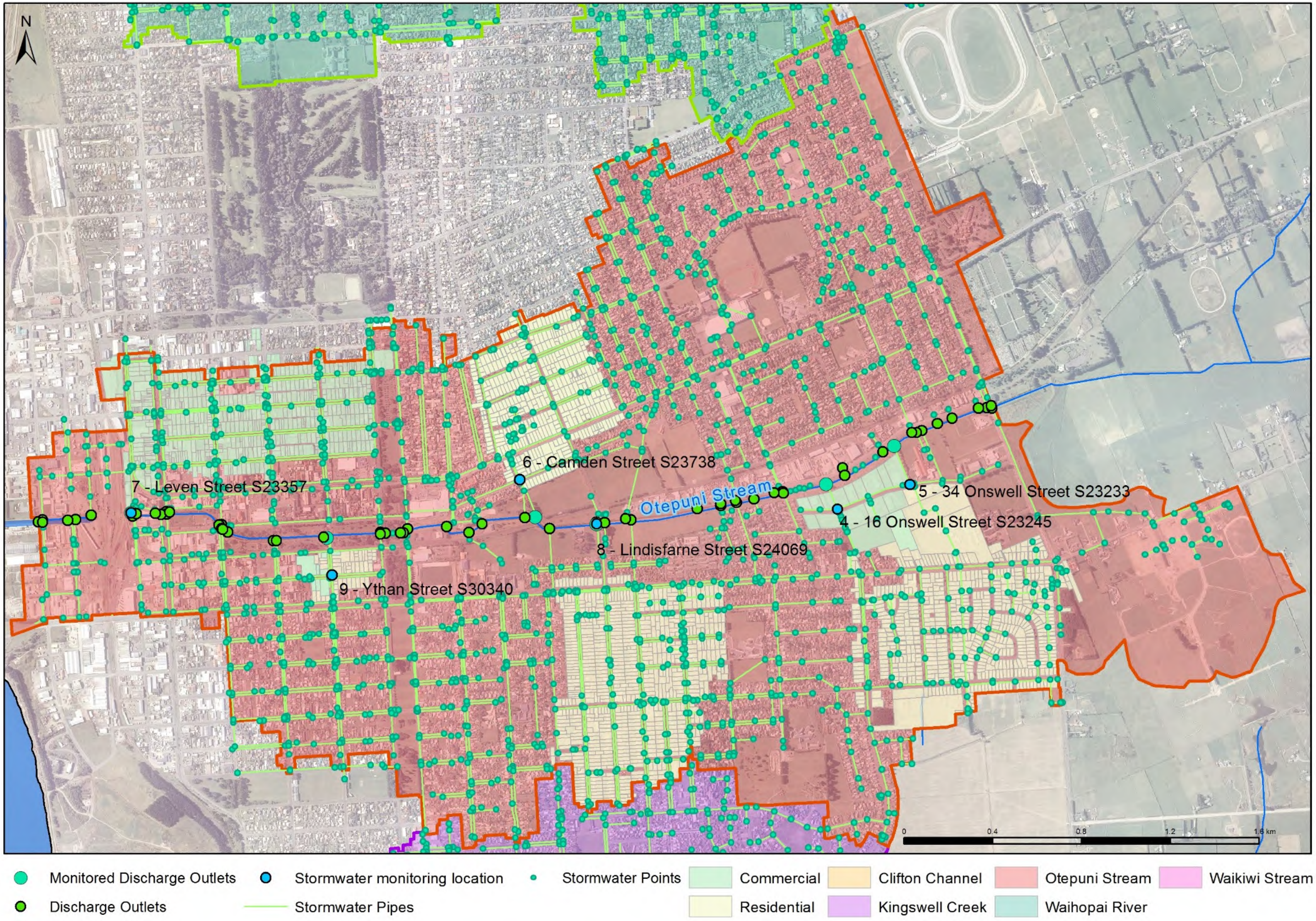
Appendix C Maps of Stormwater Catchments



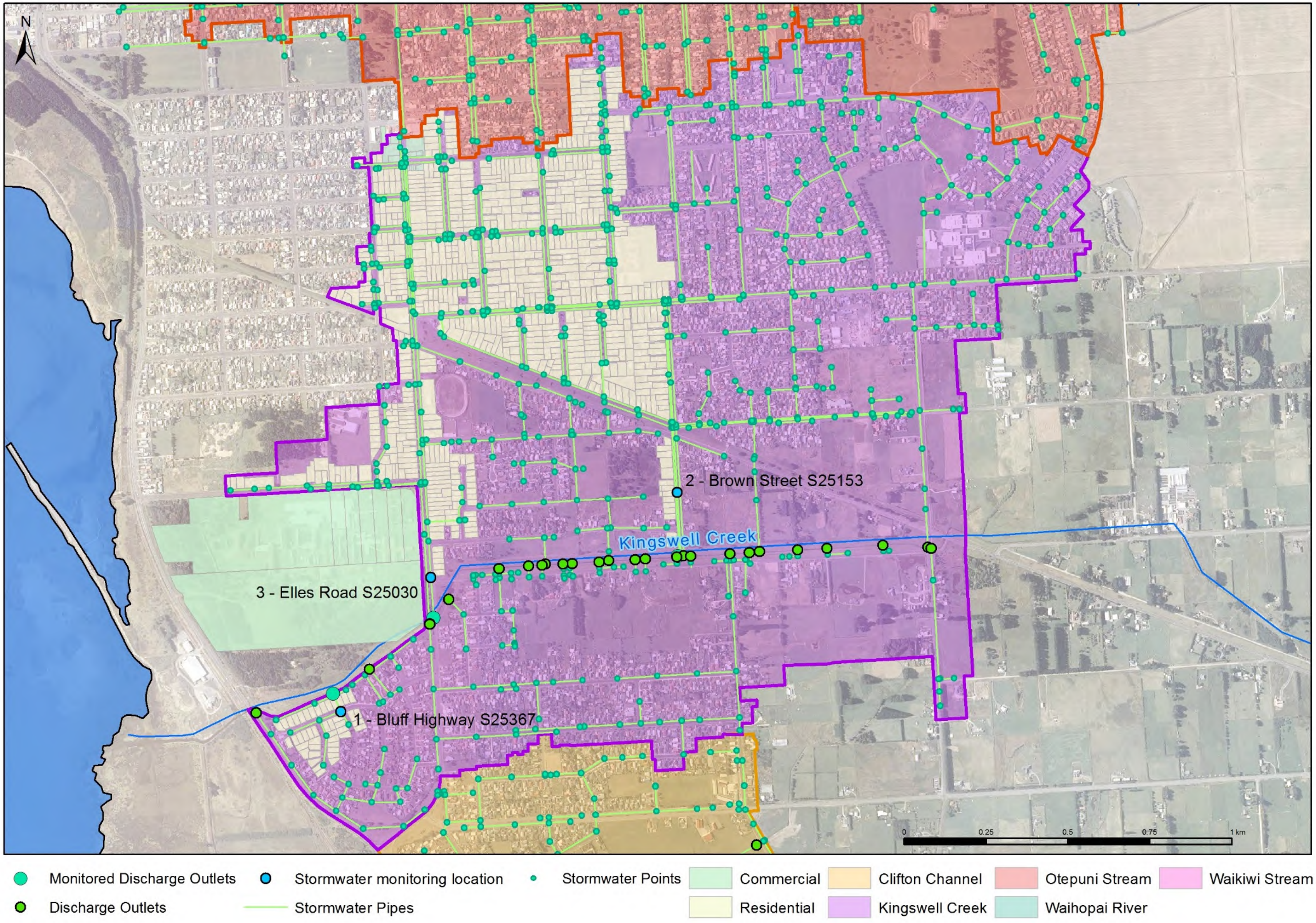
Waikiwi stormwater catchment showing points and network



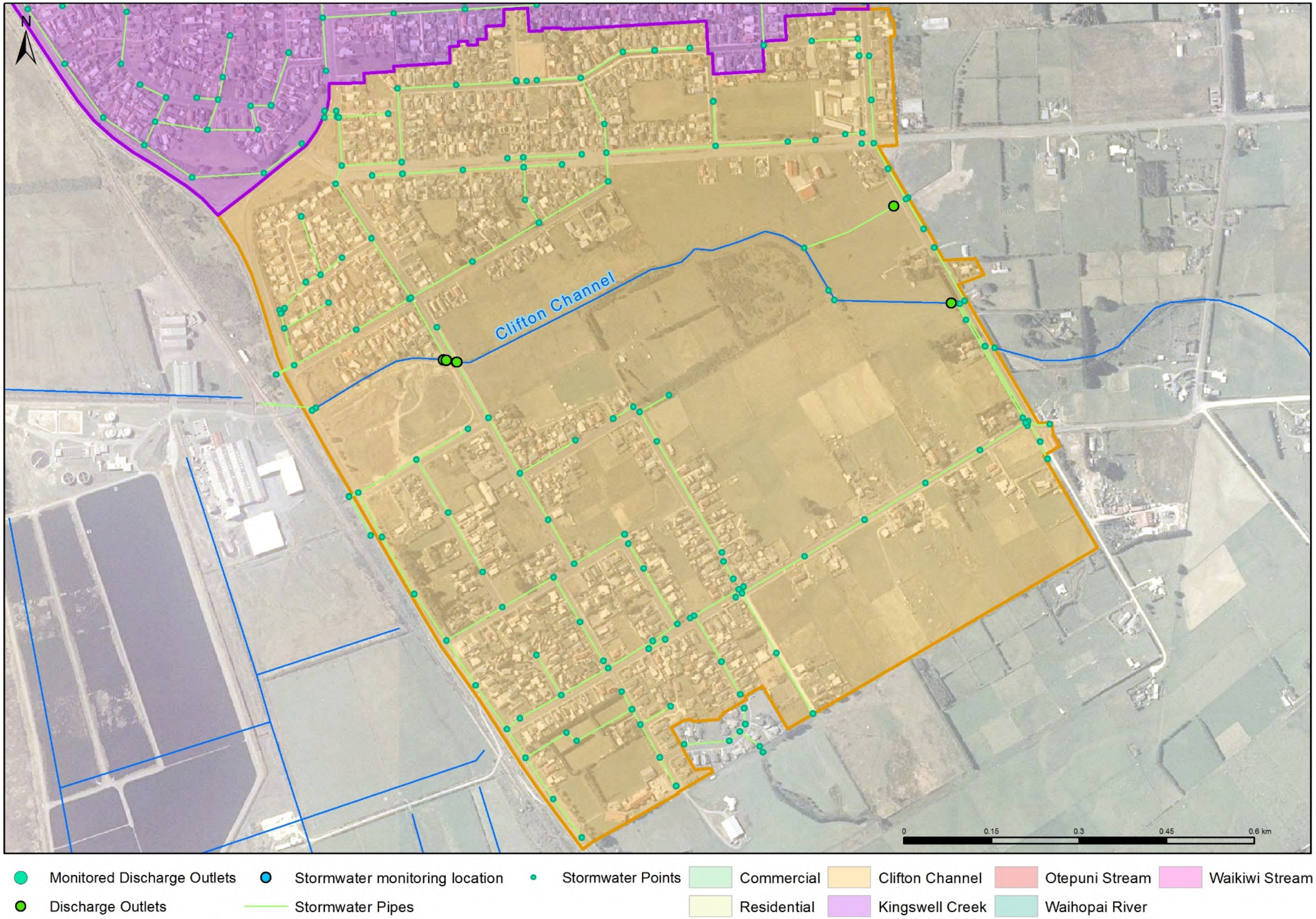
Waihopai stormwater catchment showing points and network



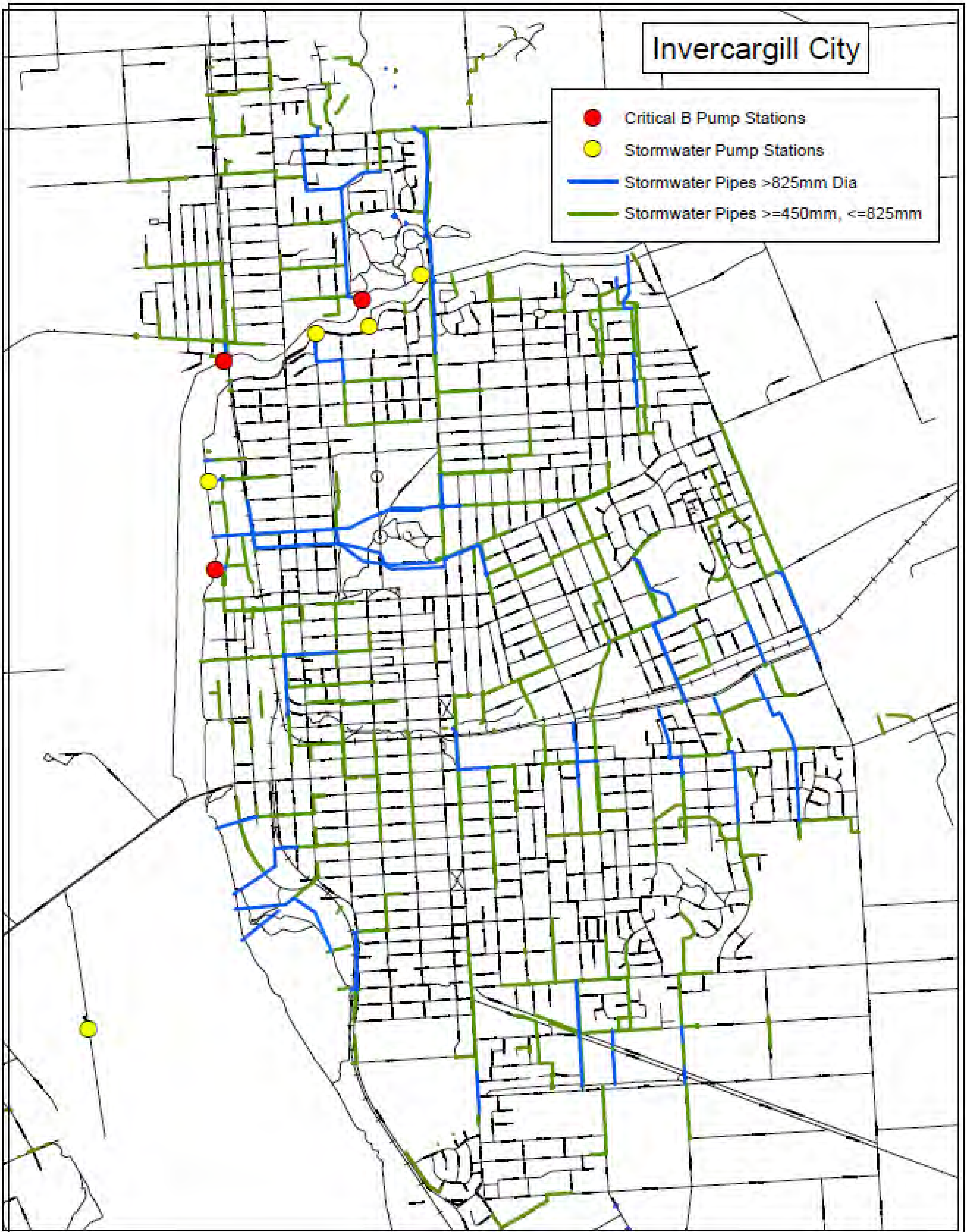
Otepuni stormwater catchment showing points and network



Kingswell stormwater catchment showing points and network



Clifton stormwater catchment showing points and network



Stormwater Reticulation
Major Pipes and Pump Stations

Appendix D Invercargill City Stormwater Catchment: Macroinvertebrate Survey, April 2016

Invercargill City Stormwater Catchment

Macroinvertebrate survey
April 2016

ryderconsulting
environment + planning + project management

Invercargill City Stormwater Catchment

Macroinvertebrate survey April 2016

Prepared for Invercargill City Council by Ryder Consulting Limited

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Table of Contents

1. Introduction

1.1 Background

The Invercargill City Council (ICC) is seeking to renew resource consents 206936, 206937, 206938, 206339, and 206940 to a new global consent that would cover all five catchment areas and authorise the discharge of urban stormwater from reticulated stormwater networks owned and operated by the ICC into Kingswell Creek, Otepuni Stream, Waikiwi Stream, and the Waihopai River. Under 'Schedule A' of the current consent, the ICC must carry out ecological surveys of the macroinvertebrate communities in Kingswell Creek, Otepuni Stream, and the Waihopai River.

'Schedule A, Condition D' of the current consent states:

(i) *the survey shall be by an appropriately qualified person who shall determine the relative abundance of macroinvertebrates. Samples shall be collected following "Protocols for sampling macroinvertebrates in wadeable streams". Analysis shall include MCI, QMCI and %EPT;*

(ii) *the survey shall be carried out with at least three replicates at each site ("kick" sampling will suffice); and*

(iii) *the consent holder shall, by 15 August 2013, submit a report providing both the field data and an interpretation of the results.*

(iv) *sampling shall occur in the period 1 December to 30 April, when river flow in the Waihopai at Kennington is less than 1.25 cumecs.*

Ryder Consulting undertook the surveys and reporting required by Condition D in 2012. Subsequently, Ryder Consulting has been engaged by the ICC to conduct another macroinvertebrate community survey to provide information to support the process of renewing the resource consent.

1.2 Objective

The underlying objective of the stream survey is to assess whether any stormwater discharged from the ICC stormwater network has had an adverse effect on the macroinvertebrate communities of Kingswell Creek, Otepuni Stream, Waikiwi Stream, and the Waihopai River. This report details the methods and results of macroinvertebrate sampling and processing undertaken in April 2016.

2. Sampling Locations

The ICC stormwater network is a reticulated piped and channelled network, which receives and channels stormwater runoff from roofs, roads and other impervious surfaces, and permeable land including reserves, lawns, gardens and rural areas.

Macroinvertebrate monitoring was carried out on four sub-catchments of the Invercargill City network: the Kingswell sub-catchment, Otepuni sub-catchment, Waihopai sub-catchment, and Waikiwi sub-catchment (Figure 1).

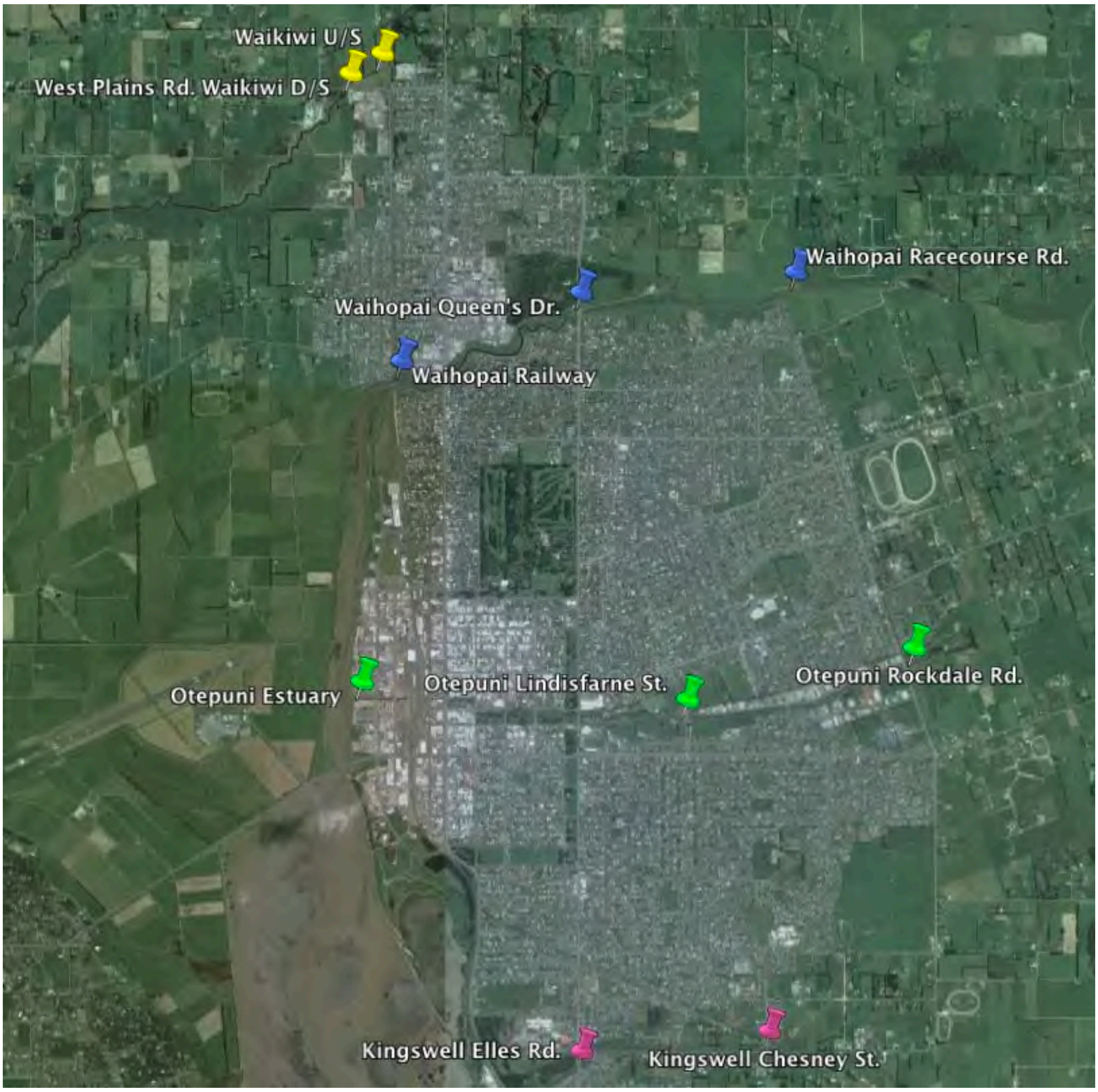

Figure 1 *Map outline of sampling sites and locations, Invercargill City.*

3. Sampling and Analysis Techniques

3.1 General

Benthic macroinvertebrate samples were collected on the 28th of April 2016 when the flow in the Waihopai River at Kennington ranged from approximately 2.3 to 3.7 m³/s (Figure 2). Flows were slightly above the prescribed survey flow limit of 1.25 m³/s stated in the consent conditions (Condition D (iv)). However, there was limited opportunity to do the required work within the given time frame and the streams were easily wadeable at the time of sampling (Figure 2). The maximum flow in the six weeks prior to the survey was 6.0 m³/s. It is believed that the higher flow level will not have unduly affected the results given in this report.

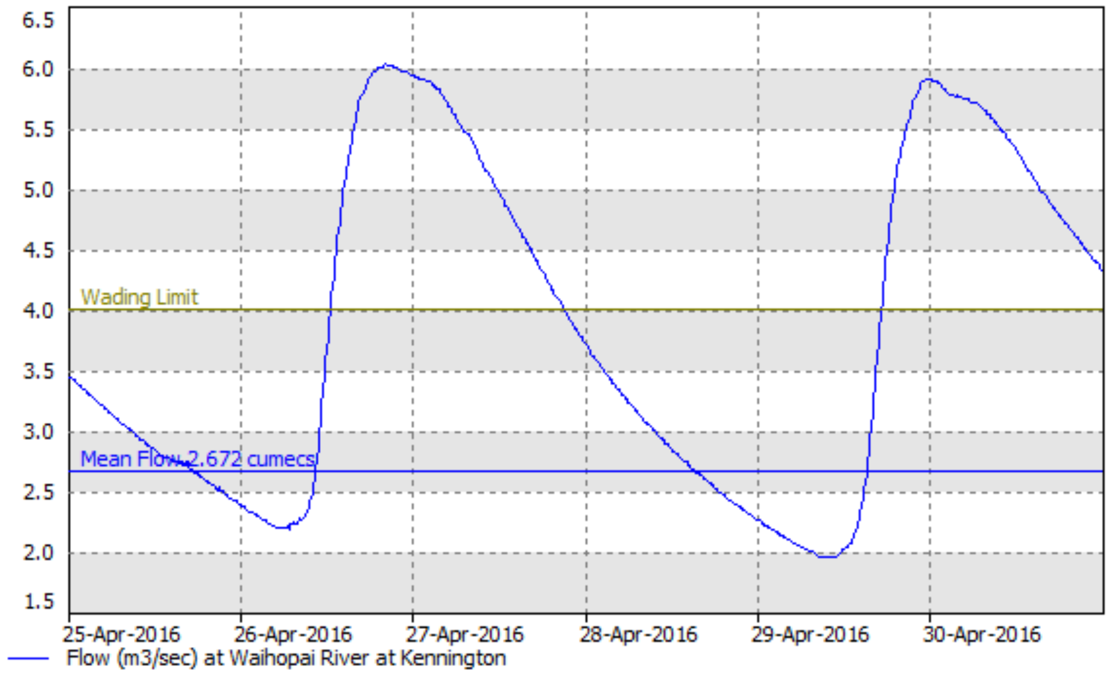

Figure 2 *Waihopai River flow data at Kennington, April 2016 (Environment Southland).*

3.2 Field collection

Benthic macroinvertebrates were sampled using a kicknet with 500 µm diameter mesh, following Ministry for the Environment's 'Protocols for sampling macroinvertebrates in wadeable streams' (Stark *et al.* 2001). Samples were collected by disturbing the substrate in a representative area immediately upstream of the net. Three samples were collected from each sampling site. Samples were preserved in 70% ethanol and returned to the laboratory.

For estuarine habitats sampling methods were adapted from the National Estuarine Environment Monitoring Protocol (Robertson *et al.* 2002). Three $1m^2$ quadrats were photographed for enumeration of epibiota. A 200 mm deep, 85 mm diameter, core sample was then collected adjacent to each quadrat.

3.3 Laboratory assessment

Macroinvertebrate samples were processed for identification and relative abundance using the semi-quantitative protocols outlined in the Ministry for the Environment's 'Protocols for sampling macroinvertebrates in wadeable streams' (Stark *et al.* 2001). Protocol 'P2: 200 fixed count and scan for rare taxa' was used, which is summarised briefly below.

Samples were passed through a 500 µm sieve to remove fine material. Contents of the sieves were then placed in a white tray of known size. A 6 cm x 6 cm quadrat was randomly placed in the tray and the contents of the quadrat removed to a second tray. All of the macroinvertebrates visible to the naked eye in the second tray were removed and the residue transferred to a labelled vial. The macroinvertebrates were then identified under a dissecting microscope (10-40x) using criteria from Winterbourn *et al.* (2006) and transferred to a labelled vial. If 200 individuals were not present in the first quadrat a further quadrat was taken, and this process continued until 200 macroinvertebrates had been identified. At the end of the process the first tray was scanned to find any rare taxa not found in the quadrats. These individuals were identified under a dissecting microscope (10-40x) using criteria from Winterbourn *et al.* (2006) and transferred to a labelled vial.

3.4 Data summaries and metric calculations

Abundances of macroinvertebrates in the quadrats were scaled up to the total number in each sample using a weighting factor based on tray size.

For each site, benthic macroinvertebrate community health was assessed by determining the following characteristics:

Number of taxa: A measurement of the number of taxa present.

Number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa and percentage of the total number of taxa comprising EPT taxa (% EPT taxa): These insect groups are generally dominated by invertebrates that are indicative of higher quality conditions. In stony bed rivers, these indexes usually increase with improved water quality and increased habitat diversity.

Macroinvertebrate Community Index (MCI) (Stark 1993): The MCI uses the occurrence of specific macroinvertebrate taxa to determine the level of organic enrichment in a stream. Taxon scores are between 1 and 10, 1 representing species highly tolerant to organic pollution (e.g., worms and some dipteran species) and 10 representing species highly sensitive to organic pollution (e.g., most mayflies and stoneflies). A site score is obtained by summing the scores of individual taxa and dividing this total by the number of taxa present at the site. These scores can be interpreted in comparison with national standards (Table 1). For example, a low site score (e.g., 40) represents 'poor' conditions and a high score (e.g., 140) represents 'excellent' conditions.

$$\text{MCI} = \left(\frac{\text{Sum of taxa scores}}{\text{Number of scoring taxa}}\right) \times 20$$

Semi-quantitative MCI (SQMCI) (Stark 1998): The SQMCI uses the same approach as the MCI but weights each taxa score based on how abundant the taxa is within the community. Abundance of each taxon is converted into one of five coded abundance categories (Table 2). As for MCI, SQMCI scores can be interpreted in the context of national standards (Table 1).

$$\text{SQMCI} = \frac{\text{Sum of (Taxa coded abundance x Taxa score)}}{\text{Sum of coded abundances for sample}}$$

Table 1 *Interpretation of macroinvertebrate community index values from Boothroyd and Stark (2000) (Quality class A) and Stark and Maxted (2007) (Quality class B).*

Quality Class A	Quality Class B	MCI	SQMCI
Clean water	Excellent	≥ 120	≥ 6.00
Doubtful quality	Good	100 – 119	5.00 – 5.99
Probable moderate pollution	Fair	80 – 99	4.00 – 4.99
Probable severe pollution	Poor	< 80	< 4.00

Table 2 *Coded abundance scores used to summarise macroinvertebrate data (after Stark 1998).*

Abundance	Coded Abundance	Weighting factor
1 - 4	Rare (R)	1
5 - 19	Common (C)	5
20 - 99	Abundant (A)	20
100 - 499	Very abundant (VA)	100
> 500	Very very abundant (VVA)	500

3.5 Data presentation and analyses

Data has been presented graphically as means +/- one standard error. A one-way Analysis of Variance (ANOVA) was used to test for differences between sites using the statistical package Data Desk®. Analysis of variance tables can be interpreted by looking to see whether the 'p-values' for tests are less than 0.05. If they are, then an effect is said to be 'statistically significant'.

Due to the low abundance of animals in estuarine samples raw counts were merely transformed to give a number per square metre.

4. Kingswell Sub-catchment Macroinvertebrate Survey

4.1 Kingswell Creek Sampling Locations

The Kingswell sub-catchment of the Invercargill City stormwater network delivers and discharges stormwater into Kingswell Creek (Figure 3). To assess the effect of the stormwater outfall on Kingswell Creek, conditions in the current consent outline two macroinvertebrate monitoring sites (Table 3, Figure 3).

The upstream 'Chesney Street' sampling site (Figure 4) was located approximately 50 m upstream of a stormwater outfall draining into Kingswell Creek (Figure 5). Managed grasses covered stream banks and adjacent land use was residential with roads, parks, and urban and semi-rural dwellings. Stream flow was moderate and aquatic plants were common within the stream channel. Gravel was the main substrate type, while cobbles and boulders were present but less common.

The downstream 'Elles Road' site (Figure 4) was located approximately 20 m below Kingswell Creek Bridge and approximately 2000 m downstream of the stormwater outfall. The riparian vegetation was similar to that of the upstream 'Chesney Street' site, and similar urban land uses surrounded the sampling reach. Stream flow was moderate and water depth was greater than upstream. Mud and fine sediment was the dominant substrate type and aquatic plants grew densely and covered most of the stream bed.

Figure 3 *Map outline of sampling sites and locations along Kingswell Creek, Invercargill City (blue line). The Kingswell sub-catchment of the ICC stormwater network is outlined in red. The direction of river flow is from the right to left of the map.*

Table 3 *Location and coordinates of macroinvertebrate sampling sites in Kingswell Creek.*

Site name	Coordinates (NZTM)
Chesney Street - upstream	E1245211 N4846754
Elles Road - downstream	E1243689 N4846497

Figure 4 *Upstream 'Chesney Street' (top) and downstream 'Elles Road' (bottom) macroinvertebrate sampling sites in Kingswell Creek, April 2016.*

Figure 5 *Stormwater drain entering Kingswell Creek downstream of Chesney Street Bridge, Invercargill. View taken from true left, April 2016.*

4.2 Kingswell Creek Results and Discussion

Twelve invertebrate taxa were identified across both sampling sites (Table 4). This consisted of seven distinct taxa that were identified at the upstream site, and 12 taxa at the downstream site (Table 4). The average number of taxa found was six and 10 at the upstream and downstream sites, respectively (Table 4). An ANOVA indicated that the number of taxa significantly differed between sites (p = 0.013, Table 5).

Molluscs numerically dominated communities at both sites, particularly the aquatic snail *Potamopyrgus antipodarum* (Table 4). The upstream site also had high numbers of oligochaete worms, and the downstream site high numbers of *Physa* snails and crustaceans, particularly the amphipod *Paracalliope fluviatilis*. In contrast, the diversity and abundance of pollution sensitive EPT taxa was low at both sites (Table 4, Figure 6). Neither stoneflies nor mayflies were present at either site. Caddisflies were not found at the upstream site, and only one distinct caddisfly genus, *Triplectides*, was found downstream. ANOVA tests revealed no significant difference in the number of EPT taxa between sites upstream and downstream of the discharge (p = 0.116, Table 5).

Low MCI scores characterised the macroinvertebrate communities collected from both sampling sites (Table 4). The SQMCI scores for the upstream site were low, and average scores for the site indicate 'poor' habitat quality (Figure 6). The average scores for the downstream site were slightly higher, indicating 'poor' to 'fair' habitat quality. ANOVA tests revealed a statistically significant difference in MCI scores (p = 0.009) and SQMCI scores (p = 0.026, Table 5) between upstream and downstream sites.

Table 4 *Processing results of macroinvertebrate kicknet samples collected from Kingswell Creek, Invercargill. Data shown is the relative abundance of individual taxa per kicknet sample (R = rare, C = common, A = abundant, VA = very abundant, and VVA = very, very abundant).*

		Upstream			Downstream		
TAXON	**MCI score**	**1**	**2**	**3**	**1**	**2**	**3**
ACARINA	5					R	
CRUSTACEA							
Ostracoda	3		A	VA	R	R	R
Paracalliope fluviatilis	5			R	VA	VVA	VVA
DIPTERA							
Orthocladiinae	2	A	C	A	A	A	
HIRUDINEA	3				R		R
MOLLUSCA							
Ferrissia species (formerly *Gundlachia*)	3				VA	VA	VA
Physa species	3	C		R	VA	VVA	VA
Potamopyrgus antipodarum	4	VVA	VVA	VVA	VVA	VVA	VVA
Sphaeriidae	3	A	C	A	A	VA	VA
ODONATA							
Xanthocnemis zealandica	5				R	A	VA
OLIGOCHAETA	1	VA	VVA	VVA	R		
TRICHOPTERA							
Triplectides species	5				R		R
Number of taxa		5	5	7	11	9	9
Number of EPT taxa		0	0	0	1	0	1
Percentage of EPT taxa		0.0	0.0	0.0	9.1	0.0	11.1
MCI score		52	52	60	67	73	76
SQMCI score		3.4	3	3	3.8	4	4
Average number of taxa		6			10		
Average number of EPT taxa		0.0			0.7		
Average MCI score		54.7			72.1		
Average SQMCI score		2.8			4.0		

Table 5 *Results of ANOVA tests on macroinvertebrate matrices measured. Statistically significant results (p<0.05) are indicated in bold.*

Metric	$F_{1,4}$	p-value	Interpretation
Number of taxa	**18.0**	**0.013**	**Downstream > Upstream**
Number of EPT taxa	4.0	0.116	No significant difference
MCI score	**22.8**	**0.009**	**Downstream > Upstream**
SQMCI score	**12.0**	**0.026**	**Downstream > Upstream**

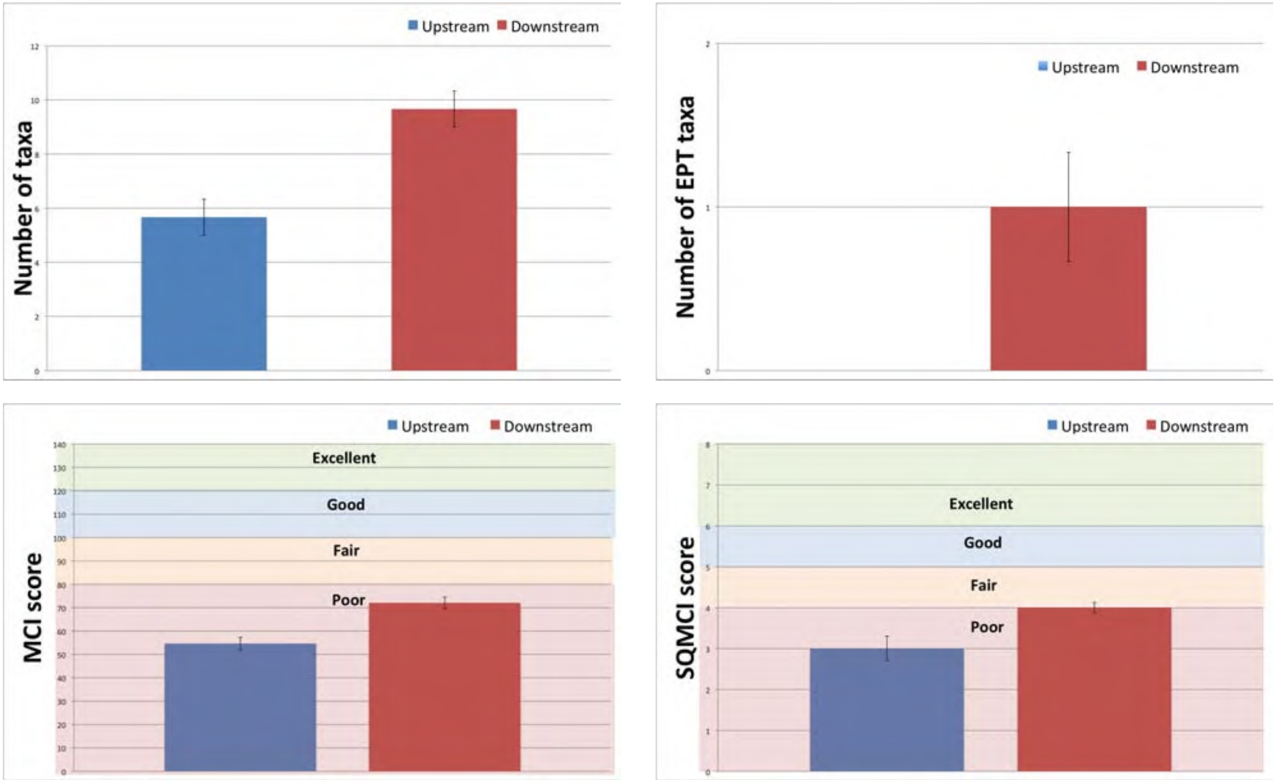

Figure 6 *Graphs displaying average macroinvertebrate matrices for each sampling site in Kingswell Creek. Error bars are +/- one standard error.*

5. Otepuni Sub-catchment Macroinvertebrate Survey

5.1 Otepuni Stream Sampling Locations

The Otepuni sub-catchment of the Invercargill City network delivers and discharges stormwater into Otepuni Creek (Figure 7). To assess the effect of the stormwater outfall on Otepuni Creek, consent conditions outline three monitoring sites (Table 6, Figure 7).

The upstream 'Rockdale Road' sampling site (Figure 8) was located approximately 10 m upstream of a small stormwater drain confluence. Bank vegetation consisted of long and short grasses, and exotic trees, while adjacent land-uses were predominantly rural pasture and cemetery gardens. Small cobbles, gravels, and some fine sediment were the main substrate types and aquatic plants densely populated the stream channel. Flow velocity at the site was moderate.

The downstream 'Lindisfarne Street' site (Figure 8) was located approximately

40 m below the Otepuni Creek Bridge at Lindisfarne Street, about 20 m below the confluence of a large stormwater pipe (Figure 9). Long grasses, bushes and exotic trees were the main bank vegetation with impervious roading prevalent beyond the left bank. Bed substrates, aquatic plant growth, and stream velocity were similar to that of the upstream site.

The 'Estuary' sampling site (Figure 8) was situated about 50 m upstream of the mouth of Otepuni Creek that leads into the lower Waihopai River. The intertidal zone comprised very deep, fine grey sediment with rip-rap at the highest extremes. Beyond the rip-rap banks were characterised by unkempt exotic grasses. Macroflora were notably sparse with just a few small clumps of *Gracilaria chilensis* and occasional patches of diatom film on the surface of the mud.

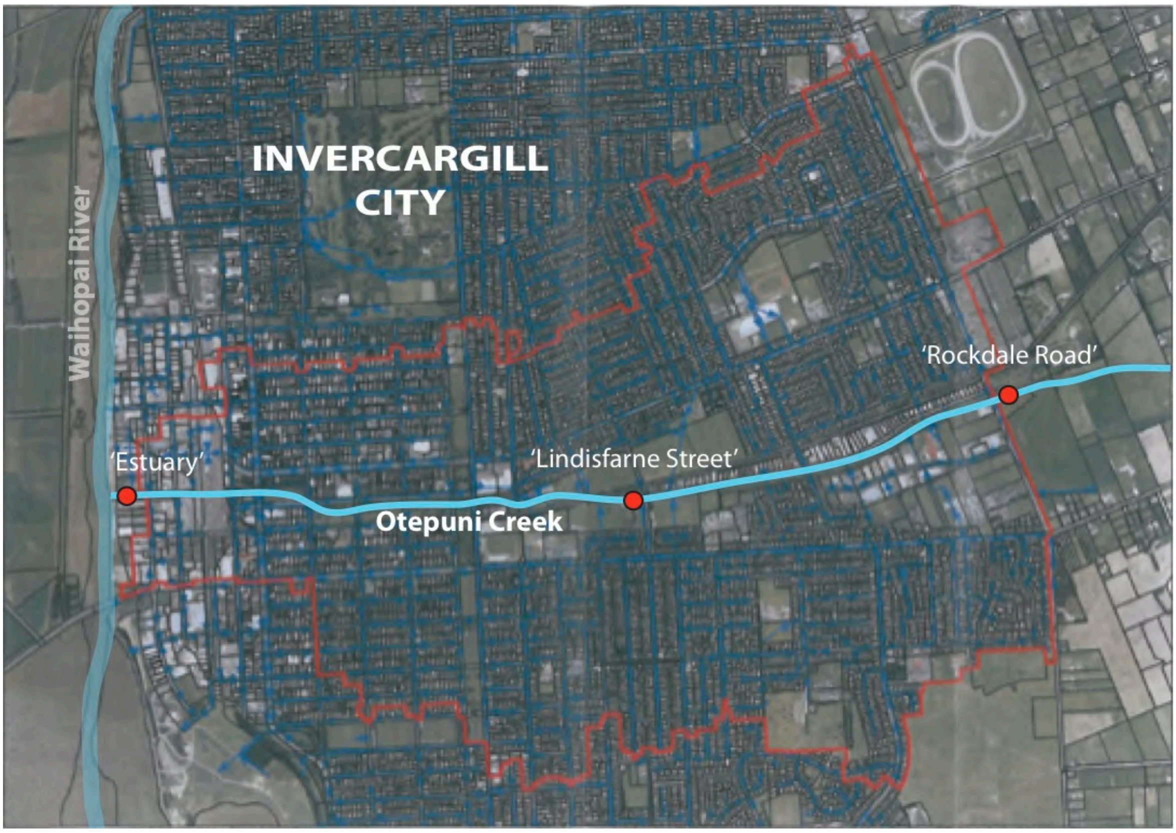

Figure 7 *Map outline of sampling sites and locations along Otepuni Creek, Invercargill City (blue line). The Otepuni sub-catchment of the ICC stormwater network is outlined in red. The direction of river flow is from the right to left of the map.*

Table 6 *Location and coordinates of macroinvertebrate sampling sites in Otepuni Creek.*

Site name	Coordinates (NZTM)
Rockdale Road - upstream	E1246204 N4849949
Lindisfarne Street - downstream	E1244381 N4849407
Estuary	E1241723 N4849399

Figure 8 *Upstream 'Rockdale Road' (top), downstream 'Lindisfarne Street' (centre), and 'Estuary' (bottom) sampling sites in Otepuni Creek, April 2016.*

Figure 9 *View of a stormwater drain entering Otepuni Creek (left) near Lindisfarne Street, Invercargill. View taken from true left, April 2016.*

5.2 Otepuni Stream Results and Discussion

Eighteen freshwater invertebrate taxa were identified across the two freshwater sampling sites (Table 7). This consisted of 15 distinct taxa that were identified at the upstream site and 12 at the downstream site (Table 7). An ANOVA indicated that the number of taxa in samples did not differ significantly between sites (p = 0.374, Table 8).

Of the taxa found, oligochaetes, crustaceans (particularly the amphipod species, *Paracalliope fluviatilis*), and molluscs (specifically the aquatic snail, *Potamopyrgus antipodarum*) numerically dominated communities at the upstream and downstream sites (Table 7). In contrast, the abundance and diversity of pollution sensitive EPT taxa were low (Table 7, Figure 10). No stonefly or mayfly taxa were identified in samples collected from the upstream and downstream sites in Otepuni Stream. Three caddisfly taxa were present at the upstream site, however only one was found at downstream site. The overall percentage of EPT taxa (consisting only of caddisfly taxa) found in the upstream samples ranged from 16.7% to 25.0% (Table 7). The overall percentage of EPT taxa in the downstream samples, however, reached only 8.3%, with no EPT taxa found at all in one of the samples from this site. ANOVA tests revealed a statistically significant difference in the number of EPT taxa present between sampling sites (p = 0.024, Table 8).

Low MCI and SQMCI scores characterised macroinvertebrate communities collected from both sampling sites (Table 7) and average scores indicated 'poor' habitat quality throughout (Figure 10). There was no significant difference in MCI (p = 0.105) and SQMCI (p = 0.392, Table 8) scores between sites.

Table 7 *Processing results of macroinvertebrate kicknet samples collected from upstream and downstream sites in Otepuni Creek, Invercargill. Data shown is the relative abundance of individual taxa per kicknet sample (R = rare, C = common, A = abundant, VA = very abundant, and VVA = very, very abundant).*

		Upstream			Downstream		
TAXON	**MCI score**	**1**	**2**	**3**	**1**	**2**	**3**
ACARINA	5				R		
CNIDARIA							
Hydra species	3	C					
COLEOPTERA							
Elmidae	6		A				
CRUSTACEA							
Ostracoda	3	VA	A	A	VA	VA	A
Paracalliope fluviatilis	5	VA	VVA	VVA	VA	VA	VA
Phreatoicidae	5			R			
DIPTERA							
Austrosimulium species	3	A	A	A			
HIRUDINEA	3	A	A	R	R	A	C
MOLLUSCA							
Ferrissia species (formerly *Gundlachia*)	3				R	A	C
Physa species	3	A	A	A	VA	VA	A
Potamopyrgus antipodarum	4	VVA	VVA	VVA	VVA	VVA	VVA
Sphaeriidae	3	VA	VA	A	A	VA	A
ODONATA							
Xanthocnemis zealandica	5				A	R	R
OLIGOCHAETA	1	VA	VA	VA	VA	VA	A
PLATYHELMINTHES	3		A	R	R	R	R
TRICHOPTERA							
Hudsonema amabile	6	R	R	A			
Hydrobiosis umbripennis group	5	R					
Triplectides species	5	C	R	R	R	R	
Number of taxa		12	12	12	12	12	10
Number of EPT taxa		3	2	2	1	1	0
Percentage of EPT taxa		25	16.7	16.7	8.3	8.3	0.0
MCI score		73	75	73	72	72	66
SQMCI score		3.5	4	4	3.6	3	4
Average number of taxa			12			11	
Average number of EPT taxa			2.3			0.7	
Average MCI score			73.9			69.8	
Average SQMCI score			3.9			3.7	

Table 8 *Results of ANOVA tests on macroinvertebrate matrices measured. Statistically significant results (p<0.05) are indicated in bold.*

Metric	F1,4	p-value	Interpretation
Number of taxa	1.0	0.374	No significant difference
Number of EPT taxa	**12.5**	**0.024**	**Upstream > Downstream**
MCI score	4.4	0.105	No significant difference
SQMCI score	0.9	0.392	No significant difference

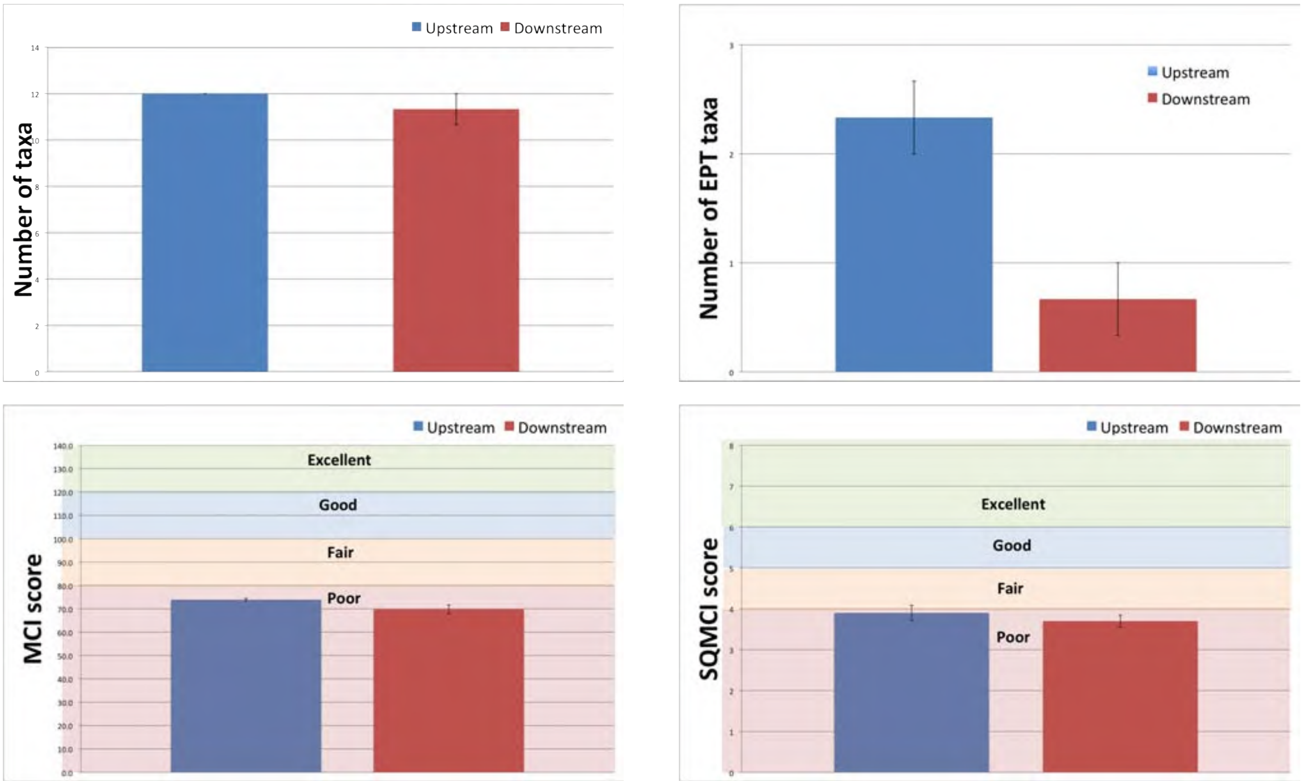

Figure 10 *Graphs displaying average macroinvertebrate matrices for each sampling site in Otepuni Stream. Error bars are +/- one standard error.*

Estuarine samples numbers were dominated by oligochaete worms, with occasional polychaetes and amphipods (Table 9). No epifauna were observable within the quadrats, but one mud snail (*Amphibola crenata*) and two notoacmeid limpets were observed beyond the quadrats on mud and rip-rap respectively.

None of the species encountered in estuarine samples were rare or unusual and were typical of modified estuarine environments from southern New Zealand (e.g. Morton and Miller 1973; Grove 1995; Grove and Probert 1997; Stewart 2007, 2008a,b; 2009a,b; Stewart and Ryder 2004). No species encountered were known to be particularly pollution sensitive.

Table 9 *Abundance (per m^2) of macroinvertebrate taxa identified in cores taken at the mouth of the Otepuni Stream (estuary site).*

	Organism m2		
Core:	Otepuni 1	Otepuni 2	Otepuni 3
Aglaophamus macroura	223		
Amphipoda A			446
Chironomus sp	223		
Glyceridae	223	223	
Nematoda		223	
Nereidae	223	669	
Oligochaeta	1115	27	3791
Ostracod sp		223	223
Paracalliope novizealandiae	223		446
Paraonidae			
Potamopyrgus sp.	223		
Prionospio sp.	223		446

6. Waihopai Sub-catchment Macroinvertebrate Survey

6.1 Waihopai River Sampling Locations

The Waihopai sub-catchment of the Invercargill City network delivers and discharges stormwater into the Waihopai River (Figure 11). To assess the effect of the stormwater outfall on the Waihopai River, conditions of the current consent outline three monitoring sites (Table 10, Figure 11).

The upstream 'Racecourse' sampling site (Figure 12) was located approximately 50 m upstream of a stormwater drain confluence (Figure 13). Riparian vegetation at the site consisted primarily of ungrazed pasture grasses, while adjacent land-uses were predominantly urban and rural pasture. Gravels and some small cobbles were the main substrate types and aquatic plant growth was very abundant.

The downstream 'Queens Drive' site (Figure 12) was located approximately 20 m below the Waihopai River Bridge at Queens Drive and 1700 m downstream of the outfall. It was approximately 2000 m upstream of the estuarine 'Railway' sampling site. Long grasses dominated the riparian zone immediately adjacent to the stream and a band of mature native plantings was present on the true right. Stream substrates were similar to that of the upstream site, however aquatic plant growth was less dominant.

The most downstream 'Railway' sampling site (Figure 12) was situated approximately 20 m upstream of the Ohai Industrial Line railway bridge. A mix of industrial and urban land surrounds this site and the shallow stream banks were covered by largely wetland shrub and rush species. The 'Railway' site differs from both the upstream 'Racecourse' and downstream 'Queens Drive' sites in that the reach is tidal and the habitat estuarine. The intertidal zone comprised moderately deep, fine grey sediment with scattered beds of exposed cobbles and gravel. As at the Otepuni Stream estuarine site, macroflora were notably scarce. However, the diatom film on the surface of the mud was more pronounced at this site.

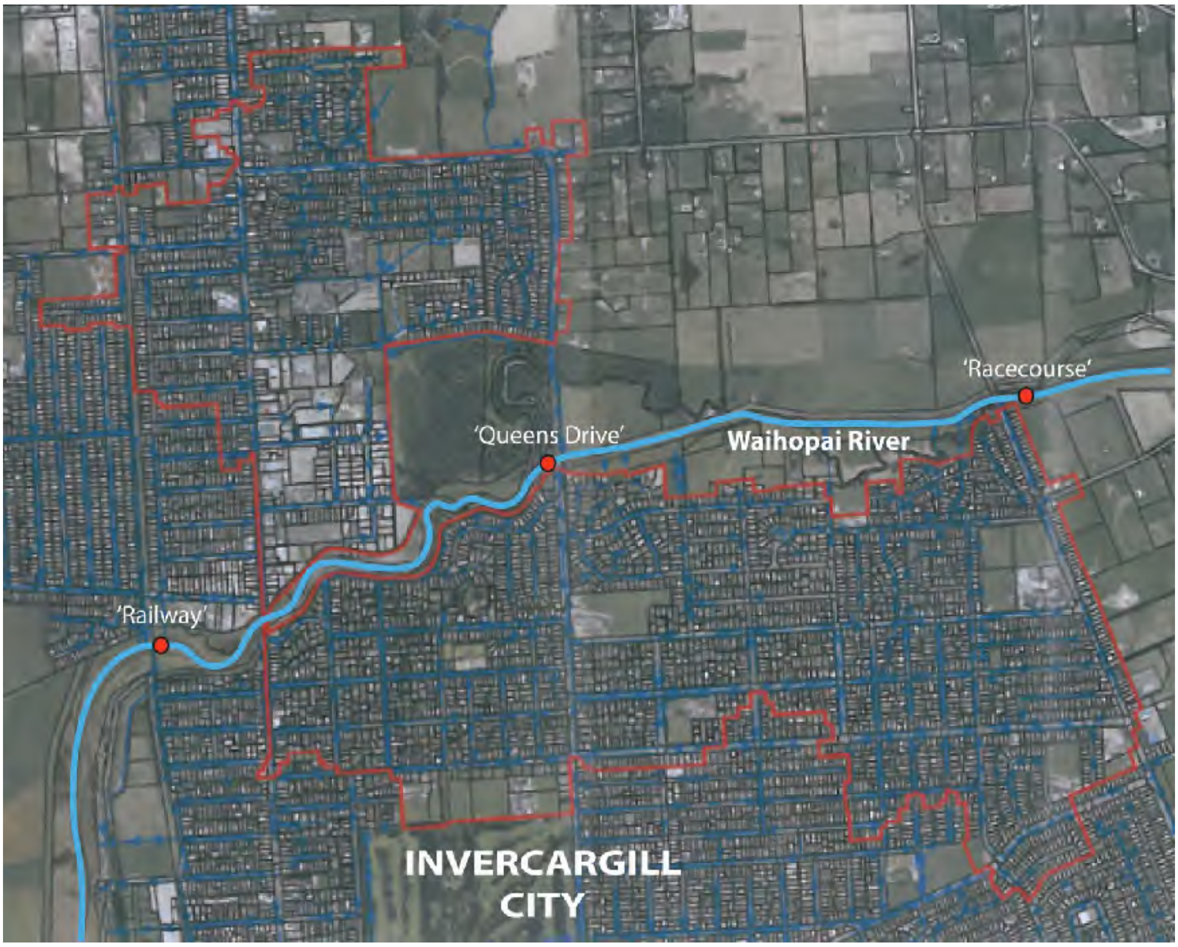

Figure 11 *Map outline of sampling sites and locations along the Waihopai River, Invercargill City (blue line). The Waihopai sub-catchment of the ICC stormwater network is outlined in red. The direction of river flow is from the right to left of the map.*

Table 10 *Location and coordinates of macroinvertebrate sampling sites in the Waihopai River.*

Site name	Coordinates (NZTM)
Racecourse - upstream	E1241901 N4852020
Queens Drive - downstream	E1243320 N4852656
Railway - estuary	E1245084 N4852930

Figure 12 *Upstream 'Racecourse' (top), downstream 'Queens Drive' (centre), and estuarine 'Railway' (bottom) sampling sites in the Waihopai River, April 2016.*

Figure 13 *Downstream view of a stormwater drain that enters the Waihopai River near Racecourse Road, Invercargill, April 2016.*

6.2 Waihopai River Results and Discussion

Twenty-seven invertebrate taxa were identified across the two freshwater sampling sites (Table 11). This consisted of 25 distinct taxa identified in the upstream samples and 15 taxa in samples collected from the downstream site (Table 11). An ANOVA indicated that the number of taxa in the samples did not significantly differ between sites (p = 0.072, Table 11).

Of the taxa found, molluscs, oligochaetes and crustaceans numerically dominated communities (Table 11). The aquatic snail *Potamopyrgus antipodarum*, the amphipod species *Paracalliope fluviatilis* and ostracods were particularly abundant at both sites. Eleven pollution sensitive EPT taxa were identified at the upstream site, where EPT taxa were also represented in relatively high abundance. Comparatively, EPT abundance and EPT taxa diversity were low at the downstream site (Table 11, Figure 14). No stoneflies were present in any sample and no mayflies were found at the downstream site. One genus of mayfly, *Deleatidium*, was represented in the samples from the upstream site. The upstream samples also revealed a reasonably high percentage of EPT taxa, reaching 47.1% in one sample (Table 11). The percentage of EPT taxa in the downstream samples was comparatively lower, ranging from 20 to 30%. ANOVA tests revealed a statistically significant difference in the number of EPT taxa present between sampling sites (p = 0.019, Table 12). In one of the samples from the downstream 'Queens Drive' site a saltwater polychaete worm of the genus *Prionospio* was also found (Table 11).

Low SQMCI scores characterised the macroinvertebrate communities collected from all sampling sites (Table 11), indicating 'poor' habitat quality throughout (Figure 14). Consistent with this, the average MCI score for the downstream site also indicated 'poor' habitat quality. However, the average MCI score for the upstream site fell into the 'fair' class. ANOVA tests revealed a statistically significant difference in MCI scores between sites (p = 0.018) but no difference in SQMCI scores (p = 0.582, Table 12).

Table 11 *Processing results of macroinvertebrate kicknet samples collected from upstream and downstream sites in the Waihopai River, Invercargill. Data shown is the relative abundance of individual taxa per kicknet sample (R = rare, C = common, A = abundant, VA = very abundant, and VVA = very, very abundant).*

		Upstream			Downstream		
TAXON	**MCI score**	**1**	**2**	**3**	**1**	**2**	**3**
COLEOPTERA							
Elmidae	6	R	A	VA			
CRUSTACEA							
Ostracoda	3	VVA	VA	VA	VA	VA	VA
Paracalliope fluviatilis	5	VVA	VVA	VVA	VA	VVA	VA
DIPTERA							
Austrosimulium species	3	A	R				
Chironomus species	1	A			A	C	
Orthocladiinae	2	A	VA	A	C	C	C
Tanytarsini	3			A			
EPHEMEROPTERA							
Deleatidium species	8	R	A	VA			
HIRUDINEA	3	A					
LEPIDOPTERA							
Hygraula nitens	4	A	A	A		R	C
MOLLUSCA							
Ferrissia species (formerly *Gundlachia*)	3					C	C
Gyraulus species	3	R					
Physa species	3	VA	VVA	A	A	A	A
Potamopyrgus antipodarum	4	VVA	VVA	VVA	VA	VA	VA
Sphaeriidae	3	A	VA			C	C
ODONATA							
Xanthocnemis zealandica	5	R				R	R
OLIGOCHAETA	1	VVA	VA	R	VA	VA	
POLYCHAETA	-						
Prionospio species	-					C	
TRICHOPTERA							
Aoteapsyche species	4			R			
Hudsonema alienum	6			A			
Hudsonema amabile	6		A	A			
Hudsonema species	6	A		A			
Hydrobiosis umbripennis group	5	R	R	R			
Oecetis species	6	VA	A	A	C	R	R
Oxyethira albiceps	2		A	A	C	C	A
Pycnocentria species	7	A					
Triplectides species	5	R			C	R	R
Number of taxa		20	15	17	10	15	12
Number of EPT taxa		6	5	8	3	3	3
Percentage of EPT taxa		30	33.3	47.1	30.0	20.0	25.0
MCI score		83	81	87	64	63	75
SQMCI score		3.4	4	5	3.2	4	4
Average number of taxa			17			12	
Average number of EPT taxa			6.3			3.0	
Average MCI score			83.8			67.2	
Average SQMCI score			3.9			3.7	

Table 12 *Results of ANOVA tests on macroinvertebrate matrices measured. Statistically significant results ($p<0.05$) are indicated in bold.*

Metric	$F_{1,4}$	p-value	Interpretation
Number of taxa	5.9	0.072	No significant difference
Number of EPT taxa	**14.3**	**0.019**	**Upstream > Downstream**
MCI score	**15.1**	**0.018**	**Upstream > Downstream**
SQMCI score	0.4	0.582	No significant difference

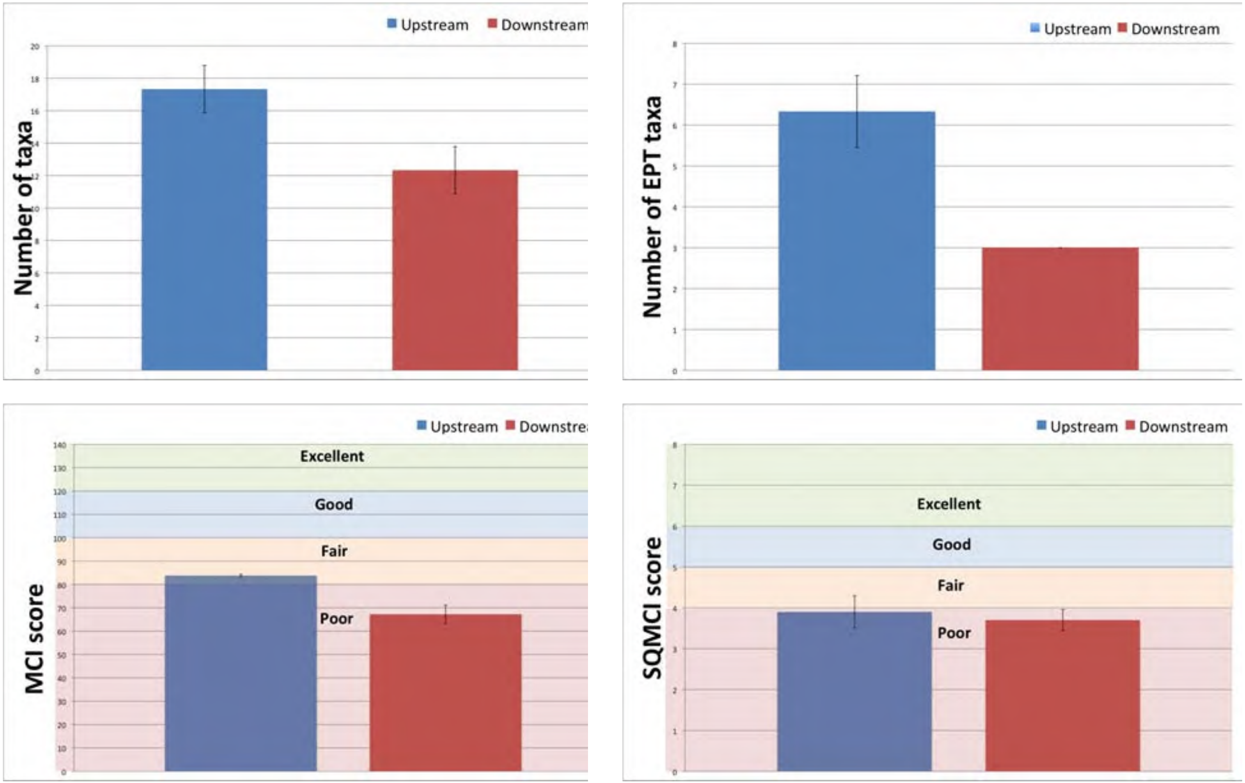

Figure 14 *Graphs displaying average macroinvertebrate matrices for each sampling site in Waihopai River. Error bars are +/- one standard error.*

Waihopai estuarine samples were dominated by polychaete worms with occasional amphipods (Table 13). No epifauna were observable within the quadrats, but numerous animal tracks, likely gastropod molluscs, and occasional burrows, likely polychaete worms and/or amphipods were visible.

Once again none of the species encountered were rare or unusual and were typical of modified estuarine environments from southern New Zealand (e.g. Morton and Miller 1973; Grove 1995; Grove and Probert 1997; Stewart 2007, 2008a,b; 2009a,b; Stewart and Ryder 2004). No species encountered were known to be particularly pollution sensitive.

Table 13 *Abundance (per m²) of macroinvertebrate taxa in cores taken upstream of the railway bridge at the Waihopai River (estuary site).*

	Organism m2		
Core:	Waihopai 1	Waihopai 2	Waihopai 3
Aglaophamus macroura	669	1561	1115
Amphipoda A			
Chironomus sp	223		
Glyceridae			
Nematoda			
Nereidae	446	223	446
Oligochaeta	223	446	446
Ostracod sp			223
Paracalliope novizealandiae	223	223	
Paraonidae		223	
Potamopyrgus sp.			
Prionospio sp.			

7. Waikiwi Sub-catchment Macroinvertebrate Survey

7.1 Waikiwi Stream Sampling Locations

The Waikiwi sub-catchment of the Invercargill City stormwater network delivers and discharges stormwater into the Waikiwi Stream (Figure 15). To assess the effect of stormwater outfall on the Waikiwi Stream, macroinvertebrate monitoring was carried out at two sites (Table 14, Figure 15).

The upstream sampling site (Figure 16) was located approximately 300 m upstream of West Plains Road Bridge and approximately 150 m upstream of a stormwater outfall draining into Waikiwi Stream (Figure 17). Riparian vegetation consisted of pasture grasses, with some exotic trees further removed from the stream edge. The surrounding land use was rural pasture, and there was evidence that it is used for grazing sheep. The substrate at the sampling site consisted of very fine sediment and mud. Aquatic plants and algae existed in a dense population, with charophytes being especially abundant.

The downstream site (Figure 16) was located approximately 150 m below the stormwater outfall and 10 m below a bridge on West Plains Road. The riparian vegetation consisted of pasture grasses and mature exotic trees. The surrounding land use was rural and industrial, with a sand and gravel workshop located immediately adjacent to the sampling site. Stream velocity was similar to that upstream, as was the substrate, which was predominantly mud. Aquatic plants also densely populated the streambed.

Figure 15 *Map outline of sampling sites and locations along the Waikiwi Stream, Invercargill City (blue line). The Waikiwi sub-catchment of the ICC stormwater network is outlined in red. The direction of river flow is from the top to the bottom of the map.*

Table 14 *Location and coordinates of macroinvertebrate sampling sites in Waikiwi Stream.*

Site name	Coordinates (NZTM)
West Plains Road U/S - upstream	E1241595 N4854533
West Plains Road D/S - downstream	E1241345 N4854341

Figure 16 *Upstream (top) and downstream (bottom) sampling sites in Waikiwi Stream, April 2016.*

Figure 17 *Stormwater drain entering Waikiwi Stream upstream of West Plains Road Bridge, Invercargill. View taken from true left, April 2016.*

7.2 Waikiwi Stream Results and Discussion

Twenty-one invertebrate taxa were identified across both sampling sites (Table 15). Eighteen distinct taxa were identified in the samples from both sites (Table 15). The average number of taxa found in each sample was 14 for both the upstream and downstream sites and an ANOVA indicated that the number of taxa did not significantly differ between sites (p = 0.422, Table 16).

Oligochaetes, crustaceans, and molluscs numerically dominated the communities at both sites. More specifically, ostracods, the amphipod *Paracalliope fluviatilis*, and aquatic snails of the *Potamopyrgus antipodarum* species and *Physa* genus were abundant (Table 15). The overall numbers of pollution sensitive EPT animals was comparatively lower at both sites (Table 13, Figure 18), though as a percentage of the taxa list, EPT taxa proportions were reasonably high, reaching 30.8% in one of the samples collected from the upstream site (Table 15). Diversity of EPT taxa was slightly greater at the upstream site, where six EPT taxa were identified, compared with the four identified in the downstream samples. One mayfly genus, *Deleatidium*, was also identified in the upstream samples, though in very low numbers. No stoneflies were found in any of the samples from Waikiwi Stream. ANOVA tests however revealed no significant difference in the number of EPT taxa located between sampling sites (p = 0.374, Table 16).

Low MCI and SQMCI scores characterised the macroinvertebrate communities collected from both sampling sites (Table 13), and average scores indicated 'poor' habitat quality (Figure 18). ANOVA tests revealed a statistically significant difference in MCI scores between sites (p = 0.037), but no difference in SQMCI scores (p = 0.645, Table 16).

Table 15 *Processing results of macroinvertebrate kicknet samples collected from Waikiwi Stream, Invercargill. Data shown is the relative abundance of individual taxa per kicknet sample (R = rare, C = common, A = abundant, VA = very abundant, and VVA = very, very abundant).*

		Upstream			Downstream		
TAXON	**MCI score**	**1**	**2**	**3**	**1**	**2**	**3**
CRUSTACEA							
Ostracoda	3	VA	VA	A	VA	C	VA
Paracalliope fluviatilis	5	VVA	VVA	VVA	VVA	VA	VVA
DIPTERA							
Chironomus species	1	R					R
Corynoneura scutellata	2				A		
Orthocladiinae	2		A	A	VA	A	A
EPHEMEROPTERA							
Deleatidium species	8	R					
HEMIPTERA							
Sigara species	5			R			
LEPIDOPTERA							
Hygraula nitens	4		R	R	R	C	A
MOLLUSCA							
Ferrissia species (formerly *Gundlachia*)	3				A	C	A
Gyraulus species	3	R	R	A		R	
Physa species	3	VA	VVA	VVA	VVA	VA	VVA
Potamopyrgus antipodarum	4	VVA	VVA	VVA	VVA	VVA	VVA
Sphaeriidae	3	C	A	A	VA	C	A
ODONATA							
Xanthocnemis zealandica	5	C	A	A	A	C	A
OLIGOCHAETA	1	VA	VVA	VA	VA	C	VA
PLATYHELMINTHES	3						R
TRICHOPTERA							
Hudsonema species	6			R			
Hydrobiosis umbripennis group	5		R		R		R
Oecetis species	6	R	R	R	A	C	A
Oxyethira albiceps	2	C	A		R	R	
Triplectides species	5	R	R	R	A		A
Number of taxa		13	14	14	15	13	15
Number of EPT taxa		4	4	3	4	2	3
Percentage of EPT taxa		30.8	28.6	21.4	26.7	15.4	20.0
MCI score		75	73	79	71	68	71
SQMCI score		4.0	3	4	3.7	4	4
Average number of taxa			14			14	
Average number of EPT taxa			3.7			3.0	
Average MCI score			75.6			69.7	
Average SQMCI score			3.7			3.8	

Table 16 *Results of ANOVA tests on macroinvertebrate matrices measured. Statistically significant results (p<0.05) are indicated in bold.*

Metric	F1,4	p-value	Interpretation
Number of taxa	0.8	0.4216	No significant difference
Number of EPT taxa	1.0	0.3739	No significant difference
MCI score	**9.5**	**0.0371**	**Upstream > Downstream**
SQMCI score	0.2	0.6453	No significant difference

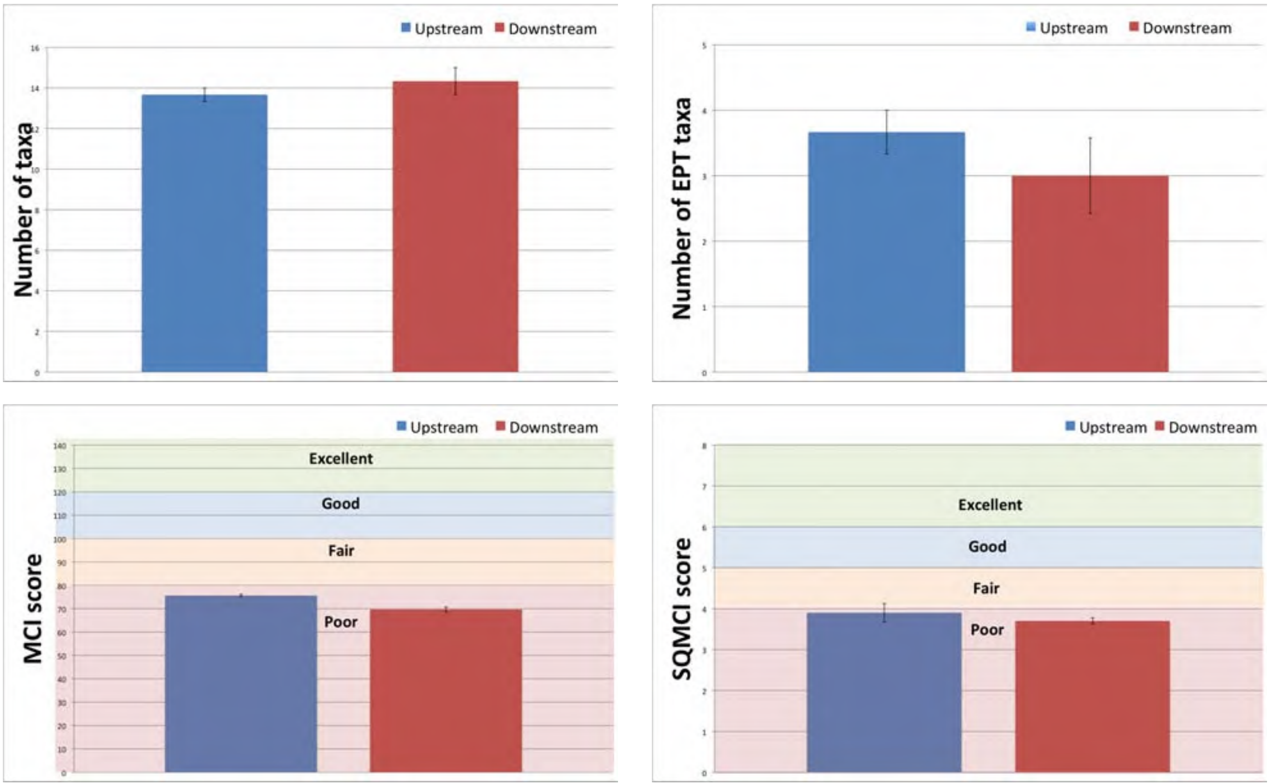

Figure 18 *Graphs displaying average macroinvertebrate matrices for each sampling site in Waikiwi Stream. Error bars are +/- one standard error.*

8. Comparisons with previous survey results

Prior to the April 2016 survey described in this report, macroinvertebrate surveys of the Invercargill City stormwater catchment were last undertaken in March 2012 (Arthur 2012). A comparison of data between these surveys can provide an indication of any changes over time to the benthic communities of the Invercargill City stormwater catchment that could be attributed to the stormwater discharge. Note that the 2012 survey did not include the Waikiwi Stream, thus no temporal comparison can be made with the results of the 2016 macroinvertebrate survey of the Waikiwi Stream.

The macroinvertebrate communities of the streams sampled in 2012 were somewhat similar to those in 2016, dominated by oligochaetes, crustaceans, and molluscs (e.g. *Potamopyrgus antipodarum*). However, in 2016 *Deleatidium* mayflies were found in considerably higher abundance at the upstream Waihopai sampling site than they were at the same site in 2012. This indicates an improvement in the habitat quality upstream of the stormwater discharge in the Waihopai River. The macroinvertebrate communities of the three surveyed sites in 2012 were assessed as being of 'poor' quality, as indicated by low MCI and SQMCI community health index scores. MCI and SQMCI scores calculated from the 2016 macroinvertebrate surveys were similar, also indicating 'poor' quality, excepting the upstream Waihopai site, whose MCI score indicates 'fair' quality. Again, this is an indication of an improvement in the habitat quality upstream of the stormwater discharge in the Waihopai River. Despite subtle differences in the communities found in each survey, which are likely a reflection of changes in habitat factors such as the abundance and diversity of macrophyte beds in the streams, river flow, etc., the similar community health index scores at the two monitoring sites indicate that the stormwater discharge has not had an adverse effect on macroinvertebrate communities over time.

9. Summary and Conclusion

The April 2016 benthic survey of Kingswell Creek, Otepuni Stream, Waihopai River, and Waikiwi Stream in the vicinity of the ICC stormwater catchment revealed that molluscs (snails), oligochaetes (worms), and crustaceans (amphipods and ostracods) were numerically the most abundant taxa, which generally dominated the sampled freshwater macroinvertebrate communities. In comparison, EPT taxa, particularly stoneflies and mayflies, were absent or rare. The high abundance of low-scoring 'pollution tolerant' taxa, and low abundance of 'pollution sensitive' taxa, meant that low MCI and SQMCI scores were recorded for all sampled sites. All average MCI and SQMCI scores fell within the 'poor' water quality class, with the exception of the average MCI score for the upstream Waihopai River sampling site, 'Racecourse Road', which fell within the 'fair' water quality class, and the average SQMCI score for the downstream Kingswell Creek sampling site, which just fell within the 'fair' water quality class. Overall, the MCI and SQMCI scores at all sampling sites indicate poor habitat quality and the possibility of degraded water quality and habitat throughout the Invercargill City Stormwater Catchment.

Statistical analyses revealed some differences in the macroinvertebrate matrices where upstream and downstream samples were compared. Firstly, the Kingswell Creek macroinvertebrate survey revealed that the site downstream of the stormwater discharge had a higher MCI score, SQMCI score and average number of taxa. This change in macroinvertebrate community structure downstream indicates poorer habitat quality at the upper end of the Kingswell stormwater catchment. The change in macroinvertebrate community structure with distance downstream indicates improved, rather than degraded, habitat quality. Thus there is no evidence to suggest that the discharge of stormwater is adversely affecting macroinvertebrate communities in Kingswell Creek.

However, statistical analyses of the results from the other three sub-catchments revealed differences between upstream and downstream sampling sites that indicate poorer habitat quality at the sites downstream of the stormwater outfalls. Statistical analyses of the macroinvertebrate matrices for the Otepuni sub-catchment revealed a significant difference in the number of EPT taxa found at the two sampling sites. More EPT taxa (specifically caddisflies) were found in samples upstream of the stormwater outfall than downstream. ANOVA tests did not, however, reveal any significant difference between the MCI and SQMCI scores of the upstream and downstream sites. Thus, alone, a significant difference in EPT taxa would not be considered conclusive evidence that the stormwater discharge is adversely affecting benthic communities in the Otepuni Stream.

The average MCI scores for both upstream and downstream Waikiwi sites indicated 'poor' habitat quality at both sites. However, an ANOVA test revealed a significant difference between the scores, with the MCI score being higher at the upstream site. It is important to note that although an ANOVA test revealed significant differences in MCI, statistical tests showed no significant difference in the SQMCI scores of comparable upstream and downstream sites. SQMCI can be considered more informative than MCI because the SQMCI calculation takes into account the abundance of each taxon in the sample, whereas the MCI score gives each taxon found in the sample an equal weighting, regardless of abundance. Therefore, the significant difference in MCI scores of upstream and downstream sites in the Waikiwi Stream does not provide conclusive evidence that stormwater discharge is adversely affecting the benthic communities of the Waikiwi Stream.

ANOVA tests revealed that the MCI scores and number of EPT taxa differed significantly between the upstream and downstream sites of the Waihopai River. The average MCI score of the upstream site fell into the 'fair' class, while the average MCI score for the downstream site fell into the 'poor' class. The upstream samples also contained a greater diversity of 'pollution sensitive' caddisfly taxa, as well as mayflies of the *Deleatidium* genus. Conversely, no mayflies were found at the downstream site and there was less diversity in caddisfly taxa.

The stream substrate was similar at both the upstream and downstream sampling sites of the Waihopai River. The freshwater habitat at the two sampling sites differed in that the upstream site was deeper and aquatic plant growth much denser, a habitat that would generally be considered to be less favourable to 'pollution sensitive' taxa than the downstream site. Therefore, the difference in the numbers of EPT taxa and MCI score between the two sites cannot be attributed to such factors. The most likely reason for the lower MCI score and number of 'pollution sensitive' taxa at the downstream site is saltwater influence. The accepted extent of saltwater intrusion into the Waihopai River is approximately 200 to 400 metres above the downstream 'Queens Drive' sampling point. The presence of a saltwater polychaete worm in the downstream 'Queens Drive' samples supports this. The saltwater intrusion provides the most likely explanation for the lower MCI score and absence of *Deleatidium* mayflies at the downstream site. In order for more informative comparisons to be made between macroinvertebrate community health upstream and downstream of the stormwater discharge, it would be necessary to choose a downstream site with similar physicochemical conditions to the upstream site. A site further upstream without saltwater influence would be recommended.

For estuarine sites the abundance and diversity of macroinvertebrates present was much as expected for modified estuarine environments in Southern New Zealand. Having just one site at each location does not allow comparisons, but the organisms present reflect those seen in cores from the New River Estuary SOE monitoring carried out since 2001. The data collected during this survey may be used as a baseline against which future surveys can be compared to establish any trends in the health of the intertidal macroinvertebrate communities at the study locations.

In summary, the results of the April 2016 macroinvertebrate surveys of the estuarine sites revealed the abundance and diversity of the macroinvertebrates present in samples was much as expected for modified estuarine environments in Southern New Zealand, and the data collected may be used as a baseline against which future surveys can be compared. The freshwater macroinvertebrate surveys of the ICC stormwater catchment indicated that the stormwater discharge is having no adverse affect on macroinvertebrate communities in Kingswell Creek. Conversely, freshwater macroinvertebrate surveys of the Otepuni and Waikiwi catchments showed some evidence of habitat degradation downstream of stormwater outfalls. However, there is no conclusive evidence that the discharge of stormwater from the ICC stormwater network is adversely affecting macroinvertebrate communities in these streams. The comparison of the macroinvertebrate matrices calculated for the upstream and downstream sampling sites in the Waihopai River also indicated significant changes in the benthic communities downstream of the stormwater discharge. This is can be attributed to saltwater influence at the downstream site. In order for more concrete conclusions to be drawn regarding the effect of stormwater discharge on the macroinvertebrate communities in the Waihopai sub-catchment, it is recommended that a downstream sampling site be chosen with similar physicochemical conditions to the upstream 'Racecourse' sampling site.

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Appendix E Minutes of the Key Stakeholder Meeting

MWH
BUILDING A BETTER WORLD

Meeting Minutes

Meeting Name	Invercargill City Council Stormwater Consenting Project		
Date Of Meeting	Monday 14 March 2016	Time Of Meeting	10.00 am
Chairperson	Malcom Loan	Recorder	Simon Beale

Meeting Venue	Invercargill City Council Civic Theatre – Drawing Room

Attendees

Malcolm Loan, Invercargill City Council (ML)
Adrian Cocker, Invercargill City Council (AC)
Sue Bennett, MWH New Zealand Limited (SB)
Simon Beale, MWH New Zealand Limited (SHB)
Michael Skerrett, Te Ao Marama (MS)
Dean Whaanga, Te Ao Marama (DW)
Hilary Lennox, Environment Southland (HL)
Daniel Smith, Environment Southland (DS)
Graeme McKenzie, Environment Southland (GM)
Jacob Smyth, Southland Fish and Game Council (JS)
Jennifer Sycamore, Department of Conservation (JES)
Jo Grimwood, Southern DHB (JG)

The meeting commenced with a presentation by SB summarising the information presented in the pre-circulated consultation document.

A question and answer session followed with respect to key sections of the document.

<u>Scope of Application, Nature of Discharge and Nature of Network</u>

MS queried whether ICC would be looking at providing swales in the network. ML confirmed that Council would install these in Greenfield sites but it is unlikely these could be used in infill developments.

ML noted that the S/W and F/S pipelines are generally in different trenches but on private properties they are usually side by side.

JS asked about the contribution of the three sewage discharge pathways and whether there was any particular prevalence of one over the others.

HL asked whether the last three bullets listed in page 2 of the consultation document were covered by the existing consent. In response ML stated that the consent conditions require monitoring of discharges where E.Coli exceed 1000 cfu.

HL drew attention to a legal opinion obtained by ES which stated that some activities such as the discharge of stormwater contaminated by sewage may be prohibited. She added that the activities listed as the third bottom and bottom bullets on page 2 of the document would be difficult to include in the consent.

JS asked whether such sewage discharges were covered under the emergency provisions of the Act. HL indicated that this would be difficult given that they are from a reticulated system.

JS enquired whether there are specific parts of the network designed for overflows. In response ML referred to several constructed overflows that are specifically designed for this purpose.

SB noted that the consent process would include a review of the treatment options.

HL asked about the sampling at manholes and how achievable this was in situations where there are back flows in the system. AC stated that sampling points are placed to ensure samples are not influenced by back flows.

ML noted that the Waihopai River, Otepuni Creek and Kingswell Creek have stopbanks but these are absent from the Clifton Channel.

JS asked whether discharges occur on an outgoing tide and whether the outlet structures have mechanisms to prevent backflow on incoming tides. ML stated that some have flood gates to prevent this occurring while some other discharges are pumped where necessary.

HL stated by way of a heads up that ES was seeking a fresh legal opinion in relation to discharges to the coastal marine area, specifically coastal permit requirements. She added that these discharges could be covered under the one application process.

DS noted the requirement for a consent for discharge of dye whether required during investigations on contaminant sources.

Monitoring of Discharges

GM asked whether there would be any changes to the sampling locations. SB replied that the locations would be reviewed during the preparation of the application and anticipates that an adaptive approach to be taken.

JS enquired about exceedances of heavy metals, Cu and Zn. SB stated these were typical concentrations for urban S/W.

JS enquired about the nutrient standards, which SB explained were based on the ANZEEC guidelines that provide an indicative potential for impact.

HL asked over what period the data has been collected. SB replied that the data had been collected over the last 4 to 5 years over the term of the current consent.

DS queried whether the data is used to assess a particular discharge. SB confirmed that the data is critiqued on the basis of catchment types and dataset type.

SB noted that for the audits of commercial and industrial sites, most of the sites were found to be complying in terms of methods of preventing ingress of hazardous materials to the stormwater system.

GM enquired about determining contaminant sources and whether this was a resourcing issue or there was inherent difficulty to the task.

AC replied that it is both and noted the importance of a duration of dry weather in order to get meaningful results.

Sewer Overflows

DS emphasised the importance of reducing overflows and queried whether Council is addressing this matter.

ML confirmed that this issue was being addressed as part of the renewal programme targeted at preventing infiltrations.

Management and Treatment

HL stated she was keen to see how resources would be best directed towards addressing adverse effects of the discharges.

GM asked whether the renewal programme would be driven by quantity and quality. ML replied that it would be driven by the age of the pipe network to address leakages. He made specific reference to the Otepuni sewer.

ML noted that the replacement of some of the S/W infrastructure would be co-ordinated with road upgrades and sometimes with flood remediation works.

Receiving Waters

JS indicated that assessment purely against the national bottom lines set out in the NPS- Freshwater Management was not appropriate and assessment against the better grades of water quality should be undertaken.

DS asked how many dry samples were taken in the Otepuni catchment to gauge *E.coli* contamination. SB referred to Table 3-1 of the document which shows sampling undertaken over the last five years. SB added that long term monitoring data from the ES State of the Environment programme will be utilised in the application.

JS asked whether the application will include an assessment of the estuarine waters. SB replied that ES data will be used for this purpose.

General

JS asked whether Council will be applying for a maximum duration for the consents and what provisions are to be promoted that will lead to an improvement over time. He emphasised the need for structured conditions targeted at achieving improvements such as by way of a strategy.

SB noted that the conditions would be based on a targeted renewal programme to achieve the best results.

ML emphasised the importance of a sustainable programme.

JS stated that Fish and Game was seeking an improvement especially in the Waihapoi catchment.

JG saw infrastructure upgrades as a critical part of the process of achieving improved outcomes.

DW reinforced the importance of a firm commitment to improvement in light of a 35 year term of consent sought.

JG queried whether this would cover both S/W and sewerage. ML replied, yes.

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