[LEI, 2015:A1I1]

Wairoa Wastewater Discharge Re-Consenting

Summary of Wastewater and Stormwater Overflow Issues

Prepared for

Wairoa District Council

Prepared by

Lowe Environmental Impact

October 2015

Wairoa Wastewater Discharge Re-Consenting Summary of Wastewater and Stormwater Overflow Issues

Wairoa District Council

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3	29'10/2015	HL	Inclusion of flow monitoring recs and map.
2	20/10/2015	HL	Revision, addition of work plan
1	08/10/2015	HL	Initial draft for client review

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1 EXECUTIVE SUMMARY

Wairoa District Council ("WDC") manages the Wairoa municipal wastewater system, the discharge from which to the Wairoa River estuary is authorised by resource consent number CD 940404W. This consent was granted by Hawke's Bay Regional Council ("HBRC") on 23 August 1999, and is scheduled to expire (and therefore to require renewal) on 31 May 2019. Lowe Environmental Impact Limited ("LEI") has been engaged to assist WDC with the re-consenting of the discharge.

While the "normal" discharge usually meets all specific consent requirements, in times of wet weather and high river flows, which happen several times in most years, there are unmanaged overflows of wastewater from the wastewater system. These overflows are not consented, and remain the significant ongoing non-compliance issue for the wastewater discharge.

As the first Task in the overall re-consenting package, the character, causes and effects of the overflows are described, options to manage the overflows are considered, and priorities for remedial works and investigations to address the identified issues are recommended.

The directly involved parties in the reconsenting process are WDC as the utility manager, and HBRC as the regulatory authority. The Minister of Conservation is also involved as co-regulatory authority for the coastal marine area, which is immediately downstream from the sites of most of the overflow events. The wider Wairoa township and district communities, including Iwi and Hapu, are involved as generators of wastewater, as users of the receiving environment, and ultimately as ratepayers who will foot the bill for the management of the overflow issue.

Previous investigations into Ingress and Infiltration ("I&I") into the Wairoa sewer network by EAM and by Opus were assessed. WDC provided detailed wastewater pump station flow data for 2013 and 2014 to LEI for review of more recent flows. GIS data for Wairoa's sewer and stormwater reticulation networks was also provided to LEI for spatial and design understanding of these systems. This data enabled comparisons with the earlier data used by Opus as well as assessments of the relationships between each station's flows and overflow events across Wairoa's wastewater network.

While available flow data relating to unmanaged overflows has some limitations, it has nevertheless been sufficient to enable reasonably robust review and modelling of Wairoa wastewater flows in high rainfall and high river level conditions. The investigations and modelling by Opus have shown that the Wairoa sewer network has adequate capacity to handle normal dry weather wastewater and groundwater leakage (infiltration), and that even the increased groundwater leakage into the sewer network that occurs when the river level is high or during winter months is still generally within the network's capacity.

What causes the majority of the overflow problem is the very high rate of stormwater entry into the sewer network during heavy and/or protracted rain events. Such events have pushed the flow rate in the network, as measured at Fitzroy Street and Kopu Road Pump Stations, from 1,800 m^3/day out to in excess of 5,000 m^3/day on numerous occasions, and as high as 8,000 m^3/d on some occasions.

Despite the limited historical data available, it is clear that the Kopu Road pump station contributed a large proportion of flows to the Fitzroy Street pump station loads, and its flows were very strongly influenced by seasonally elevated groundwater levels and rainfall events. This was more apparent during 2013 than during 2014. These seasonal trends of increased flow do not appear to be limiting the capacity of the sewer network as greater flows from rain events are possible within the reticulation.

Overflows from North Clyde and Kopu Road pump stations have reduced during 2012-14, but they have increased at Fitzroy Street instead. Despite this, the total duration and frequency of overflows over the relatively short period of available records has decreased across the entire Wairoa sewerage system.

Wairoa's stormwater and wastewater networks appear to be well developed and serve all areas of the township, but the adequacy of these networks for their levels of service are clearly an issue during periods of heavy rainfall in some parts of Wairoa.

Accordingly, priority is recommended for investigations and works to reduce the ingress of stormwater into the sewer network, with works to reduce groundwater infiltration into the network being considered very unlikely to show a return on preventing sewer overflows for the cost involved.

The eleven priority actions recommended are as follows:

1. Areas within Wairoa that currently have access to WDC stormwater infrastructure that is capable of handling a 6 month ARI rainfall event within their sub-catchment are to be identified and delineated;
2. Areas within Wairoa that currently **do not** have access to WDC stormwater infrastructure that is capable of handling a 6 month ARI rainfall event within their sub-catchment are to be identified and delineated. Design, funding, consenting and installation of adequate stormwater infrastructure needs to be undertaken; no further I&I improvements within the sub-catchments involved will be practicable until this matter has been addressed;
3. The programming and undertaking of sewer flow monitoring and smoke testing in 17 sewer sub-catchments, in a specified priority order, is recommended in order to identify the need for, and assess the effectiveness of, stormwater ingress remedial works;
4. A budget list of works required to prevent stormwater entry to the sewer network needs to be prepared across each sub-catchment appraised, with the Kopu Road catchment taking first priority, to enable financial and logistical planning for the required works to be put in place;
5. Council needs to consider, and decide, the basis on which works to remedy stormwater entry on private property into the sewer network are to be funded. It is suggested that a 50:50 share of these works costs between Council and the individual property owners would be equitable;
6. In sewer sub-catchments that lie within areas with adequate existing stormwater infrastructure capacity, all identified remedial works on both the private connections and the public sewer network in those areas should be undertaken, with the Kopu Road catchment taking first priority;
7. WDC stormwater infrastructure upgrades identified in 2 should be undertaken, with priority given to the Kopu Road catchment and those sections identified in 4 as having a need for remedial works to exclude stormwater from the sewer. Priority can also be given to areas with greater age and earthen piping;
8. As stormwater infrastructure capacity is upgraded as may be required (7 above), all identified remedial works on both the private connections and the public sewer network in those areas should be undertaken, with the Kopu Road catchment taking first priority;
9. Consideration needs to be given to whether or not resource consenting to authorise the ongoing (and diminishing) overflows will be required;
10. Works should be designed, funded and developed to progressively upgrade the main public sewer network to reduce the infiltration of groundwater into the sewer. The first targets for this upgrade should be sewer mains and connection points within the South-eastern river margin of the Kopu Road catchment; and
11. Stormwater asset identification needs improvement, and sewer pump station flow recording should be continued.

2 INTRODUCTION

2.1 Purpose

The purpose of this report is to characterise the issue of uncontrolled overflows from the Wairoa municipal wastewater system in the light of available and existing information, and to recommend options to manage the issue.

2.2 Background

The Wairoa District Council ("WDC") manages the Wairoa municipal wastewater discharge, which is due for re-consenting in 2019. The performance of the existing system, and an assessment of alternative discharge options, will be needed to inform the re-consenting. The location of Wairoa is shown in Figure 1 in Appendix A.

Overflows from the wastewater reticulation network occur at times of heavy rainfall and/or high river flow, several times in most years. These overflows are the single major non-compliance issue for wastewater discharges from the community.

EAM undertook an assessment of stormwater infiltration into the Wairoa sewer reticulation in January 2011 (EAM 2011). It assessed flow rates and conductivity at selected inspection manholes, and found that a significant rainfall event led to measurable flow and conductivity changes. Conductivity dropped with increased flows, consistent with increased dilution of raw wastewater. At about one third of the flow measurement sites the effect of rain was to lift the flow rate by a factor of up to 2, and at another third of sites the flow rate lifted by a factor of 2 to 10. The remaining sites, with a flow increase of 10-fold or greater, were located in the south-east sector of the town and were recommended for "possible CCTV inspection and maintenance". A further investigation into the cause of the overflows (Opus 2012b) undertook modelling of the Wairoa wastewater flows, identified leakage in the reticulation as an issue, and identified a $12M reticulation upgrade as a solution. Opus (Section 3.7, page 17) found that some 75 % of dry weather wastewater flows were sourced from Ingress and Infiltration ("I&I") and that this was considered to be the main cause of the overflow issue.

Hawke's Bay Regional Council ("HBRC") in its annual consent compliance monitoring reporting has repeatedly drawn attention to the overflows as Significant Non-Compliances. It should be noted that the uncontrolled overflows themselves are not consented. In response to both the ongoing non-compliance and the Opus report, WDC has tasked Lowe Environmental Impact Limited ("LEI") to give priority to the soundly-based recommendation of a program of remedial works to reduce the uncontrolled overflows, within an overall package for the re-consenting of the Wairoa municipal wastewater discharge.

2.3 Scope

An overall package of Scopes for the various Tasks required to achieve the re-consenting of the Wairoa wastewater discharge was prepared by LEI and provided to WDC on 30 July 2015. This package proposed an outline of the overall Task framework, but only provided detailed scopes for the 4 "Project Management" Tasks and the 12 "Initial" Tasks. More detailed specification of the further 58 identified Tasks was to be provided later, in the light of the findings of the Initial reports.

Within this package Task A1I1 ("Summary of Wastewater and Stormwater Overflow Issues") was the first Task to be addressed, with its scope as follows:

- Information on the location, timing, preceding rainfall and river level in relation to overflow events;
- Information on the effects of overflows.

It was specifically noted under the heading "Exclusions" that "*Options to manage the overflows (would be) covered elsewhere.*"

The package of Task Scopes proposed that within Phase A (Resource Assessment and Data Gathering) there would be 7 Categories, of which the first (A1 – Reticulation) would involve 5 identified Tasks. Phase B (Optioneering and Conceptual Design) included Category B6 (Reticulation Upgrade Options) with specific Tasks yet to be identified in the light of the resource assessment and data gathering work.

Acting on the instructions of WDC, LEI has expanded the scope of Task A1I1 to address the following matters:

- Information on the location, timing, preceding rainfall and river level in relation to overflow events;
- Information on the effects of overflows;
- Assessment of causes of overflows;
- Identification of priority actions required to reduce, and ultimately eliminate, the un-managed overflows; and
- Recommendation of a program of investigations to identify specific works requirements for the reduction of the overflows.

3 INFORMATION

3.1 Sources of Information

The primary source of most of the required information was from WDC staff. The key information included spreadsheets of hourly and daily sewage pump station levels and flows, and WWTP monitoring data. WDC provided copies of previous reports that investigated the I&I concerns relating to Wairoa's reticulated sewerage system. These reports were:

- EAM (2011): Investigation of groundwater infiltration of the Wairoa District Council reticulated wastewater network;
- Opus (2012a): Wairoa Wastewater Modelling – Stage 1 – Trunk Model Downstream of Pump Stations; and
- Opus (2012b): Wairoa Wastewater Modelling – Stage 3 Detailed Wastewater Network Model.

Hawkes Bay Regional Council's (HBRC) reports on compliance of the Wairoa WWTP discharges against the discharge consent conditions were also obtained from HBRC for 2008/09, 2009/10, 2012/13, and 2013/14.

WDC's internet pages provided 2015-25 Long Term Plan documents including strategies and asset management plans that described the known issues, target performance levels, and intended budgets for maintenance and improvement of the wastewater and stormwater systems. The key documents were as follows:

- Trade Waste and Wastewater Bylaw 2012;
- Water and Sanitary Services Assessment 2015;
- Wastewater Asset Management Plan 2015; and
- Stormwater Asset Management Plan 2015.

NIWA's internet-based climate information database system provided relevant daily total rainfall data. HBRC provided river level and modelled flow data for the Wairoa River at its railway bridge monitoring site, some 11 km upstream from the SH 2 road bridge in Wairoa town.

3.2 Data Descriptions

The individual datasets provided to LEI are summarised in Table 3.1 below.

Table 3.1: Dataset Summary

Description	Source	Data Parameters	Duration of Dataset	Frequency of Data	Data Gaps
Rainfall	NIWA	Total daily rainfall (mm)	01/01/12 to 31/12/14	Daily	01/09/13-19/09/13 24/04/14-12/06/14
Wairoa River stage level	HBRC	Mean river stage level (mm amsl)	01/01/13 to 31/12/14	Daily	No gaps
North Clyde pump station daily volume	WDC	Total daily volume (m^3)	01/01/13 to 29/09/14	Hourly and Daily	20/06/13-23/06/13 18/06/14-13/07/14
Alexandra Park pump station daily volume	WDC	Total daily volume (m^3)	01/01/13 to 29/09/14	Hourly and Daily	No gaps
Kopu Road pump station daily volume	WDC	Total daily volume (m^3)	01/01/13 to 29/09/14	Hourly and Daily	13/05/13-14/05/13 20/11/13-06/12/13

Description	Source	Data Parameters	Duration of Dataset	Frequency of Data	Data Gaps
Fitzroy Street pump station daily volume	WDC	Total daily volume (m^3)	01/01/13 to 25/09/14	Hourly and Daily	23/04/13-28/04/13 29/07/13-04/08/13 15/11/13-21/11/13
North Clyde pump station water levels plus high level alarm and discharge to river event logs	WDC	Water level (mm) Event counts & durations (hours:mins)	01/01/12 to 27/10/14	Continuous (<1 minute) Daily and Monthly summaries	02-04/03/12 28/10/12 07-10/12/12 19-21/01/13 05-06/02/13
Alexandra Park pump station water levels plus high level alarm and discharge to river event logs	WDC	Water level (mm) Event counts & durations (hours:mins)	01/01/12 to 27/10/14	Continuous (<1 minute) Daily and Monthly summaries	02-04/03/12 28/10/12 07-10/12/12
Kopu Road pump station water levels plus high level alarm and discharge to river event logs	WDC	Water level (mm) Event counts & durations (hours:mins)	01/01/12 to 27/10/14	Continuous (<1 minute) Daily and Monthly summaries	02-04/03/12 28/10/12 07-10/12/12 30/10/13
Fitzroy Street pump station water levels plus high level alarm and discharge to river event logs	WDC	Water level (mm) Event counts & durations (hours:mins)	01/01/12 to 27/10/14	Continuous (<1 minute) Daily and Monthly summaries	02-04/03/12 28/10/12 07-10/12/12 05/02-11/02/13
North Clyde pump station running times and events	WDC	Event counts & durations (hours:mins)	01/01/12 to 27/10/14	Daily	02-04/03/12 28/10/12 07-10/12/12
Alexandra Park pump station running times and events	WDC	Event counts & durations (hours:mins)	01/01/12 to 27/10/14	Daily	02-04/03/12 28/10/12 07-10/12/12
Kopu Road pump station running times and events	WDC	Event counts & durations (hours:mins)	01/01/12 to 27/10/14	Daily	02-04/03/12 28/10/12 07-10/12/12
Fitzroy Street pump station running times and events	WDC	Event counts a durations (hours:mins)	01/01/12 to 27/10/14	Daily	17-18/10/12 27-28/10/12 07/11/12/12 13/07/13-17/07/13 06/09/13

The Opus (2012) report provided an analysis of pumped flow data from 1 January 2010 to 1 November 2011. The raw data used in this Opus report could not be located to be used in this assessment. Also, there is a period from 1 November 2011, which was the end of the Opus data set, to mid 2013 where no records appear to be available. This is unfortunate as it decreases the accuracy of analyses in this report. As a result this report relies primarily on text and data presented in the Opus (2012b) report.

Given the limited actual flow data information available, this report is based on the period of flow records from 2013 to 2015 only.

3.3 Sewer Network

The existing wastewater collection system consists of 745 manholes, with 40 km of gravity pipes with diameters ranging from 100 mm to 450 mm in diameter. The original network was built in around 1948 and some improvements, extensions and replacements have been carried out at different periods since then. 70% of the pipe network is over 60 years old. 60% of the pipes by length are earthen ware (EW), 15% is asbestos cement (AC) and 10% is sulphide resistant cement concrete (CC-SR).

The Wairoa township area is very flat and is encompassed by a large meander of the Wairoa River. When initially commissioned reticulation directed sewage flow to the coastal side of the community where largely untreated sewage was discharged into the Wairoa River close to its entrance to the sea. In early 1980s, the flows were directed into a new gravity trunk sewer which pumped sewage to a new treatment plant. From the new treatment plant flows returned via gravity to utilise the existing river discharge structure.

A key part of the sewer network is a series of pump stations. These are referred to as:

- Alexandra Park;
- North Clyde;
- Kopu Road; and
- Fitzroy Street.

Alexandra Park, North Clyde and Kopu Road are essentially lift stations, pumping the flow into a downgradient gravity sewer trunk main. Fitzroy Street is a main collector pump station that pumps the combined flows up a hill to the wastewater treatment plant. Further detail on the pump stations is provided in Opus (2012b). The sewer catchments are shown in Figure 2 in Appendix A.

Based on asset records and GIS information provided by WDC, a series of figures have been generated that describe the sewer network and the adjacent stormwater network. These are presented in Appendix A, with a summary provided below.

- Figure 3 shows an overview of the sewer catchments and the location of pump stations;
- Figure 4a shows the North Clyde catchment and the age and type of sewer piping material;
- Figure 4b shows the Kopu Road catchment and the age and type of sewer piping material;
- Figure 4c shows the Alexandra Park Catchment and the age and type of sewer piping material;
- Figure 4d shows the Main Drain catchment and the age and type of sewer piping material leading to the Fitzroy pump station;
- Figure 5 shows the sewer piping materials and diameters;
- Figure 6 shows observation and monitoring locations within the sewer network; and
- Figure 7 shows stormwater infrastructure and its location relative to the sewer network.

Figures 4a to 5 clearly describe and show the age, diameter and materials of the sewer network. It is clearly evident that the majority of the network was installed prior to 1960, and that the residential connector network consists of 150 mm earthenware piping.

4 WASTEWATER FLOW DATA

4.1 General

LEI assessed the daily flow data for each of Wairoa's four main sewage pump stations during 1 January 2013 to 26 September 2014 in order to understand the following aspects:

- relationships between rainfall events and pump station flow rates;
- relationships between river levels and pump station flow rates;
- relationships between the daily flows at each pump station;
- trends over time at each pump station;
- differences between expected flow rates and actual flow rates at each pump station on a population basis for each catchment; and
- differences between storm peak flow rates and dry weather flow rates at each pump station.

4.2 Pump Station Flow Trends and Relationships

Figure 4.1 graphs the entire 2013-14 datasets of total daily volumes for each of the four pump stations so that they can be directly compared.

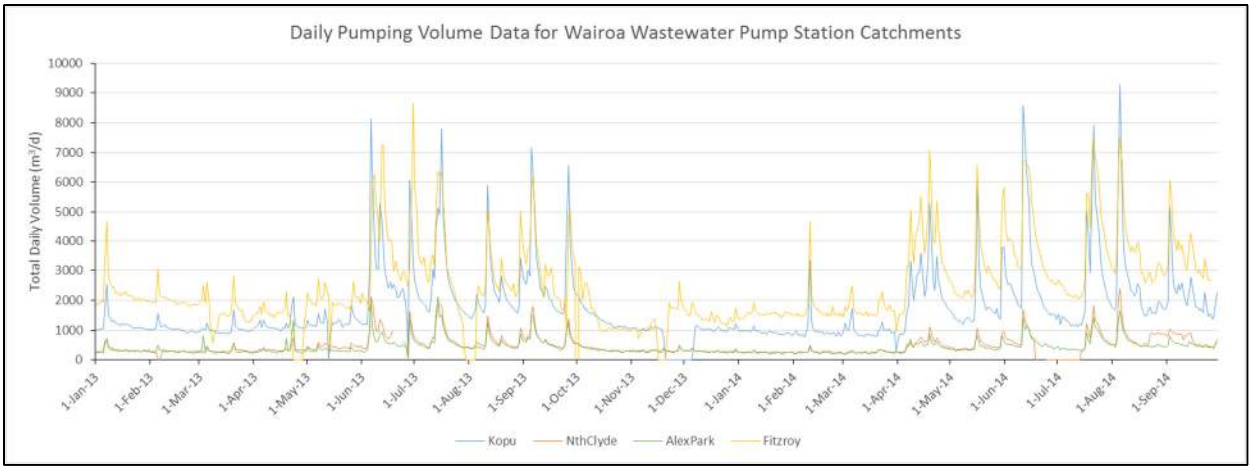

Figure 4.1: Pump Station Total Daily Volumes for 2013-14

Figure 4.1 shows that Alexandra Park and North Clyde flows are very similar and contribute far less than Kopu Road to the Fitzroy Street flows (note the Fitzroy Street flow is the combined flow from all upgradient catchments). They are also far less prone to seasonal and storm flow variations than Kopu Road and Fitzroy Street. The overall averages across this dataset showed that North Clyde contributed 20% and Alexandra Park contributed 18% of the Fitzroy Street pump station's average total daily volumes. The Kopu Road flows clearly dominate the volumes entering the Fitzroy Street pump station.

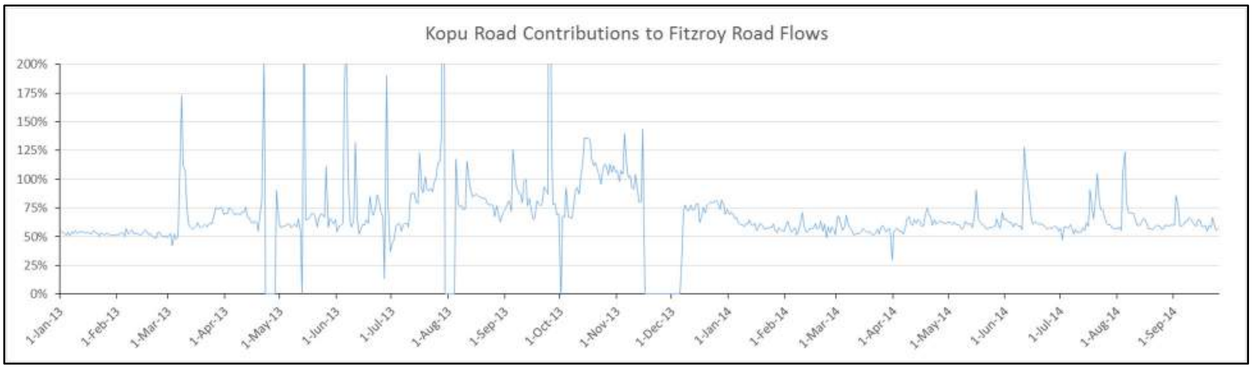

Figure 4.2: Percentage Contributions of Kopu Road to Fitzroy Street Flows

Figure 4.2 shows that Kopu Road flows dominate the Fitzroy Street flows; Kopu Road generally contributes between 50% and 75% of the Fitzroy Street pump station's total daily flows. During May to December 2013, Kopu Road flows often exceeded 100% of the Fitzroy Street flows. It should also be noted that flows exceeding 90-100% of the Fitzroy Street flows must have been lost through surcharging or overflows of the sewer network between Kopu Road and Fitzroy Street. Assuming that Kopu Road contributes 100% of the Fitzroy Street flows makes no allowance for flows from North Clyde and Alexandra Park, so in fact the overflows will potentially have occurred whenever Kopu Road volumes exceed the residual Fitzroy Street flows after subtracting the North Clyde and Alexandra Park flows. Figure 4.3 graphs this comparison. Note that this analysis does not include the gravity inline flow along the gravity trunk sewer main contributing to Fitzroy Street, which will increase the difference, and means that an even greater portion of the Kopu Road flows do not reach Fitzroy Street.

It is noted that the Kopu Road flows during 2014 have become smaller and more consistent (less peaky) compared with 2013. Based on observations elsewhere in this report, this appears to reflect an improved ability of the Fitzroy Street pump station to keep pace with the flows from Kopu Road pump station, and consequently resulting in fewer sewer overflows between Kopu Road and Fitzroy Street. The reason for this is unclear at this stage but likely to be a change in flow regime as a consequence of adjusting the pump controls so that the pumped volumes do not overload the sewer downstream.

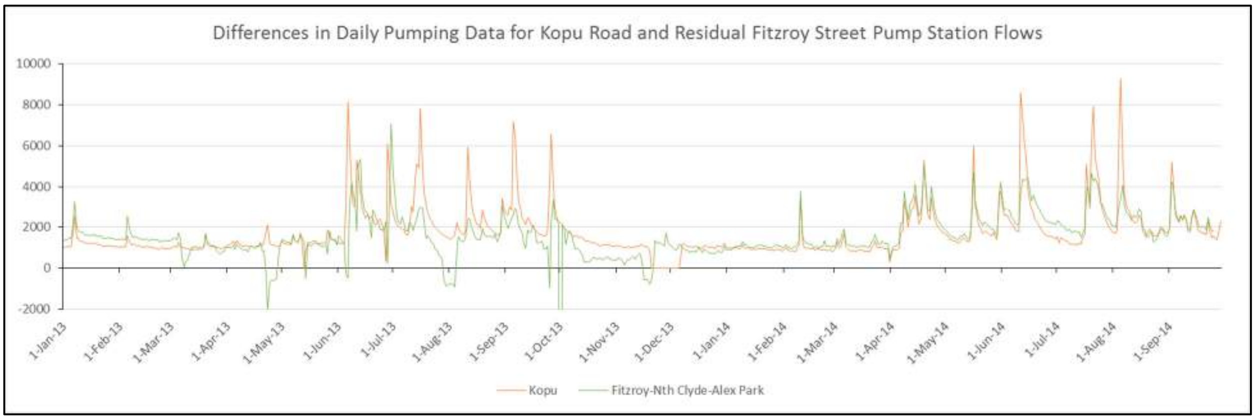

Figure 4.3: Comparison of Kopu Road and Residual Fitzroy Street Flows

Figure 4.3 shows a generally very close match between the Kopu Road flows and the residual Fitzroy Street flows after subtracting the Alexandra Park and North Clyde flows, particularly during January to April 2013 and throughout 2014. The winter 2013 volumes from Kopu Road were often much higher than the residual Fitzroy Street flows. Note that the highest peak volumes for Kopu Road during 2014 still exceeded the residual Fitzroy Street flows, which indicates that overflows were likely to have occurred in the sewer network between the Kopu Road and Fitzroy Street pump stations at these times. This graph also indicates that the additional wastewater inflows into the sewer network between Alexandra Park and North Clyde pump stations and Fitzroy Street (ie the Fitzroy Street sub-catchment) are almost negligible.

4.3 Rainfall and River Level Influences on Wastewater Flow Rates

It is clear from the graphs above that environmental conditions influence both short term peak flows and longer term increases and decreases in flows. Rainfall ingress is the usual cause of peak flows, while groundwater elevation (particularly during winter months) is the usual cause of longer term seasonal infiltration, and of increases in flows and lags in flows returning to pre-storm dry weather flows. In the case of Wairoa, the presence of the Wairoa River around or through three sides of the township is expected to strongly influence groundwater levels. Wairoa River has also been identified by WDC as a direct source of water inflows as a consequence of floodwaters from the river flowing back up the sewer pump station overflow pipes and into the wastewater system. The following graphs seek to identify the main environmental drivers of wastewater I&I flows. Kopu Road pump station flow data was used for this analysis, as it has been identified as the pump station most prone to these river inflows, and it has also been identified as the sewerage catchment prone to the greatest I&I concerns resulting from stormwater ingress and shallow groundwater infiltration.

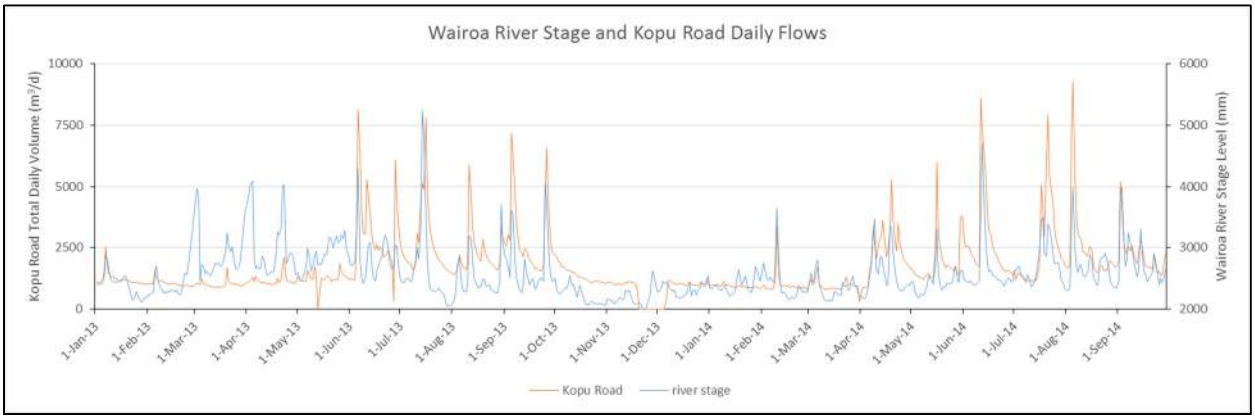

Figure 4.4: Wairoa River Stage and Kopu Road Total Daily Flows

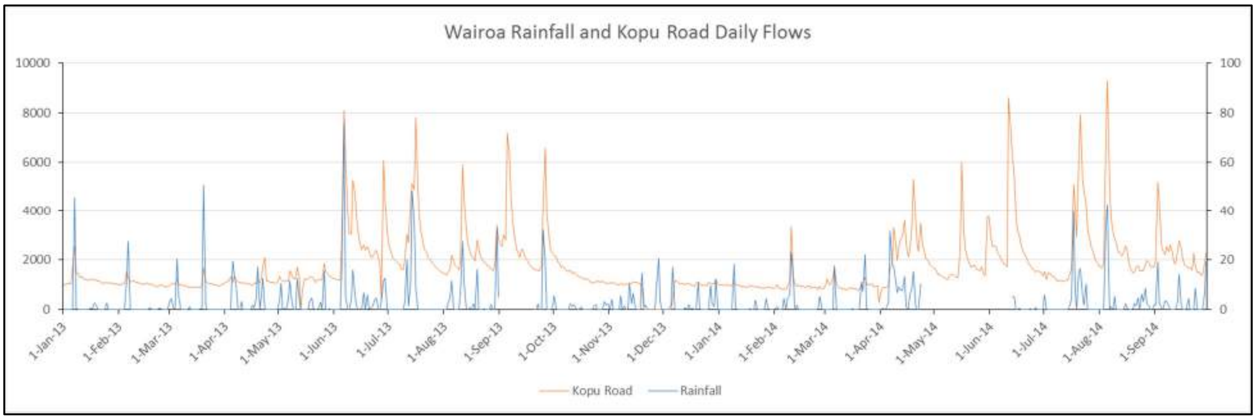

Figure 4.5: Wairoa Total Daily Rainfall and Kopu Road Total Daily Flows

The incomplete rainfall record makes full comparison impossible, but it appears from these graphs that rainfall is the dominant driver of peak inflows while river levels may be a factor in the time lag for flows returning to pre-storm flow rates. There does not appear to be a specific river level that consistently generates very large flows at the Kopu Road pump station. Note that during summer months larger rainfall events are necessary before any additional I&I is observed (which is a consequence of lower soil moisture and reduced stormwater runoff).

4.4 I&I Analysis of Pump Station Flow Data

Figure 4.6 below presents the pump stations' total daily volumes on a population basis for each catchment compared with the theoretical dry weather wastewater volume of 200 l/d/pe. Figure 4.6 shows that the Kopu Road catchment consistently receives higher wastewater volumes per person than North Clyde and Alexandra Park pump stations.

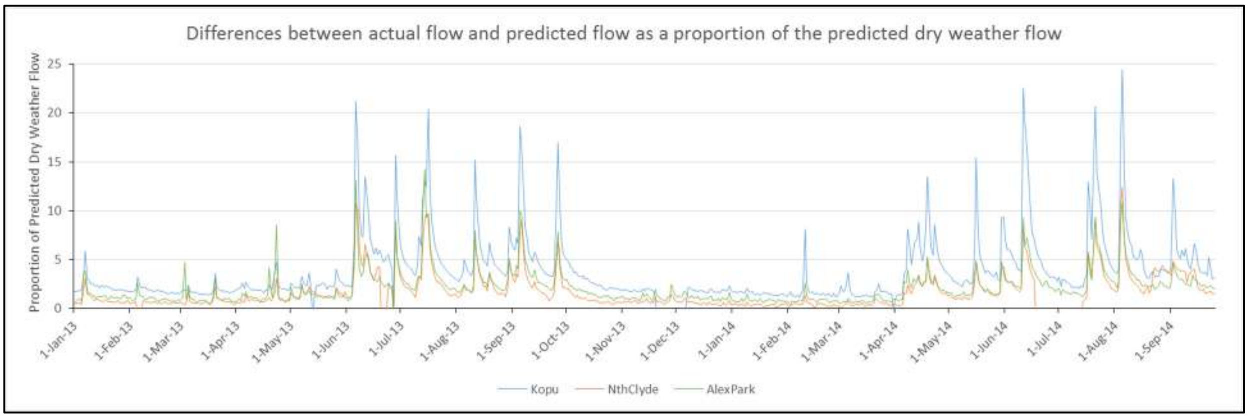

Figure 4.6: Daily Volumes per Person Compared With Theoretical Volumes

Table 4.1 summarises the dry weather average and wet weather peak flow comparisons of these pump station catchments on a population basis. Kopu Road flows are compared with Alexandra Park flows in order to avoid any differences that might be generated by the more industrial nature of the North Clyde catchment area.

Table 4.1: Population Based Volume Comparisons

Parameter/Measure	North Clyde	Alexandra Park	Kopu Road	Kopu Road vs Alex Park
Theoretical DWF (m^3/d)	179	139	365	2.04
5th Percentile Flow (m^3/d)	210	239	813	3.40
5th Percentile versus Theoretical DWF (%)	117	172	223	1.30
Mean DWF (m^3/d)	433	391	1,589	4.06
Mean DWF versus Theoretical DWF (%)	242	281	435	1.55
Mean Total Daily Flow (m^3/d)	474	432	1,746	4.04
Mean Total Daily Flow versus Theoretical DWF (%)	265	311	478	1.54
Mean Wet Weather Flow (m^3/d)	599	512	2,191	4.28
Mean Wet Weather Flow ($m^3/d/mm/pe$)	0.43	0.52	0.79	1.55
Mean Wet Weather Peaking Factor versus 5th Percentile	2.85	2.15	2.70	1.20
Maximum Wet Weather Peaking Factor versus 5th Percentile	4.78	4.12	7.22	1.75

The comparisons in Table 4.1 above clearly show that the Kopu Road pump station flows are consistently much higher than expected for its catchment on a population basis and also when compared with the other Wairoa pump station catchments.

WDC's hourly pump station flow data enabled a more detailed flow analysis of the dry weather and wet weather flows, and some examples are presented in Figures 4.7 and 4.8 below.

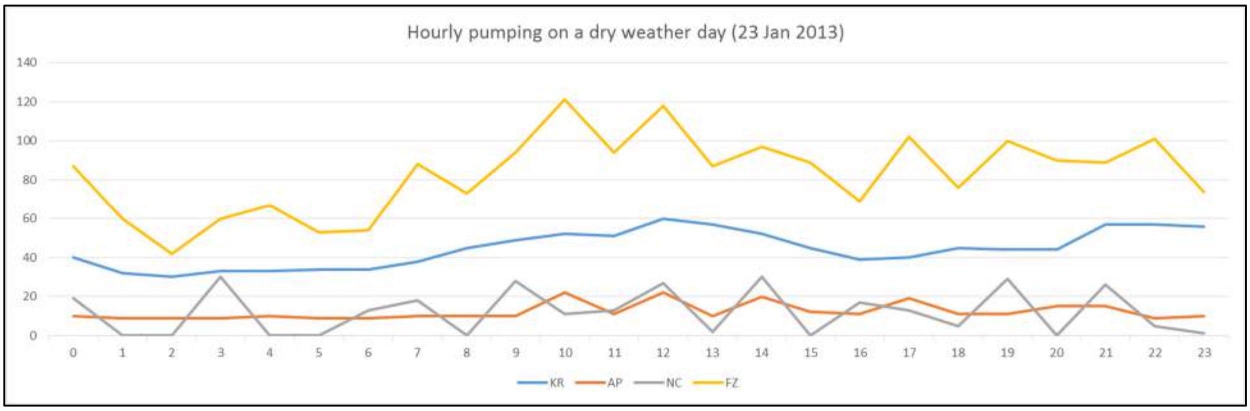

Figure 4.7: Hourly Pump Station Volumes for a Dry Weather Day

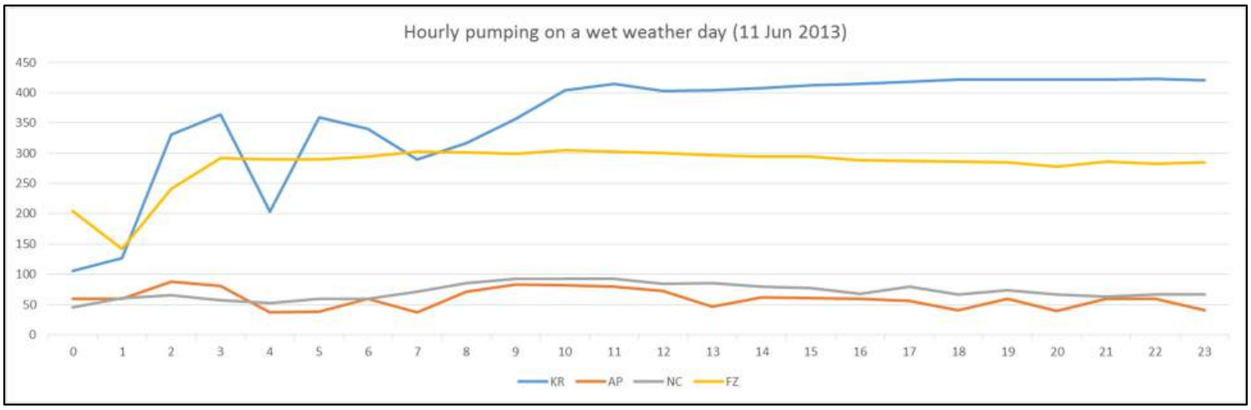

Figure 4.8: Hourly Pump Station Volumes for a Wet Weather Day

These figures show that Kopu Road dry weather flows do not ever approach zero flows due to continuous high levels of groundwater infiltration, but there are some diurnal variations linked to the normal timing of residential activity levels. North Clyde and Alexandra Park tend to have flows closer to zero, but still show signs of more minor continuous groundwater infiltration. During wet weather conditions, it appears that each pump station plateaus at its pumping capacity. It is interesting to note that the flows at Kopu Road are significantly higher than those of Fitzroy Street pump station; the excess from Kopu Road is clearly either added to storage within the network, or overflowed. As will be discussed later in the report, there is a regularly used relief overflow port at the corner of Lion Street and Kopu Road.

4.5 Comparison of Flows with Other Towns

The Wairoa sewer catchment area is described in Opus (2012b) at Section 3.5 as comprising 172 sub-catchments with an average area of 2.2 ha. On this basis the entire Wairoa sewer catchment area would be 378.4 ha; this area is confirmed by a quick map measurement showing close agreement.

As shown in Figure 4.1, typical wet weather peak flows are in the order of 8,000 m^3/d. Opus also modelled at Table 13 in Section 4.5 a total wastewater flow of 18,081 m^3 from the 3 year ARI rainfall event of 19-20 March 2012. Making the assumption that this flow was sustained for 2 days, the flow equates to 23.9 m^3/ha/d (0.28 L/s/ha). If the entire wastewater flow of 18,081 m^3 occurred over just one day, the flow rate would equate to 47.8 m^3/ha/d (0.55 L/s/ha). It should be noted that the daily flow has been averaged over a 24 hour period to provide the instantaneous flow.

A check of Peak Wet Weather Flow design standards used in sewer systems around New Zealand finds typical values as shown in Table 4.2 below. Wairoa town may be considered to be mostly residential in character, with comparatively small inclusions of light to medium commercial and industrial.

Table 4.2: Typical Peak Wet Weather Sewer Flows in New Zealand Towns

Wastewater Source	Peak Wet Weather Flow (m^3/d/ha and L/s/ha)
Residential (16 TLA's)	74.5 and 0.86
Commercial (12 TLA's)	85.1 and 0.99
Light Commercial/Industrial (12 TLA's)	35.7 and 0.41
Medium Commercial/Industrial (11 TLA's)	60.5 and 0.70
Wairoa (typical peak of 8,000 m^3/d)	21.2 and 0.24
Wairoa (19-20 March 2012; 18,000 m^3/d)	23.9 - 47.8 and 0.28 – 0.55

Against the values shown in Table 4.2 above, Wairoa's wet weather wastewater flow rates of 8,000 to 18,000 m^3/d are not out of line with flow rates in other New Zealand towns. 18,000 m^3/d indicates a peak sewer catchment specific yield value of 47.8 m^3/ha/d, which is less than the average value for 16 other TLA's. However, it should be noted that the Wairoa values have been expressed over a 24 hour period and therefore the peak instantaneous flow, depending on time of concentration and reticulation constraints, will be higher and more comparable, or slightly greater, than the design standards used elsewhere.

The New Zealand Standard for Land Development and Subdivision Engineering (NZS:4404:2012) indicates reticulation should be designed for a dry weather diurnal peaking factor of 2.5 and a dilution/infiltration factor of 2, being that pipes should have the capacity of at least 4.5 times the base flow. The Standard also recommends that commercial and industry flows should range from 0.4 to 1.3 L/s/ha depending on water usage.

Also of relevance are the Peaking Factors, being the peak flow relative to the base dry weather flow. Wairoa typically has a base flow of around 2,000 m^3/d. An increase to 8,000 m^3/d results in a peaking factor of 4, when expressed over a 24 hour period. The storm event that resulted in 18,000 m^3/d resulted in a peaking factor of 9. This compares to the NZS:4404:2012 peaking factor of 4.5 and averages in design standards around the country of 4.2. However, it should be noted that the Wairoa peaking factor is expressed over a day and not instantaneous and will therefore be greater during an actual storm event.

The comparative exercise above indicates that it is typical to expect (and design for) higher flows in sewers during wet weather conditions. It also suggests that, with limitations of the averaging period, Wairoa flows are at the upper end of what is used in designs standards. Of interest, while not typically reported, many small communities report peaking factors of 10-15 during high intensity storms, noting that measurement of high flows is problematic especially if wet weather bypass flow systems are used.

4.6 Flow Data Analysis Conclusions

The following conclusions were formed from this data analysis:

- The Kopu Road pump station flows dominate the Fitzroy Street pump station flows at all times (they form at least 50% of the Fitzroy Street flows);
- The Kopu Road pump station flows are consistently about twice those of North Clyde and Alexandra Park on a per head of population basis;
- Rainfall events cause clear spikes in flows at all pump stations, but are most dramatic at Kopu Road and consequently also at Fitzroy Street;
- The Kopu Road flows are the most strongly influenced by groundwater and stormwater I&I compared with North Clyde and Alexandra Park pump stations;
- The relationship between daily total rainfall and flows at Kopu Road is stronger than the relationship between river levels and flows at Kopu Road;
- River backflows up the Kopu Road pump station's overflow pipe do not appear to occur at a consistent flood level, or dramatically increase flows over rainfall effects;
- Rainfall events during warmer months (1 October to 1 April or as late as 31 May in the case of drier autumn months) only cause significant increases in flows at Kopu Road when total daily rainfall exceeds about 20 mm;
- During periods of high stormwater inflows to Kopu Road pump station, Kopu Road pumps more wastewater than Fitzroy Street pump station, which indicates that significant volumes of wastewater must be overflowing from the sewerage system between Kopu Road and Fitzroy Street during these times;
- The Kopu Road flows during 2014 have become a smaller and more consistent (less peaky) percentage component of the Fitzroy Street flows compared with 2013, and this is likely to have occurred as a consequence of adjusting the pump controls so that the pumped volumes do not overload the sewer downstream;
- Peak flows are typical and should be allowed for in sewer networks. Comparison with development guidelines and peaking rates suggests that Wairoa flows are greater than that typically allowed for in new modern sewers, but possibly not inconsistent with other small rural communities around the country.

5 CHARACTERISATION OF OVERFLOW ISSUES

5.1 General

This Section of this report is to describe the overflows as far as possible in terms of time, place, quality and quantity, and with reference to the circumstances in which they occur; including ambient conditions of weather, river flow and environmental effects of the overflows. Much of the content of this Section is sourced from Opus (2012b) and WDC's sewer pump station wet well level monitoring data for 2012-14.

The frequencies, dates, durations, and volumes of any overflows upstream from the North Clyde, Alexandra Park, and Kopu Road pump stations (i.e. within the sewer catchments of the respective pump stations) cannot be determined from WDC's pump station flow data. However, the wet well level monitoring for each pump station provides a record of pump station overflows for 2012-14. LEI assessed the daily level data for each of Wairoa's four main sewage pump stations during 1 January 2012 to 27 October 2014 in order to understand the following aspects:

- relationships between high level events and overflows to Wairoa River;
- relationships between rainfall events and overflow events; and
- relationships between overflow events and pump station flow rates including losses prior to the downstream Fitzroy Street pump station.

Based on the wet well overflow records, it seems likely that the larger winter rainfall events have also generated overflows from some or all of the overflow points identified by Opus (2012b). This is discussed further below.

5.2 Locations of Overflow Events

When the circumstances leading to overflow events occur, there are identified locations at which the overflows take place. Observations and modelling by Opus (2012b) in relation to the rainfall event of 19-20 March 2012 have identified 9 manholes (uncontrolled) and 3 constructed overflows (controlled) where overflows are either known or inferred to have occurred. Table 5.1 below lists the information relevant to this overflow event.

Table 5.1: Overflow Sites, 19-20 March 2012 Event (from Opus 2012b)

Catchment	Asset No	Type of Structure	Modelled Discharge Volume (m^3)	Location
North Clyde	SMN0700	Manhole	8	Ormond Road
	SMN0780	Manhole	14	Mackley Street
	SMN0650	Manhole	60	Crarer Street
	SMN0190	Manhole	19	Glengarry Place
	SMN0150	Manhole	1	Mahia Avenue
	SMN0010	Overflow Pipe	3,650	River Parade
Subtotal			**3,752**	
Alexandra Park	SMA0490	Manhole	63	Lockwood Place
	SMA0440	Manhole*	1,020	Marine Parade
Subtotal			**1,083**	
Kopu Road	SMK?	Manhole	5	Campbell Street
	SMK0284	Manhole	2,240	Kopu Road
	SMK0005	Overflow Pipe	6,500	Kopu Road
Subtotal			**8,745**	
Main Drain	SMF0380?	Manhole	1	Kitchener Street
Total			**13,581**	

Note: * While indicated as a manhole, and the fact that there is no Alex Park pump station overflow, the volume would suggest it is the pump station overflow.

Issues relating to the locations of modelled and observed overflow events are as follows:

- The two largest overflows from the 19-20 March 2012 event were from the overflow pipes at the North Clyde and Kopu Road pump stations, involving between them 10,150 m^3, or 75% of the total volume that overflowed during that event;
- The overflow pipes at the pump stations appear to have been originally constructed as the main river discharge points, but now overflow only when inflow exceeds available outflow plus storage capacity;
- The manhole at SMK0284 is in the sewer main about 100 m downstream from the Kopu Road pump station. It gives by far the largest individual overflow volume when pumped wastewater from the Kopu Road pump station exceeds downstream sewer main capacity, and forces off the manhole cover;
- While the total overflow volumes from the manholes excepting Kopu Road and Marine Parade, at a combined volume of only 170 m^3 or 1% of the overall total are quite modest, they occur on or adjacent to private property where the individual effect of an overflow can be out of all proportion to the volume involved;
- The overflow event observed and modelled by Opus (2012b), on 19-20 March 2012, involved 126 mm of rain, falling over a period of 30 hours, with a peak intensity of 12 mm/hr, and was assessed by NIWA and quoted by Opus as having an ARI of 3 years. It follows that a lesser rainfall event may be expected to yield smaller overflow volumes, from less than all the overflow points listed in Table 5.1 above. It also follows that a greater rainfall event may be expected to yield greater overflow volumes, and possibly from overflow points which are additional to those listed in Table 5.1.
- The data in Table 5.1 **does not** represent all overflow situations arising from all rainfall situations. It represents the modelled overflow results of a 2 year return period rainfall event. It is considered to provide a fair indication of the locations and comparative magnitudes of overflows in such an event.

5.3 Occurrence and Magnitude of Overflow Events

Prior to Opus (2012b), no formal record had been kept which was capable of yielding reliable information on the actual timing of past overflow events. Following heavy rain and/or high river levels, overflows were known to have occurred, but there was no compiled record of dates, times or places when such overflows started, or stopped, or were even known to have occurred.

For this reason the Opus (2012b) description of the circumstances in which overflows occur had to rely on modelling with limited calibration checks. Opus (2012b) has modelled, for example, an average of 26 overflow events per year at the Kopu Road pump station, based on an assumption that 80% of the high level alarms at that site will have led to overflows. Table 3 in the Opus (2012b) report shows that in the 4 years from 2008 to 2011 (inclusive) the average annual number of high level alarms in each pump station were:

- North Clyde, 18;
- Alexandra Park, 24;
- Kopu Road, 32; and
- Fitzroy Street, 23.

Thus the **timing** of overflow events had not been recorded prior to Opus (2012b), but the **frequency** of overflows was modelled. The magnitudes of overflows predicted by the Opus (2012b) modelling of the existing system in a 1 year return period rainfall event were as follows:

- Flow to treatment plant during the duration of the overflow event, 9,500 m^3;
- Pump station overflow volume during the event, 8,020 m^3;
- 3 manholes overflowing, with a combined overflow volume of 2,050 m^3.

While the additional effect of increased I&I has been modelled for the same 1 year return period rainfall event, there has not been modelling of the change in overflow volume with increasing rainfall.

WDC's pump station monitoring data since 2012 does not measure overflow volumes from the pump station wet wells. Instead of flow metering of overflow volumes or rates, water levels within the wet wells adjacent to each of the pump stations are monitored continuously and alarms are triggered at specified high levels. It is possible to calculate estimates of overflow volumes from the water levels exceeding the overflow levels and the overflow pipe dimensions, but these calculations have not been undertaken at this stage.

The levels within the wet wells for the high level alarms and overflows to the river were physically checked at North Clyde, Alexandra Park, and Kopu Road pump stations on 15 November 2012, and the Fitzroy Street pump station levels were physically checked on 30 November 2012. The telemetry levels were calibrated at North Clyde on 26 March 2013 (it had been noted that the level monitoring data was inconsistent with the physical levels measured previously). Table 5.2 presents this data.

Table 5.2: Pump Station Wet Well Alarm Levels

Pump Station Name	High Level Alarm	Discharge to River Level
North Clyde	2314 mm	2411 mm
Alexandra Park	2510 mm	2628 mm
Kopu Road	2502 mm	2833 mm
Fitzroy Street	3335 mm	3844 mm

Based on these wet well level measurements, all of the pumping station wet well level data for 2012-14 was analysed by WDC for the occurrences and durations of high level alarm and overflows to the river. Table 5.3 summarises the annual frequencies and durations of high level alarms and overflows to the river for these pump station wet wells.

Table 5.3: Annual Statistics for Pump Station Wet Well High Levels and Overflows

Year	North Clyde	Alexandra Park	Kopu Road	Fitzroy Street
Wet Well High Level Alarm Events				
2012	433:06 39 days	94:24 14 days	110:48 25 days	14:42 6 days
2013	129:33 days	67:31 days	113:23 days	66:52 days
2014	14:43 7 days	18:51 4 days	80:35 21 days	196:17 20 days
Wet Well Overflow Events				
2012	400:30 36 days	81:30 11 days	80:52 12 days	4:00 3 days
2013	114:42 13 days	46:28 7 days	101:24 10 days	15:37 2 days
2014	6:10 2 days	11:19 4 days	44:43 6 days	89:07 12 days

It is apparent from Table 5.3 that North Clyde has dramatically reduced its overflow frequency and duration, while Alexandra Park and Kopu Road have also very significantly reduced their overflows. However, the Fitzroy Street overflow frequency and duration have increased during this time. Despite the increase at Fitzroy Street, the total annual duration of overflows has reduced. It appears that efforts to reduce overflows from upstream pump stations have led to more frequent overflows at Fitzroy Street.

The assumption by Opus (2012b) that 80% of the high level alarms at each site will lead to overflows was not validated by the actual 2012-14 pump station data, particularly in the case of Fitzroy Street which overflowed to the river for 23-45% of the high level duration.

Table 5.4 below summarises all of the pump station overflow events that were recorded between 1 January 2012 and 27 October 2014.

Table 5.4: Recorded Events of Overflow Discharges to Wairoa River

Date of Event	Total Daily Rainfall (mm)	Duration of Event (hh:mm)			
		North Clyde	Alexandra Park	Kopu Road	Fitzroy Street
1 January 2012	59.0	16:14	10:29	09:40	-
2 January 2012	6.8	-	-	00:59	-
8 January 2012	56.0	18:08	18:17	16:40	-
9 January 2012	1.2	00:30	01:30	02:50	-
19 March 2012	0.0	00:51	-	-	-
20 March 2012	82.2	24:00	22:30	20:26	-
21 March 2012	43.8	24:00	12:30	17:55	-
22 March 2012	1.2	00:30	-	-	-
4 April 2012	29.8	14:43	00:57	00:22	-
5 April 2012	25.0	10:10	-	-	-
8 May 2012	0.0	-	-	-	01:22
9 May 2012	5.4	-	-	-	02:15

Date of Event	Total Daily Rainfall (mm)	Duration of Event (hh:mm)			
		North Clyde	Alexandra Park	Kopu Road	Fitzroy Street
10 May 2012	21.0	-	-	-	00:23
12 May 2012	23.0	00:30	-	-	-
3 July 2012	0.8	-	00:41	-	-
4 July 2012	10.6	12:21	03:11	05:19	-
5 July 2012	27.4	16:02	-	-	-
6 July 2012	15.0	02:20	00:30	-	-
11 July 2012	9.2	22:30	-	-	-
12-15 July 2012	0.0	96:00	-	-	-
16 July 2012	0.0	07:26	-	-	-
23 July 2012	0.0	01:00	-	-	-
24 July 2012	0.0	-	-	00:50	-
25 July 2012	0.0	17:22	-	-	-
26 July 2012	11.6	23:56	-	-	-
27 July 2012	20.4	22:05	-	-	-
28 July 2012	5.2	24:00	-	-	-
29 July 2012	14	13:19	-	-	-
31 July 2012	5.6	04:43	-	-	-
6 September 2012	10	00:26	-	-	-
7 September 2012	0.0	00:26	-	-	-
8 September 2012	13.2	00:05	-	-	-
10 September 2012	0.0	00:08	-	-	-
30 September 2012	0.0	00:13	-	-	-
1 October 2012	0.0	00:10	-	-	-
15 October 2012	0.0	-	-	00:08	-
13 November 2012	0.0	16:29	10:14	05:13	-
14 November 2012	0.0	10:26	-	00:30	-
15 November 2012	0.2	00:11	-	-	-
18 December 2012	85.0	00:13	00:41	-	-
20 March 2013	38.0	00:35	-	-	-
19 April 2013	0.4	-	00:13	-	-
31 May 2013	0.2	-	-	00:14	-
5 June 2013	50.6	03:58	-	04:50	-
6 June 2013	17.0	23:02	11:00	18:50	15:30
7 June 2013	0.0	03:05	-	-	-
13 July 2013	16.8	12:32	09:50	13:04	-
14 July 2013	75.8	24:00	12:37	24:00	-
15 July 2013	5.6	24:00	07:42	24:00	-
16 July 2013	10.8	04:00	-	00:20	-
11 August 2013	48.4	02:19	-	00:26	-
5 September 2013	34.8	08:32	04:41	09:20	-
6 September 2013	8.4	-	-	06:20	-
21 September 2013	27.6	05:50	-	-	-
22 September 2013	-	02:32	-	-	-
26 September 2013	-	00:17	00:25	-	-
19 November 2013	0.0	-	-	-	00:07
13 January 2014	2.4	00:11	-	-	-
29 March 2014	19.0	01:32	-	-	-
31 March 2014	14.8	-	-	10:57	-

Date of Event	Total Daily Rainfall (mm)	Duration of Event (hh:mm)			
		North Clyde	Alexandra Park	Kopu Road	Fitzroy Street
1 April 2014	0.0	-	-	11:10	-
10 April 2014	0.0	-	00:36	-	-
19 April 2014	0.0	00:10	-	-	-
15 May 2014	0.0	-	-	-	05:15
16 May 2014	6.6	-	-	-	06:30
11 June 2014	15.4	-	-	11:00	18:28
12 June 2014	-	-	-	-	04:15
13 June 2014	-	-	-	-	06:30
17 July 2014	-	-	-	01:00	08:25
20 July 2014	-	-	-	-	02:30
21 July 2014	5.2	-	-	-	05:14
4 August 2014	39.8	06:00	08:00	11:25	13:15
5 August 2014	15.2	-	02:00	08:55	18:14
2 September 2014	16.4	-	-	01:13	-
9 September 2014	34.4	-	00:43	-	-
7 October 2014	42.6	-	-	-	00:22
12 October 2014	19.2	-	-	-	00:09

Analysis of the pump station flows during each of the recorded overflow events indicated that some events may have been the result of reticulation blockages, pump failures, or datalogging errors. It is also interesting to note that a large number of the North Clyde pump station overflows during 2012 and 2013 occurred when no rainfall had occurred. This could indicate large industrial inflows or perhaps (less likely) faulty datalogging.

Comparisons of the total daily volumes of wastewater pumped by each pump station on the day of each overflow event during 2013 and 2014 identified that overflows must also have occurred between Fitzroy Street pump station and the upstream pump stations. A known overflow point exists near Lion Street for the main from Kopu Road pump station, and this could have been operating on many of these occasions. This was indicated by the fact that the combined total volumes pumped by North Clyde, Alexandra Park, and Kopu Road pump stations often exceeded the volume pumped by Fitzroy Street pump station. It is important to note that these overflows are **in addition** to the overflows recorded for each pump station's wet wells. Figures 5.1 and 5.2 below present these sewer overflow volumes.

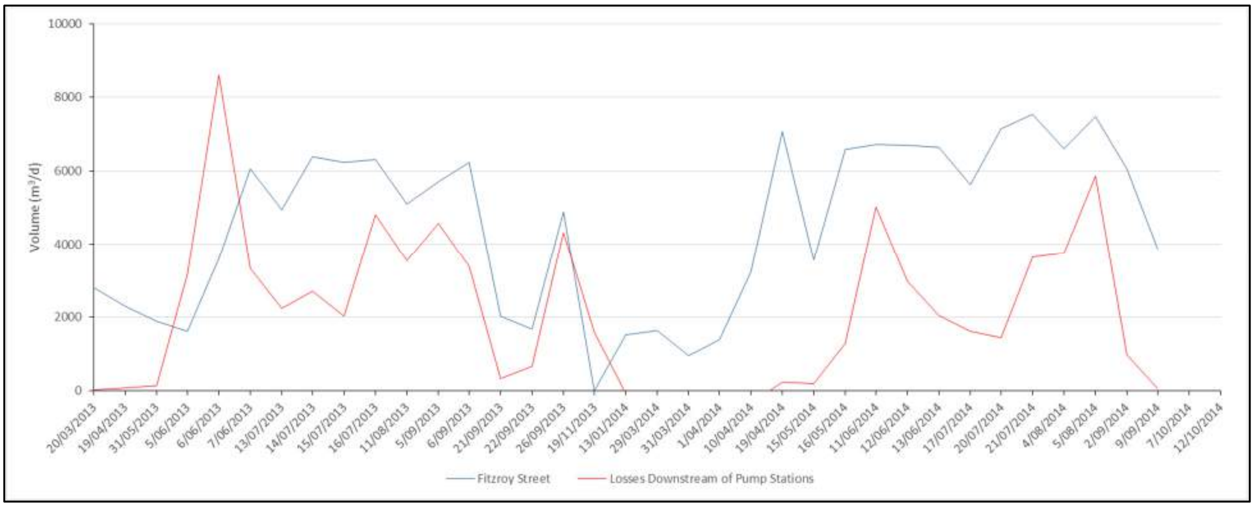

Figure 5.1: Pumping Loss Volumes Versus Fitzroy Station Flows

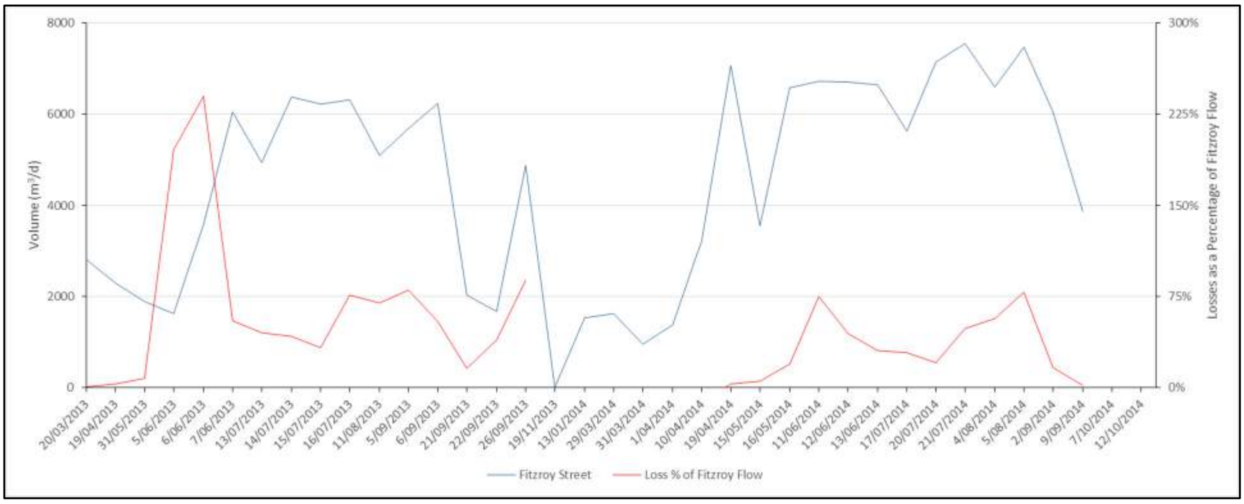

Figure 5.2: Pumping Losses as a Percentage of Fitzroy Station Flows

It is clear from these graphs that the losses within the system between the pump stations are often above 2,000 m^3/d **in addition** to the unknown volumes lost via the overflow pipes at each pump station **and** the volumes potentially overflowing upstream of each pump station. As a percentage of the volume actually pumped through the Fitzroy Street pump station, the recorded pump station volume losses are often 40-80 % of the Fitzroy Street volumes, which implies that the sewerage network and/or Fitzroy Street pump station capacities are significantly under-capacity for such flows.

5.4 Quality of Overflow Discharges

The overflow discharges have not been sampled or analysed, so there is no definitive information on the quality of the overflow material.

However, there are useful observations to be made on wastewater quality. EAM (2011) found that conductivity at 22 sampled manhole sites throughout the network was consistently reduced following a significant rainfall event, consistent with increased wastewater dilution resulting from I&I.

Opus (2012b) records at Section 3.2.1 that average daily dry weather wastewater inflow to the treatment plant ("WWTP") is 1,800 m^3. At Section 3.7 Opus (2012b) calculates that "(if) *75% of the total flow is considered as being due to groundwater infiltration*". 1,800 m^3/d from a population of about 4,000 people equates to a wastewater yield of about 450 L/person/day, which is more than twice the industry standard for domestic wastewater production. Accordingly, even the dry weather wastewater will carry half or less the contaminant loading per cubic metre of "normal" wastewater, for which standard parameter loading rates are well established. In wet weather, the daily rate of 1,800 m^3/d is modelled by Opus (2012b) to increase to 18,000 m^3/d (for the March 2012 event).

Section 7.3.1 of Opus (2012b) indicated that significant periods of flushing of the network occur during rainfall events prior to any overflows commencing. Opus (2012b) modelling of a rainfall event on 1 May 2012 indicated that a period of 9 hours of flushing occurred at North Clyde prior to the commencement of overflows, and they estimated that the percentage of sewage in the overflowing water on this occasion therefore could have been less than 2%, with the stormwater clearly dominating the overflowing water.

There are two main receiving environments for the overflows, affected differently by the quality of the discharging material involved, as follows.

5.4.1 Private Properties

Even comparatively small volumes of sewage, if welling up from a manhole onto private property, can cause distress out of proportion to the volume involved. The overflow material in this situation will of course have been substantially diluted by I&I, but there is still the prospect of identifiable items of excreta or sanitary items floating around a family's front or back lawn. This situation is unacceptable, from a public perception point of view, as well as a public health point of view. No amount of sewage overflow onto private property should be considered acceptable.

5.4.2 Wairoa River

In the circumstances where overflow occurs, there will have been significant rainfall, and the Wairoa River will be flowing at a high rate. When the river flows at a high rate, the rainfall causing that flow also causes substantial increase in contaminant loading in the river from farm run-off. At the time that an overflow event is adding wastewater (already substantially diluted due to I&I) into the river from the pump station overflows, the river as the receiving environment already has a contaminant loading well in excess of that during its "normal" flow conditions, and well in excess of that being discharged from the overflowing sewerage system.

HBRC compliance reports reinforce this, with the report for 9 April 2014, for example, recording in respect of consent condition 8 that performance was in compliance with the condition, with the comment *"when uncontrolled discharges occur, the Wairoa River has elevated flows and contaminant levels from surrounding land use."*

5.5 Causes of Overflow Events

There are basically two sources of additional flow in the Wairoa sewer network that can lead to overflow events, as follows:

- **Groundwater** leakage into the network through faulty sewer pipe junctions and connections; and
- **Stormwater** entering the sewer network directly, potentially both from private properties, and from Wairoa's public roading and stormwater infrastructure.

5.5.1 Groundwater Infiltration

The level of groundwater within the sewer catchment can drive leakage into the network through faulty sewer pipe junctions and connections, especially where lengths of sewer main have been installed at depths below the groundwater table. Leakage into the network by this means is increased during high river flow events, when high water level in the river increases the elevation of the groundwater table. This increase in groundwater table elevation both increases the head on lower level leakage points, and brings groundwater up and into contact with a wider extent of potentially leaky sewer main. Opus (2012b) at Figure 14 provides a map that identifies the area in the south-east of town found to have high groundwater infiltration. This groundwater leakage effect is shown by Opus (2012b) to be comparatively steady, ranging from a contribution of about 11 L/s in dry weather to about 18 L/s in wet (and therefore high river) weather.

The dry weather infiltration rate of 11 L/s equates to a total daily flow rate of 950 m^3/d. 18 L/s would contribute 1,500 m^3/d to overall wastewater flows during wet weather with its attendant higher river levels. The increase in groundwater infiltration from dry weather to wet weather is therefore about 550 m^3/d. This contribution is very much smaller than the overall flow increases modelled by Opus (2012b), and recorded by WDC, during a significant rainfall event.

The 2013-14 flow data indicates a wet weather increase in infiltration flow rate at Fitzroy Street pump station of about 1,000 m^3/d, with the majority of this increase driven by the Kopu Road flows. Very few overflow events have occurred during dry weather conditions with normal flow rates, even when groundwater infiltration has been seasonally elevated. This indicates that the sewerage system has sufficient capacity for these flows, and that groundwater leakage into the sewer does not initiate sewer overflows.

5.5.2 Stormwater Ingress

Stormwater does not enter the Wairoa sewer network at all in dry weather (by definition), but provides large flow rate peaks during and immediately following rain events, irrespective of whether the river is high or low at the time.

Opus (2012b) at Figure 6 demonstrates two years of daily inflow and rainfall data, recorded during 2010 and 2011 at Fitzroy Pump Station, through which all wastewater (except that which escapes as an uncontrolled overflow) from the Wairoa municipal network is pumped up to the WWTP. The Opus graph shows an average dry weather daily inflow of 1,800 m^3/day, and a maximum daily wet weather inflow of 8,000 m^3/d. The wet weather inflow rate is thus assessed as about 4.5 times higher than the dry weather inflow rate. Opus notes that the peak wet weather flow rate could be expected to be 6 to 10 times the dry weather flow rate.

The Opus (2012b) Figure 6 shows 21 instances of Fitzroy inflows exceeding 5,000 m^3/d during the two year period recorded, several of these for protracted periods of time. The increase of flow above the dry weather rate into Fitzroy Pump Station during these 21 events is not less than 3,200 m^3/d, which is nearly 6 times higher than the wet weather groundwater infiltration rate modelled by Opus (2012b).

Similar events are noted in the 2013-14 flow data reviewed above. Kopu Road pump station is the dominant source of stormwater peak flows passing through the Fitzroy Street pump station.

Stormwater ingress is thus clearly demonstrated to be by far the major contributor to wet weather flow increases and subsequent overflows in the Wairoa sewer network.

5.5.3 Adequacy of Recording and Modelling

Both the EAM and Opus reports place a number of caveats on their findings. There is potentially a long list of details that may be incomplete, measurements not made or recorded, and flow rates not measured or calibrated. The actual times and volumes of overflows prior to 2012 have been modelled rather than actually recorded, the overflow volumes during 2012-14 have not been recorded, and the flow rates through each of the pump stations obviously exclude the overflows that will have occurred upstream of each pump station.

This report's findings are based on consideration of previously recorded data and modelling, and the incompleteness of the available data means that definitive precision has not been able to be achieved. Nevertheless, it is suggested here that there is sufficient information on which to base decisions on priority for further investigations and work to reduce and ultimately eliminate the overflows.

5.6 Implications of Overflow Events

5.6.1 Short Term

In the short term (i.e. right now) the overflow events are not authorised by a resource consent, and as such are unlawful. The consent that currently authorises the treated wastewater discharge from the Wairoa WWTP specifies a requirement for the discharge to occur only at night time, and only on a falling tide, and only from the dedicated discharge structure. The overflows occur when it rains without regard for location, time or tide, and while the receiving water quality implications of the overflows are not as severe as they might seem, the ongoing overflows are more-or-less predictable, and remain in breach of a statutory requirement.

5.6.2 Medium Term

In the medium term (i.e. the next 3 years) the consent authorising the discharge from the Wairoa WWTP into the Wairoa River estuary is going to expire, and the discharge will need to be re-consented. With the overflows having been the main non-compliance issue for the current discharge regime, it must be expected that HBRC and the Minister of Conservation (both in their roles as consent authorities) will require a more satisfactory management of the overflow issue than is currently in place.

5.6.3 Long Term

In the long term, from now looking forward, the goal posts for consenting discharges into estuaries and the ocean have been considerably moved since last time the Wairoa wastewater discharge was consented. There is now a clearly described preference for human sewage discharges **not** to be into the ocean. The alternatives to the present estuary discharge are either further out to sea (which does not get around the preference not to discharge into the ocean) or onto land. A discharge of treated human sewage into the marine environment **can** be consented, but **only** if consultation with tangata whenua and the wider community conclude that to do so is the best practicable option.

In the event that a land discharge is required at some time in the future, it will be **essential** that I&I inputs to Wairoa wastewater are minimised, and certainly reduced very substantially from their present levels. The expensive wastewater storage and land treatment sites that would be required would need to be that much larger, and that much more expensive, to cope with any I&I that is not prevented from entering the sewer network at every point source.

5.6.4 Consenting of Overflows

At present the overflows are "uncontrolled" and un-consented. Options to address this situation are either to stop the overflows, or to obtain resource consents to authorise them. This report focuses on measures to reduce and ultimately eliminate the overflows, but at least as an interim measure some consideration should be given to consenting the overflows.

The advantage of consenting the overflows is that it would remove the present cause of a statutory non-compliance, which is clearly in the best interests of all concerned. The challenge in consenting the overflows will be convincing affected parties and consent authorities alike that the effects of the overflows are less than minor, and are in the interim the best practicable option to deal with the overflows. Detailed characterisation of the flow rates, total volumes, water quality parameters, and timing of these discharges are also likely to be required and will be difficult to obtain through monitoring.

It is noted that WDC is engaged with HBRC regarding consenting of stormwater discharges from Wairoa's urban areas. It would be prudent to include the sewer overflow discharges in the consent applications, at least for the short to medium term until the issue of sewer overflows is resolved.

6 WORKS IDENTIFIED TO REDUCE OVERFLOWS

6.1 General

This Section of this report is to **identify** the packages of work that could be required in order to reduce, and ultimately to eliminate, uncontrolled overflows of wastewater from the Wairoa municipal sewer network to private property and the Wairoa River.

6.2 Increase Sewer Main Capacity

Opus (2012b) identifies at Figure 20 the location of "pipes surcharging due to inadequate capacity". The main line from Kopu Road Pump Station, along Kopu Road to Lion Street, and from there along McLean Street to Fitzroy Pump Station is identified as the only major pipeline in this category. Opus (2012b) discusses the possibility of increasing this line's capacity by modest pressurisation, recognising that the success or otherwise of this approach will be influenced by the (unknown at present) physical condition of the pipeline and its capacity to take pressurisation without rupture.

One of the means considered for pressurising this length of sewer main is the welding-on of the manhole cover at the overflow point SMK0284, about 100 m downstream from Kopu Road Pump Station.

An alternative to pressurising the main would be to replace it, a length of about 1.63 km, with a larger diameter pipe of modern construction. This replacement would relieve a current high-flow bottle-neck, and would provide an opportunity to remedy both leaking pipe joints and leaking pipe junctions in the area identified in Opus (2012b) Figure 14 as having high groundwater infiltration.

Comment
While such work would contribute to an overall upgrade of the Wairoa sewer network, its effect would also be to transfer the present high flow overflow further downstream to Fitzroy and the WWTP beyond. It is considered that, on the basis of the available factual information, upgrading this section of the sewer main would make only a modest contribution to the overall reduction of groundwater infiltration, and potentially little or no contribution to reducing stormwater ingress. The welding-on of the manhole cover would likewise remedy one of the larger overflow sites, but only by pushing the overflow to some other point in the network. Nevertheless, when sewer main replacements are contemplated, this Kopu to Fitzroy main should be considered to have priority over other sewer mains.

6.3 Increase Pump Station Capacities

Opus (2012b) at Section 5.8.3 records the existing pump station design capacities, as presented in Table 6.1 below. The maximum daily volumes pumped by each pump station as sourced from WDC's 2013-14 flow data is also presented in Table 6.1 for comparison.

Table 6.1: Pump Station Capacities

Pump Station	Design Flow Rate (Opus 2012b)	Actual Maximum Flow (WDC 2013-14)
North Clyde	20 L/s 1,728 m^3/d	2,402 m^3/d
Alexandra Park	23 L/s 1,987 m^3/d	2,124 m^3/d
Kopu Road	90 L/s 7,776 m^3/d	9,285 m^3/d
Fitzroy Street	140 L/s 12,096 m^3/d	8,632 m^3/d

Opus (2012b) notes that *"these capacities are consistent with the design standards usually adopted in New Zealand"*. WDC's 2013-14 flow data also indicates that the Kopu Road pump station often pumps more wastewater than the Fitzroy Street pump station despite the Opus (2012b) data indicating that the capacity of the Fitzroy Street pump station exceeds the total combined capacities of the other three pump stations. This highlights that there is leakage from the reticulation networks between the Kopu Road and Fitzroy Street pump stations; which is known to occur through a dedicated overflow point at the corner of Kopu Road and Lion Street. As mentioned previously, this overflow volume is not captured in the pump station overflow records, but can be identified when considering the difference in meter readings and why the Fitzroy flows are, at times, less than the upstream network contribution.

Comment

Without providing for sewer main capacity upgrades, no compelling case has been found to increase pump station capacity. The pump stations, as well as the sewer network, evidently have the capacity to cope with considerably more than just dry weather flows, as groundwater infiltration combined with low intensity rainfall events do not exceed the sewer network's capacity. What challenges their capacity is very high rates of stormwater ingress; and if the stormwater ingress can be reduced then both the pump station capacity and that of the sewer network may be considered to be adequate.

6.4 Reduce Groundwater Infiltration to the Sewer Network

Opus (2012b) at Section 6 notes that *"both the public and private portions of the wastewater network are in good structural condition, but there is evidence of leakage occurring through joints. It is likely that most joints are leaking, adding up to a significant amount of water entering the system."*

Opus (2012b) also analysed the results of a CCTV inspection within the sewer network, reporting as follows:

"There were… many joint faults, most of these were either leaking or there was evidence that the faults extended through to the outside. All of the pipes showed signs that they were leaking at least at a few locations.

The lateral connections were also poor, with very few manufactured wye sections being used for connections. Most of the connections were formed by cutting a hole in the pipe and stabbing in the connection pipe. There were a lot of protruding laterals. There were often gaps between the main pipe and the connection pipe where water could enter."

Opus (2012b) recommended that a 6 month ARI be adopted as the standard to be targeted, which is a service standard adopted by Auckland and other Councils. In order to achieve this Opus (2012b) considered that the **rehabilitation/replacement of the entire sewer network** would be required, with an estimated cost of $12M for the public reticulation, and a further $3.2M for the repairs required to private drainage. Increasing the targeted standard from 6 months to a 5 year return period event was considered to raise the public reticulation upgrade cost from \$12M to \$22.2 M, but without change to the \$3.2M cost for the private part of the network.

Comment
The financial impact of the network upgrade costs recommended by Opus (2012b) would be very large. A 6 month return period event would still leave overflows most years, but would nevertheless come at a huge cost. A more attractive level of protection would cost nearly twice as much.

Further, the rehabilitation of the existing leaking joints in the sewer pipes would largely target groundwater infiltration, which as noted in Section 5.5.1 above contributes 950 m^3/d in dry weather, and 1,500 m^3/d in wet weather, to the flows in the sewer network. However, as identified in Section 5.5.2 above, it is clearly stormwater ingress into the sewer system that is the main cause of the overflow events. In the longer term sewer network upgrading should be expected to enable a reduction in groundwater infiltration to the network. However, the data available indicates that a reduction in groundwater infiltration should not be expected to significantly reduce the uncontrolled overflows from the sewer network during heavy rain.

6.5 Reduce Stormwater Ingress to the Sewer Network

Opus (2012b) at Section 6.2.1 describes a Smoke Testing investigation of private connections to the sewer network on 139 properties in an area in the South-east of Wairoa bounded by Kopu Road, Lion Street, McLean Street, Campbell Street, Clyde Road, Kabul Street, Apatu Street, and Grey Street. Of the 139 properties examined, 20 were recorded as having faults including the following:

- Inspection cap missing or broken;
- Low gully trap;
- Downpipe connection; and
- Smoke from Ground.

All of these faults are potentially capable of conducting stormwater into the sewer network. During the same investigation, 28 manholes into the sewer network within the same identified area were examined. Of these, 4 were found to be set low enough for stormwater to be able to directly enter the manhole, and the recommendation was made by Opus (2012b) to raise those manholes to a higher top level.

Opus (2012b) reports at Section 7.2.2 that it has made the following assumptions:

- 50% of I&I is from the private network, and 50% from the public network;
- A cost rate of \$2,400 per private property requiring repair is assumed;
- The recommended cost of \$3.2M for private drainage repairs appears to have been calculated from a population of 4,000 people (Opus (2012b) Section 1.4) at 3 people per dwelling (assumed) times \$2,400 per property, equals \$3.2M.

Opus (2012b) identifies in its closing recommendations in Section 8, that repairing private property defects identified through smoke testing is its top priority remedial work.

Comment
The smoke testing examination covered 139 properties, representing about one tenth of the Wairoa town wastewater catchment. It found potential stormwater ingress faults in 20 of these properties, representing 14% or one 7th of the properties examined. If Wairoa comprises 1,333 properties, and one 7th of these require correction of stormwater ingress faults, then that implies that about 190 properties may require these works, which at \$2,400 each would total \$457,000.

Even if the $3.2M estimate for works on private properties were to be agreed with, if that work will deal with 50% of the I&I, that seems to be a much better result for the expenditure than spending $12M (or up to $22.2M for a better standard of protection) on the assumed other 50% of the problem. It is possible that this 50/50 assumption is incorrect, as the stormwater reticulation system may be contributing more than the private properties to the sewer system's peak stormwater ingress flows.

It is clear that keeping stormwater out of the sewer at its source will be the key to reducing, and eventually eliminating, the overflows from the sewer system that are the manifestation of the current problem. This issue is addressed in part by Clauses 4.3.1(d) and 5.5.3 of WDC's Trade Waste and Wastewater Bylaw 2012 which requires all trade and domestic dischargers to ensure that stormwater and groundwater do not enter the sewerage system by way of inflow or infiltration. Clause 13.3 of Schedule 5 to this Bylaw specifies a number of design features that are required to be installed and maintained for the purpose of excluding stormwater from the wastewater system. Enforcement actions including penalties are available to WDC through this Bylaw so that these clauses can be effectively implemented.

While the focus of this report is to identify works solutions to the present overflow problems, and while it is acknowledged that now is the time for remedial works rather than more studies and investigations, there is one sewer issue that clearly requires further investigation. Opus reported on the results of smoke testing in the sewer connections on 139 properties, representing about one tenth of the town, and this established a check-list of remedial works to be undertaken. There needs to be a program put in place to progressively smoke test all the other sewer connections in Wairoa, to enable the establishment of a program to remediate all stormwater inflow issues there as well. It is noted that the 2015-25 LTP provides for this program, but it appears that the program has not yet been developed. The Kopu Road catchment consistently introduces the greatest volumes of groundwater and stormwater into the reticulated sewerage system, so it makes sense to target the Kopu Road catchment as the top priority for commencing the smoke testing and stormwater system remediation program.

The extent of stormwater ingress from Wairoa's public stormwater system into the sewer network did not appear to have been assessed by Opus or EAM. This source of flows could be far greater than the individual domestic sources combined, and it therefore should also be investigated and form a separate program for progressively sealing off any stormwater connections into the sewerage system. Section 7 of this report provides further details on this aspect of the problem.

In addition to sewer overload issues identified by Opus, and flow behaviour described in this report, the existence of a direct site stormwater discharge from a North Clyde timber yard into the sewer was noted during a teleconference in early October 2015. This should clearly be investigated further, to establish whether the installation of, or connection to, stormwater infrastructure would lead to cost-effective reduction of loads on the North Clyde sewer pump station.

7 STORMWATER MANAGEMENT ISSUES

7.1 General

This Section of this report is to discuss the current management of stormwater within the Wairoa wastewater catchment, and to consider the impact of this stormwater management on potential stormwater flows into the sewer network.

7.2 Present Stormwater System

At present there is an extensive surface channel and reticulated stormwater network in Wairoa including street-side curb and channelling linking to pipes with numerous outlets to the Wairoa River or reserves along its banks. Figure 7.1 provides an overview of Wairoa's stormwater system, reproduced from data provided by WDC.

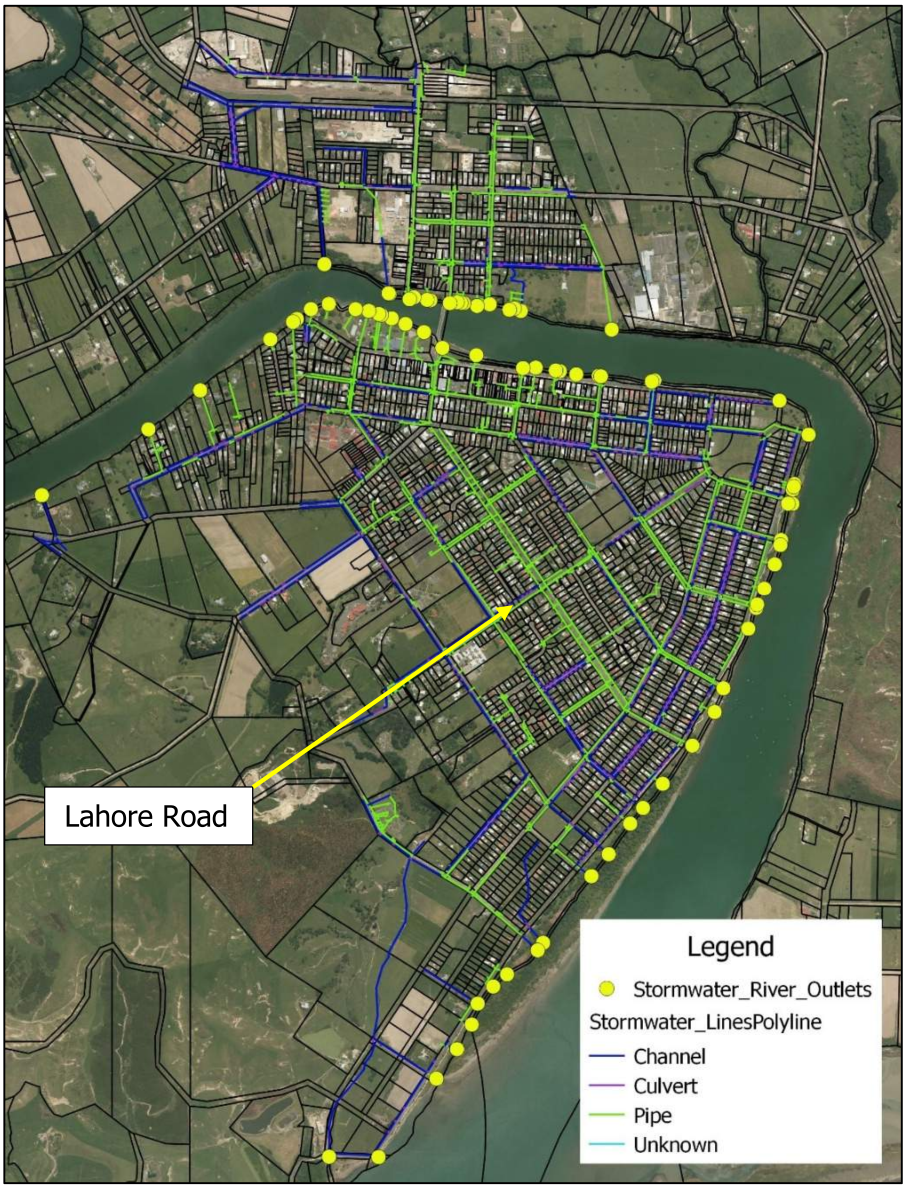

Figure 7.1: Wairoa's Stormwater System

The roads generally have road-side channels which usually feed into underground pipe networks. Some sections of the system have small catchment areas, while others are larger and more complex. There are evidently multiple discharge points for some catchments, and only a single discharge point for some others. The main residential area of Wairoa includes a lengthy double section of stormwater pipes along Lahore Road from just south of the CBD to a discharge point on Kopu Road; this is the largest single stormwater catchment within Wairoa and also covers some of the Kopu Road sewerage system's catchment area. It appears to rely on a single discharge point despite its large catchment area.

Wairoa does not have a flood protection scheme such as stopbanks to prevent the Wairoa River flooding properties. It is not known whether the stormwater system includes pumps to force urban stormwater into the river when it is in flood at levels above the stormwater outlet invert. If not, it is likely that urban stormwater is forced to back up within Wairoa township during high river level events, and ultimately to overflow. Presumably backflow flaps on the stormwater outlets ensure that the river does not flow up the stormwater pipes and into Wairoa. Similarly, it is unclear as to how siltation is managed to ensure stormwater can be released to the river and not surcharge pipelines.

It is unclear whether the stormwater system includes overflow diversions into the sewer pipes, but it seems possible given the age of both systems and the matching locations of some of the pipes, and because some short laterals of each system appear to have no other purpose. Stormwater reticulation overflow diversions into the sewerage system could also explain the very large storm flows noted in the sewer pumping records.

Retail properties along Marine Parade have downpipes conducting stormwater from verandah and building roofs into street-side gutters, but these represent only a small percentage of the entire stormwater network's total catchment area. For residential and industrial properties that are set higher than their adjacent street frontage, stormwater from roofs, hardstanding areas (mainly driveways) and the land areas themselves can run down to the street-side curb and channel and be effectively conducted by the stormwater reticulation system to the Wairoa River. However, for properties that are low-lying in comparison to the adjacent street level, there is no practicable stormwater exit to the road, and stormwater will either accumulate on site leading to localised flooding, or will most likely be diverted into the sewer as the "best practicable option", at least from the property owner's point of view.

7.3 Implications of Present Stormwater System for Sewer Management

Leakage from groundwater into the sewer network has been described in Section 5.5.1 above as contributing between 950 and 1,500 m^3/d to sewer network flows. However, wet weather causes flows in the system to increase from about 1,800 m^3/d to in excess of 8,000 m^3/d. It is clear that the great majority of the flow increase comes from stormwater, rather than from groundwater leakage into the sewer. Reducing the severity and frequency of overflow events from the Wairoa wastewater reticulation is going to require the re-routing of stormwater out of the sewer, and to the Wairoa River by some other route. Until such time as there is a suitable system into which stormwater can be discharged at **all** times, there will remain stormwater overloads in the sewer, leading to the overflow events that are the problem.

Some individual properties were identified by Opus as having roof downpipes connected to the sewer; others had low-set gully traps or leaking sewer inspection caps. All of these will have the effect of reducing stormwater flooding on the properties involved, whether deliberately or unintentionally, but in doing so they contribute to the overflow problems for the sewer. Opus (2012b) has recommended works to remedy these points of stormwater access to the sewer, and these are given the highest priority by Opus (2012b). However, property owners cannot be expected to keep their stormwater out of the sewer unless and until there is somewhere else to put it that will **not** lead to flooding of their properties. It is possible that the stormwater system is not effective for the disposal of stormwater from these particular properties and others that have installed similar diversions of their stormwater into the sewers. There is no point in managing a program of removing downpipes and other stormwater sources from their sewer connections if the result will only be increased stormwater ponding on the properties involved.

Removing the private (and public, where applicable) stormwater discharges into the sewer was identified by Opus as the top priority remedial work on the Wairoa sewer. However, before this is undertaken there **must first be** a viable stormwater outlet for each property involved**.** The identification, design, funding, consenting and installation of improved stormwater infrastructure to provide a practicable alternative to putting stormwater into the sewer must be regarded as the key to the resolution of Wairoa's wastewater overflow issue where this is the fundamental issue for specific properties and neighbourhoods.

8 PRIORITIES AND ACTION PLAN FOR OVERFLOW MANAGEMENT

8.1 General

This Section of this report is to recommend a priority order for the activities proposed to address the wastewater/stormwater overflow issues at Wairoa, and an Action Plan to put the recommended activities into effect.

8.2 Investigations

1. Before any remedial works can be undertaken, the status and capacity of the WDC urban stormwater infrastructure needs to be established. As first priority, areas within the town that **currently have** the stormwater capacity to adequately handle at least a 6 month ARI, with little or no works requirement to upgrade them to that capacity, need to be identified and delineated. These are areas that can effectively be put aside from immediate further stormwater investigations.

Action Plan

- Identify parts of **WDC stormwater network** that are considered adequate to drain their catchment, and that are adequate to connect/divert all private property stormwater outlets to the sewer within their catchment.
- This work may require the engagement of infrastructure specialist expertise.

2. Areas within the town that **do not** have WDC stormwater infrastructure with adequate capacity in place need to be identified and delineated. Design, funding, consenting and installation of adequate stormwater infrastructure should be undertaken, with priority given to those areas identified under 4 below as having an identified need for stormwater remedial works.

Action Plan

- Identify parts of **WDC stormwater network** that are considered **inadequate** to drain their catchment, and that have inadequate capacity to connect/divert all private property stormwater outlets to the sewer within their catchment.
- Identify works required to bring these parts of the stormwater network up to a standard that will enable connection/diversion of all private property stormwater outlets within their catchment.
- This work may require the engagement of infrastructure specialist expertise.

3. Wairoa sewer catchment is shown in Figure C of Appendix A subdivided into 17 sub-catchments of about 60 to 150 properties each, for the purpose of investigating, and remedying, stormwater entry into the sewer network. Specific descriptions of each sub-catchment are provided in Appendix B. A program of progressive flow monitoring and smoke testing needs to be got under way to establish what works are required and where, to prevent stormwater entry to the sewer network. At the same time and in the same sub-catchments, the public sewer infrastructure needs to be inspected and a list compiled of sites/infrastructure items and any works required to ensure that they do not act as points of access for stormwater into the sewer network.

Action Plan

- A program of monitoring sewer sub-catchment outflows at the identified manhole monitoring points should be established. For this purpose it is recommended that groups of three sub-catchments at a time should be monitored, in the following priority order;

1. K1, K7, and K8.
2. K2, K3, and K4.
3. K5, K6, and AP2.
4. AP1, NC1, and NC2.
5. MD2, MD4, and MD5.
6. MD3 and MD6.

- Suitable meters will need to be procured and installed at or near the identified monitoring points for each sub-catchment; the actual meter installation requirements will need to be investigated further.
- The flow monitoring timeframe and sequence should be as follows:

1. Meters need to be installed at the identified sites at about the same time as smoke testing for the sub-catchments involved is undertaken.
2. The meters need to stay in place until a significant rainfall event has occurred and been recorded; the flow peak in terms of timing and flow rate needs to be recorded. This data can be calibrated against the ongoing rainfall record.
3. Stormwater ingress remediation works, on both private properties and the public infrastructure within the sub-catchment, should then be undertaken. The steps for these works are proposed in Steps **4 to 8** below; it is expected that there will be a time overlap between investigations and works as both proceed progressively through the sub-catchment priority order.
4. The meter should stay in place to record the next significant rainfall event following the completion of remediation works, so that the data gathered can be used to assess the degree of flow peak reduction achieved by the remedial works. If flow peak reduction is not sufficiently achieved, then the sub-catchment will need to be further examined to determine where stormwater ingress is occurring, with identified ingress points being remediated.
5. Only once WDC is satisfied that an acceptable reduction in flow peaking has been achieved can the meter be removed and re-deployed to the next priority sub-catchment.

- Establish a program to smoke test private sewer connections in each identified sub-catchment.
- Undertake smoke testing in accordance with program.
- Record details of faults found, and of remediation required.
- Inspect public sewer reticulation in each sub-catchment, to record a list of sites with stormwater entry.
- Sewer reticulation inspection may require the engagement of infrastructure specialist expertise.

4. A budget list of works required to prevent stormwater entry to the WDC sewer network needs to be prepared, to enable financial and logistical planning for the required works to be put in place. This needs to cover both public and private parts of the network, and to set the works requirements out in appropriate sub-catchment groupings. The re-routing of stormwater at a North Clyde timber yard out of the sewer and into alternative infrastructure should be included in this.

Action Plan

- Prepare budgeted program to undertake required remedial **works to the sewer**, on both public sewer reticulation and private connections to the sewer.

8.3 Policy and Funding

5. Council needs to consider, and decide, the basis on which works to remedy stormwater entry into the sewer network are to be funded.

The usual start-point for such consideration is that Council will pay for works on the public system, and individual property owners pay for all work on their respective private connections. Such a provision is included in WDC's wastewater bylaw; fines may also be imposed for bylaw offences such as allowing stormwater to enter the sewer. However, in this instance the most cost-effective reduction in I&I, and consequent reduction in overflows, is shown by Opus to be from remedial works in the private connections. The whole community will get the benefit (in reduced overflows) of the works on the private connections. While costings of private remedial works have yet to be confirmed, it is indicated that about 190 properties at about $2,400 each would total some $457,000. It is suggested that a 50:50 share of these works costs between Council and the individual property owners would not only reflect the balance of liabilities, but the balance of benefits too. The offer of such funding support "for a limited time only" could be expected to encourage owners to get the job completed promptly. Funding for Council remedial works on the public network will also need to be planned for.

Action Plan

- A paper needs to be prepared for Council consideration on funding options for remedying stormwater entry to the sewer on private properties. Three options are that cost is carried by property owners, by Council, or by sharing cost between Council and owners. Council needs to consider the potential effect of requiring property owners to carry the entire cost, as well as effects of other options. Council decision will set direction for funding required remedial works.

8.4 Stormwater Remediation Works

6. In parts (or all) of sewer sub-catchments are identified in 1 above that lie within areas with adequate existing WDC stormwater infrastructure capacity, all/any identified works on both the private connections and the public sewer network in those areas should be put in hand. The logistics for this will need to be planned, and the program should work on the Kopu Road catchment as the first priority.

Action Plan

- Where stormwater network capacity has been found to be adequate, and where stormwater discharges into the sewer have been recorded, works are to be planned, budgeted and put in hand to **divert stormwater discharges from the sewer** to the stormwater network.

7. WDC stormwater infrastructure upgrades identified in 2 should be targeted, with priority given to the Kopu Road catchment and those sections identified in 4 as having a need for remedial works to exclude stormwater from the sewer. Priority can also be given to areas with greater age and earthen piping.

Action Plan

- Prepare budgeted program to undertake such **stormwater network upgrade works** as are found in 2 to be required.
- Attend to consenting and other authorisations for the works as may be required.
- Undertake the identified stormwater network upgrade works.

8. As WDC stormwater infrastructure capacity is upgraded (7 above), all identified works on both the private connections and the public sewer network in those areas should be undertaken. The logistics for this will need to be planned, and the program should work on the Kopu Road catchment as the first priority.

Action Plan

- As stormwater network upgrades identified in 2 are remediated as in 7, sub-catchment sewer remediation identified in 3 is to be planned, funded as decided in 5, and undertaken.

8.5 Overflow Consenting

9. Consideration needs to be given to whether or not resource consenting to authorise the ongoing (and diminishing) sewer overflows will be required, and on what basis. It cannot be determined at this stage the rate at which stormwater exclusion from the sewer network will be achieved, nor the quantities by which the overflows will be reduced. In principle the overflows should be consented as a matter of course. However, if a program of stormwater ingress reduction shows substantial progress in both the sites remediated and the consequent sewer flow rate reduction over a period of up to 2 years, HBRC and the Minister of Conservation may well take the pragmatic view that a consent to authorise something that is going away will be unnecessary.

There will, of course, continue to be overflows; even Opus' $22.2M public network upgrade option only gives protection from a 5 year return-period event, and Wairoa should expect to get larger rainfall events than this, and their consequent overflow events, from time to time. Issues relating to overflow consenting are recommended to be addressed only once there has been sufficient progress with remedial works to have some confidence in the rate at which ultimate exclusion of stormwater entry to the sewer network can be achieved.

Action Plan

- Communication with HBRC (and through them DoC if necessary) on whether consenting of overflows should be sought immediately, or whether delay in the light of the proposed remediation program will be acceptable.
- Inclusion of sewer overflows in present stormwater discharge consenting program if required, or deferral if acceptable to consent authorities.

8.6 Groundwater Infiltration

10. Works should be designed, funded and put in hand to progressively upgrade the main public sewer network to reduce the infiltration of groundwater into the sewer. The first targets for this upgrade should be sewer mains and connection points within the South-eastern river margin of the Kopu Road catchment as identified in Opus (2012b) Figure 14, for the following reasons:

- Because this has been identified as the area of highest groundwater infiltration;
- Because it includes the reach of the sewer main specifically identified by Opus as "surcharging due to inadequate capacity"; and

- Because it largely includes the sewer sub-catchment area smoke tested by Opus.

This work is not given higher priority here because on the strength of the available information, it will only remediate groundwater infiltration, which contributes only a small fraction of I&I compared to what stormwater contributes, and groundwater infiltration does not result in sewer overflows. The priority has been given to actions to reduce stormwater ingress to the sewer network, because this is expected to give the greatest portion of positive results (reduced frequencies and volumes of overflow events) for the expenditure.

Action Plan

- A rolling program of sewer main replacements should be prepared as identified in WDC's LTP.
- The priority sewer main for replacement and upgrading of connections should be from Kopu Road Pump Station to Fitzroy Street Pump Station.
- While sewer main replacement will have its own priority for WDC's asset managers, this work has **not** been found to warrant priority over the reduction of stormwater ingress into the sewer.

8.7 Information Clarification and Ongoing Requirement

11. To support and clarify the priorities and action items above, work should also be undertaken to confirm asset information retained on the WDC GIS system. The analysis of catchments has highlighted that there is infrastructure (predominately stormwater assets) which is either absent on the ground, or has been wrongly assigned. For example, Figure A in Appendix A, compiled from WDC records, shows an improbably high number of "Stormwater River Outlets".

When considering WDC infrastructure in isolation, the characteristics of the wastewater flows could be considered unacceptable, and as a result open to scrutiny during any subsequent public and consenting process. Consequently it would be beneficial to confirm catchment areas and flow characteristics to enable a more critical comparison of flow statistics with other similar communities.

Similarly in order to verify the effect of sewer network improvements made, both the continuation of pump station flow monitoring established in 2013, and the deployment of about 3 "Magflo" flow meters to monitor changes in flow characteristics in sewer sub-catchments before and after they have been remediated, would be beneficial.

Action Plan

- The WDC infrastructural asset information on the GIS needs to be reviewed, particularly in relation to the accuracy of stormwater asset identification, in order to ensure the ongoing accuracy and relevance of that information.
- The pump station flow monitoring system established during 2013, and evidently discontinued in early 2015, should be re-instated and maintained to enable overall monitoring of wastewater flows within the network, and to maintain a baseline against which sub-catchment peak flows can continue to be compared.
- About three "Magflo" flow meters should be acquired, to be installed towards the lower ends of sewer network sub-catchments, to enable the monitoring of changes in peak flows within the parts of the network that receive remedial works. The priorities and timetable for this deployment to be determined under 3 above.

8.8 Works not Given Priority

12. Opus (2012b) recommended the welding-on of the manhole cover 100 m downstream from Kopu Road pump station. This work is not seen as a priority here, because it does not reduce the overflow problem; it merely transfers it to somewhere else. At present the manhole cover (and the overflow outlet at the corner of Lion Street and Kopu Road) provides a safety valve protecting the integrity of the sewer mains in the vicinity, and impeding its ability to overflow simply puts further pressure on other parts of the network. Pressurising this section of sewer reticulation could also result in bursting of the pipework or connections which could then require an expensive emergency repair that still does not resolve the source of the overflow problem.

Action Plan

- This report has not identified any overall benefit to the overflow situation to be achieved by welding the manhole shut.

9 CONCLUSIONS AND RECOMMENDATIONS

This report has assessed the findings of the Opus and EAM reports in relation to the incidence of overflows from the Wairoa municipal sewer system, and concludes that while groundwater leakage through aged sewer pipe joints contributes a significant volume to sewer flows, even during periods of high river level adjacent to the town the volume of leakage is generally within the sewer network's capacity. The available information indicates that stormwater entry to the sewer network is the main cause of over-capacity flows, which lead in turn to wastewater overflows onto private properties and into the lower reaches of the Wairoa River.

Opus (2012b) reported on smoke-testing of a selected Kopu Road sub-catchment of the sewer network representing about one tenth of the town, and identified issues with about one seventh of the properties involved that were considered likely to enable stormwater access into the sewer network. Opus (2012b) identified the necessary on-site remedial works as its top priority for the reduction of I&I into the sewer network.

However, Opus (2012b) did not address the issue of where the stormwater involved would go if it was excluded from the sewer. Before removing downpipes from sewer connections, it will be necessary to ensure that sufficient stormwater infrastructure is in place and functional, to provide protection from stormwater flooding after any stormwater discharges have been removed from the sewer.

While the existence of the overflows is a source for concern, a sense of perspective needs to be maintained in relation to the extent of I&I peaking in comparison with other towns. A check of peak flow specific yields (m^3/ha/d) for about a dozen other towns in New Zealand shows that the intensity of flow peaking in heavy rain for Wairoa is not dis-similar to the situation in those other towns. The overflows will need to be dealt with, but an I&I contribution should be expected and Wairoa is not out of line with national norms in this regard.

This report identifies 11 priority actions for WDC to reduce, and ultimately eliminate, overflows from its sewer network to the Wairoa River. Several of the indicated priorities are capable of being addressed at the same time, and it is not necessary to wait for the completion of some of them before embarking on others. There are nevertheless some pre-requisites for some of the priorities, as identified in this report.

The priority actions recommended are as follows:

1. Areas within Wairoa that currently have access to WDC stormwater infrastructure that is capable of handling a 6 month ARI rainfall event within their sub-catchment are to be identified and delineated;
2. Areas within Wairoa that currently **do not** have access to WDC stormwater infrastructure that is capable of handling a 6 month ARI rainfall event within their sub-catchment are to be identified and delineated. Design, funding, consenting and installation of adequate stormwater infrastructure needs to be undertaken; no further I&I improvements within the sub-catchments involved will be practicable until this matter has been addressed;
3. The programming and undertaking of sewer flow monitoring and smoke testing in 17 sewer sub-catchments, in a specified priority order, is recommended in order to identify the need for, and assess the effectiveness of, stormwater ingress remedial works;
4. A budget list of works required to prevent stormwater entry to the sewer network needs to be prepared across each sub-catchment appraised, with the Kopu Road catchment taking first priority, to enable financial and logistical planning for the required works to be put in place;
5. Council needs to consider, and decide, the basis on which works to remedy stormwater entry on private property into the sewer network are to be funded. It is suggested that a 50:50

share of these works costs between Council and the individual property owners would be equitable;

6. In sewer sub-catchments that lie within areas with adequate existing stormwater infrastructure capacity, all identified remedial works on both the private connections and the public sewer network in those areas should be put in hand, with the Kopu Road catchment taking first priority;
7. WDC stormwater infrastructure upgrades identified in 2 should be undertaken, with priority given to the Kopu Road catchment and those sections identified in 4 as having a need for remedial works to exclude stormwater from the sewer. Priority can also be given to areas with greater age and earthen piping;
8. As stormwater infrastructure capacity is upgraded as may be required (7 above), all identified remedial works on both the private connections and the public sewer network in those areas should be undertaken, with the Kopu Road catchment taking first priority;
9. Consideration needs to be given to whether or not resource consenting to authorise the ongoing (and diminishing) overflows will be required;
10. Works should be designed, funded and developed to progressively upgrade the main public sewer network to reduce the infiltration of groundwater into the sewer. The first targets for this upgrade should be sewer mains and connection points within the South-eastern river margin of the Kopu Road catchment; and
11. Stormwater asset identification needs improvement, and sewer pump station flow recording should be continued.

10 REFERENCES

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Hawkes Bay Regional Council (2011): Compliance Monitoring Report. February 2011. 7 pp.

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Opus (2012a): Wairoa Wastewater Modelling – Stage 1 – Trunk Model Downstream of Pump Stations. Unpublished report to Wairoa District Council, January 2012. 20 pp plus appendices.

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Wairoa District Council (2012): Trade Waste and Wastewater Bylaw 2012. August 2012. 45 pp plus Schedules and their Appendices.

Wairoa District Council (2015a): Water and Sanitary Services Assessment 2015. July 2015. 86 pp.

Wairoa District Council (2015b): Wastewater Asset Management Plan. April 2015. 40 pp plus Glossary and Appendices.

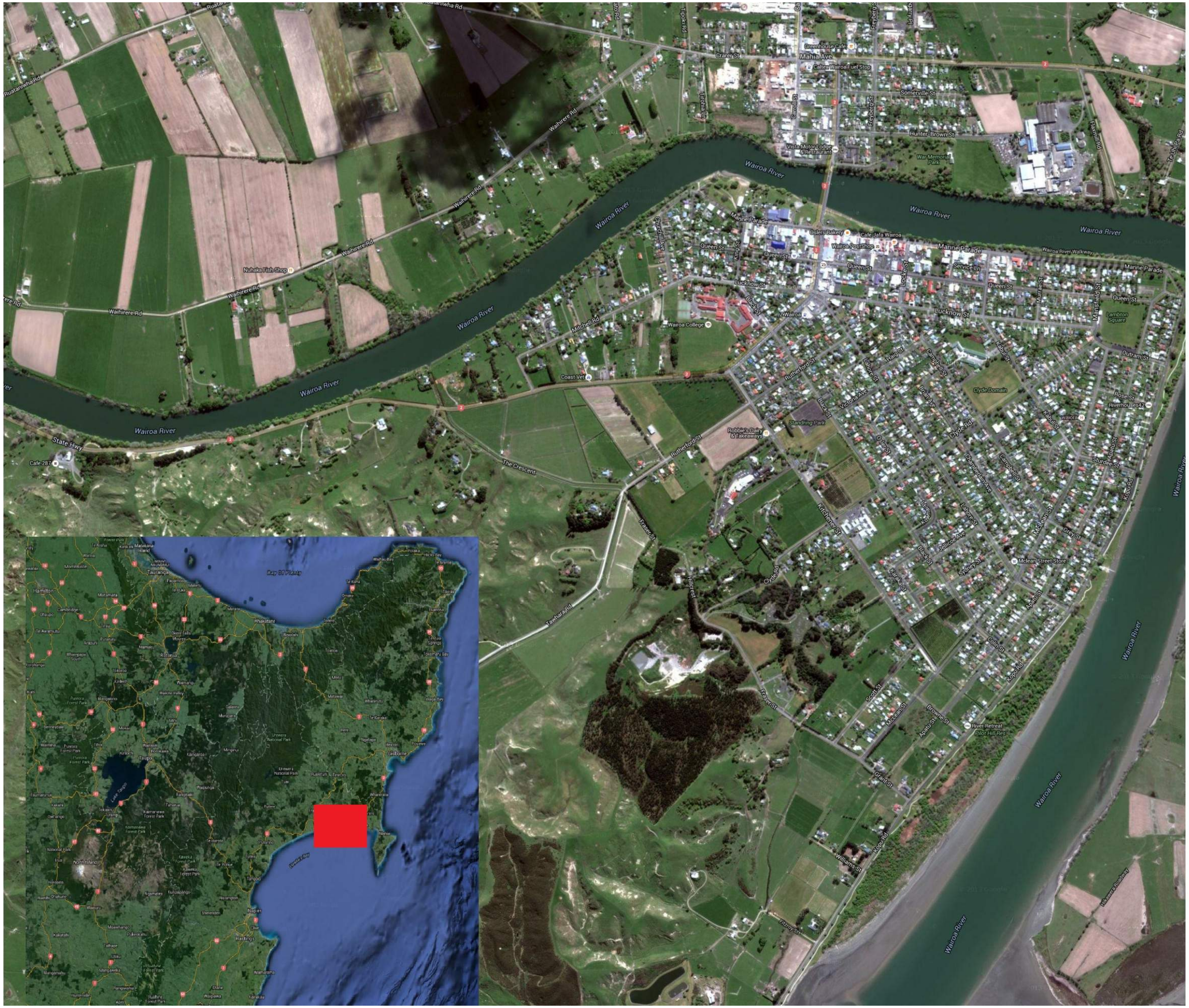
Wairoa District Council (2015c): Stormwater Asset Management Plan. July 2015. 43 pp plus Glossary and Appendices.

11APPENDICES

Appendix A Figures
Appendix B Wairoa Sewer Sub-catchments

APPENDIX A

Figures



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DRAWING TITLE
Figure 1: Location

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DATE	SCALE
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FILE NAME
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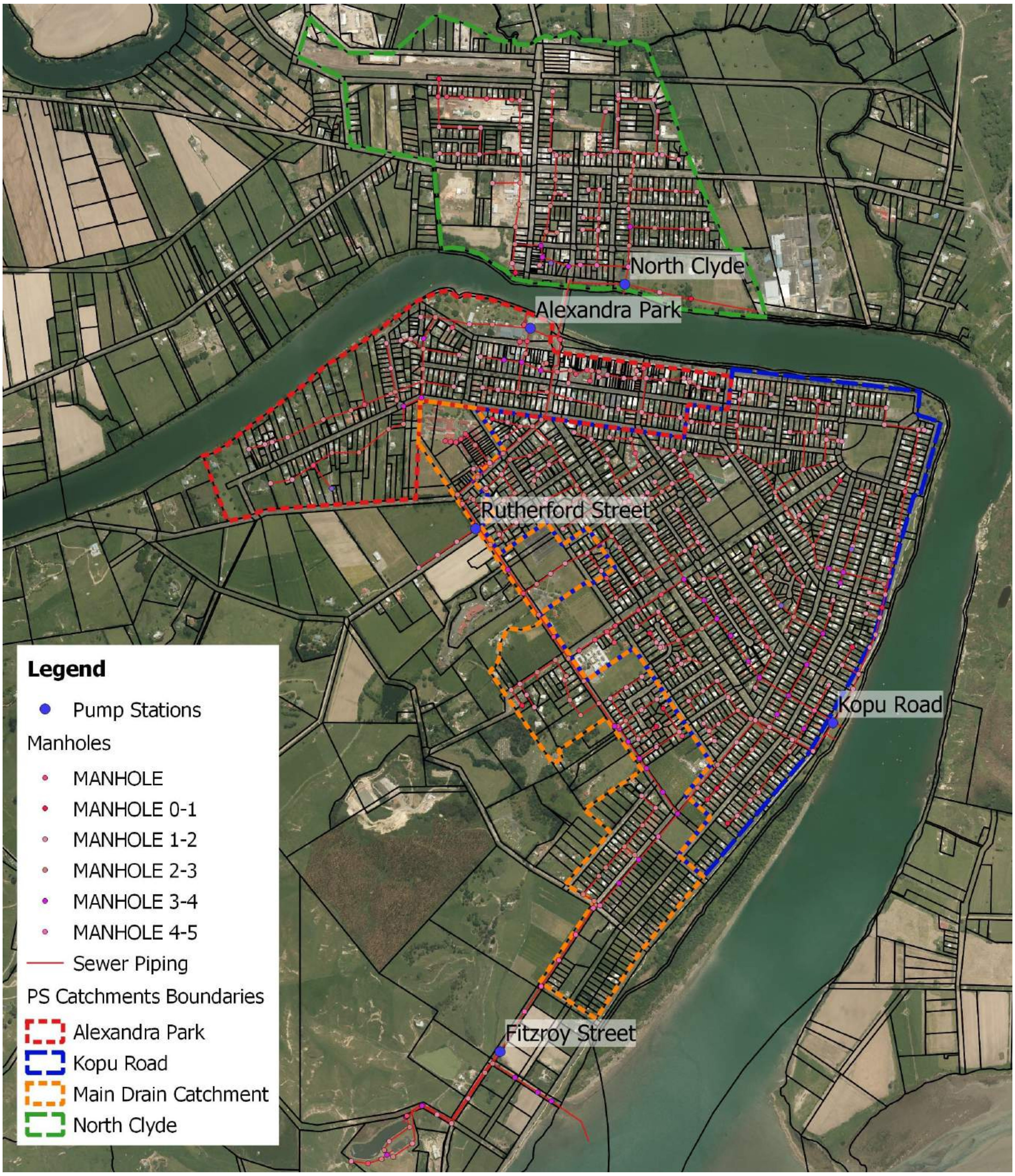

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Figure 2: Sewer Catchments

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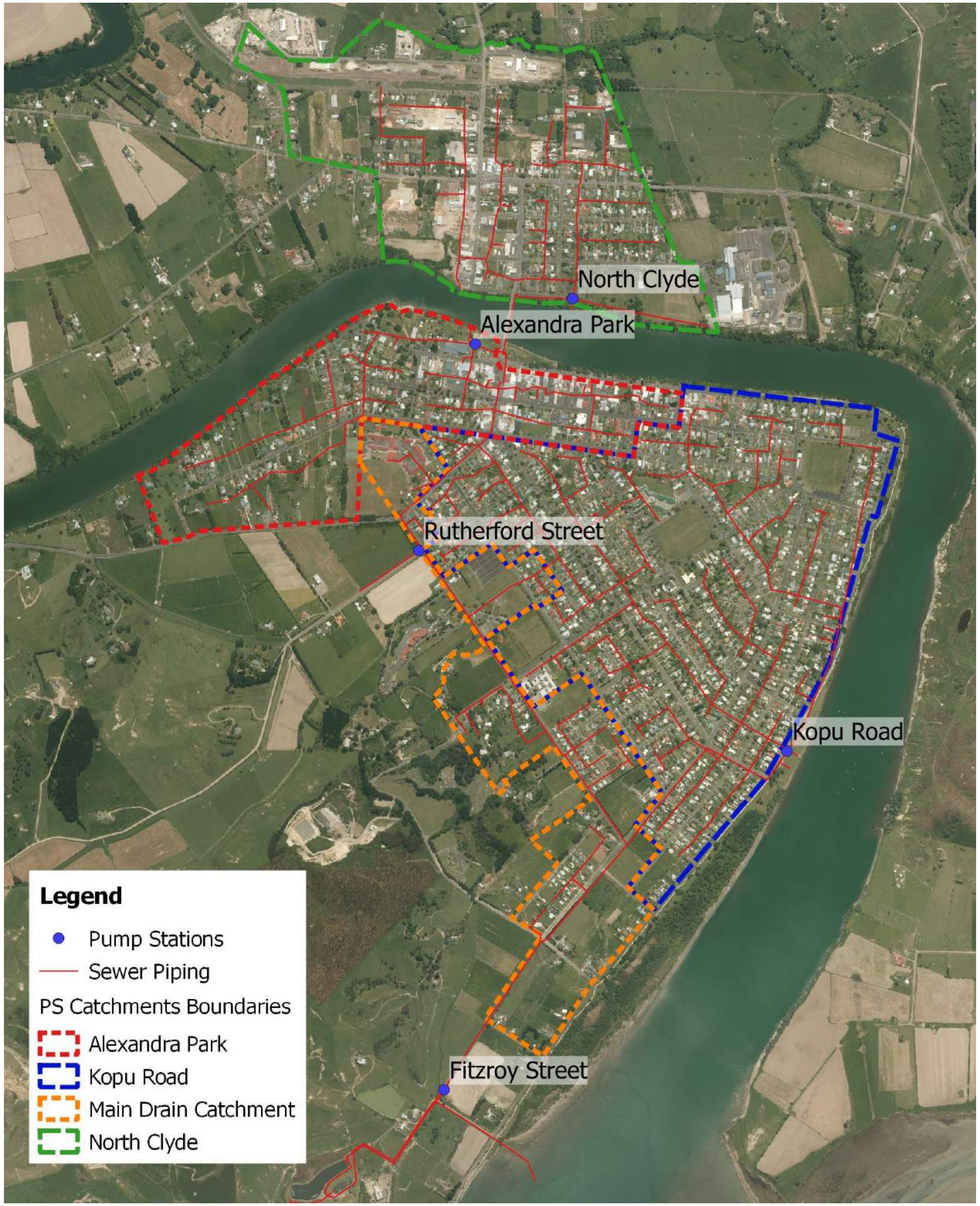

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Figure 3: Pump Stations and Catchments

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DATE	SCALE
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FILE NAME
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Figure 4a: North Clyde Catchment - Pipe Age and Pipe Materials

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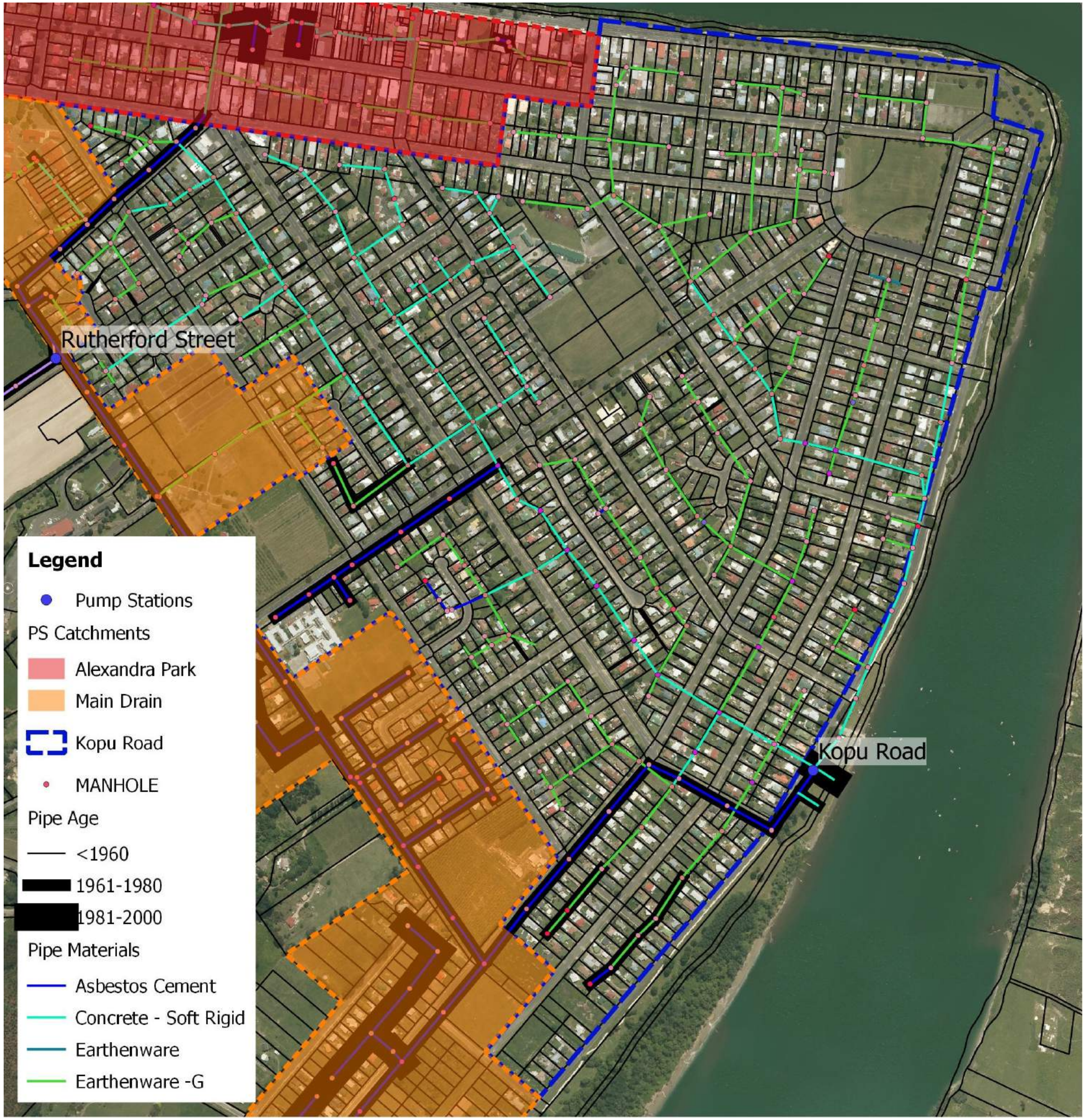

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Figure 4b: Kopu Road Catchment - Pipe Age and Pipe Materials

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SCALE
NTS

FILE NAME
10292-WDC-A1I1-Fig4b_Kopu_Road_Pipes

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Figure 4c: Alexandra Park Catchment - Pipe Age and Pipe Materials

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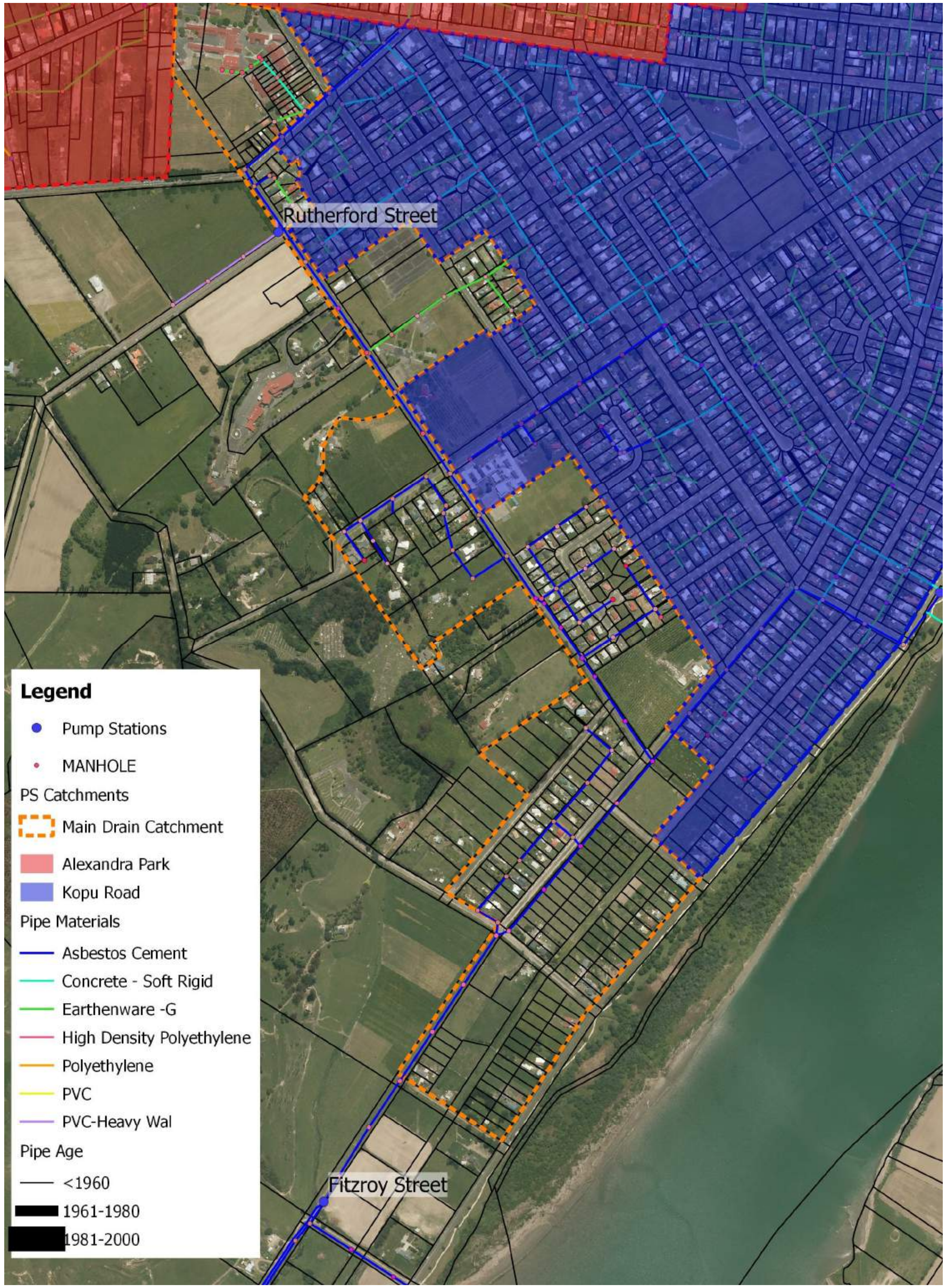

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Figure 4d: Main Drain Catchment - Pipe Age and Pipe Materials

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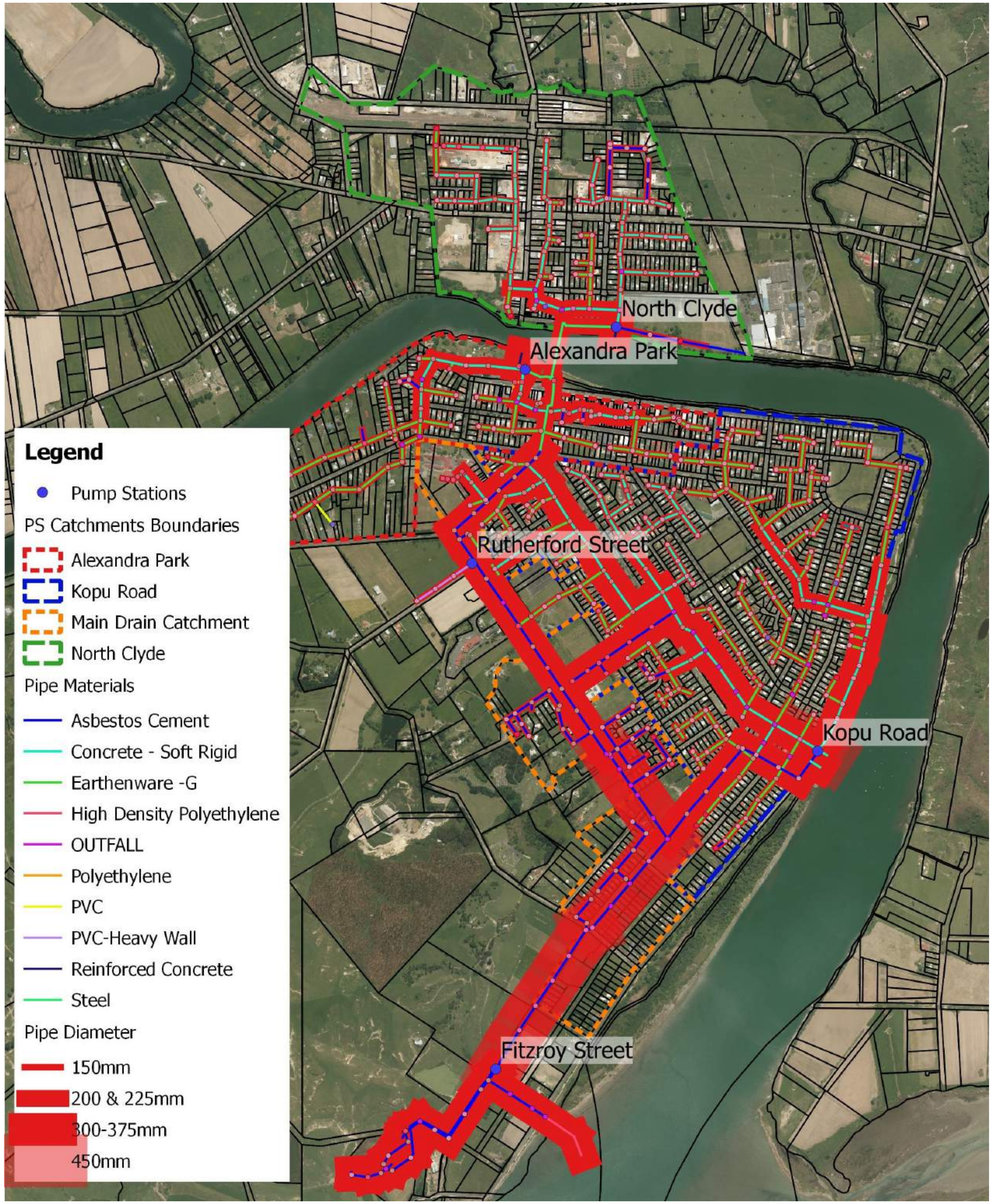

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Figure 5: Sewer Pipe Material and Diameter

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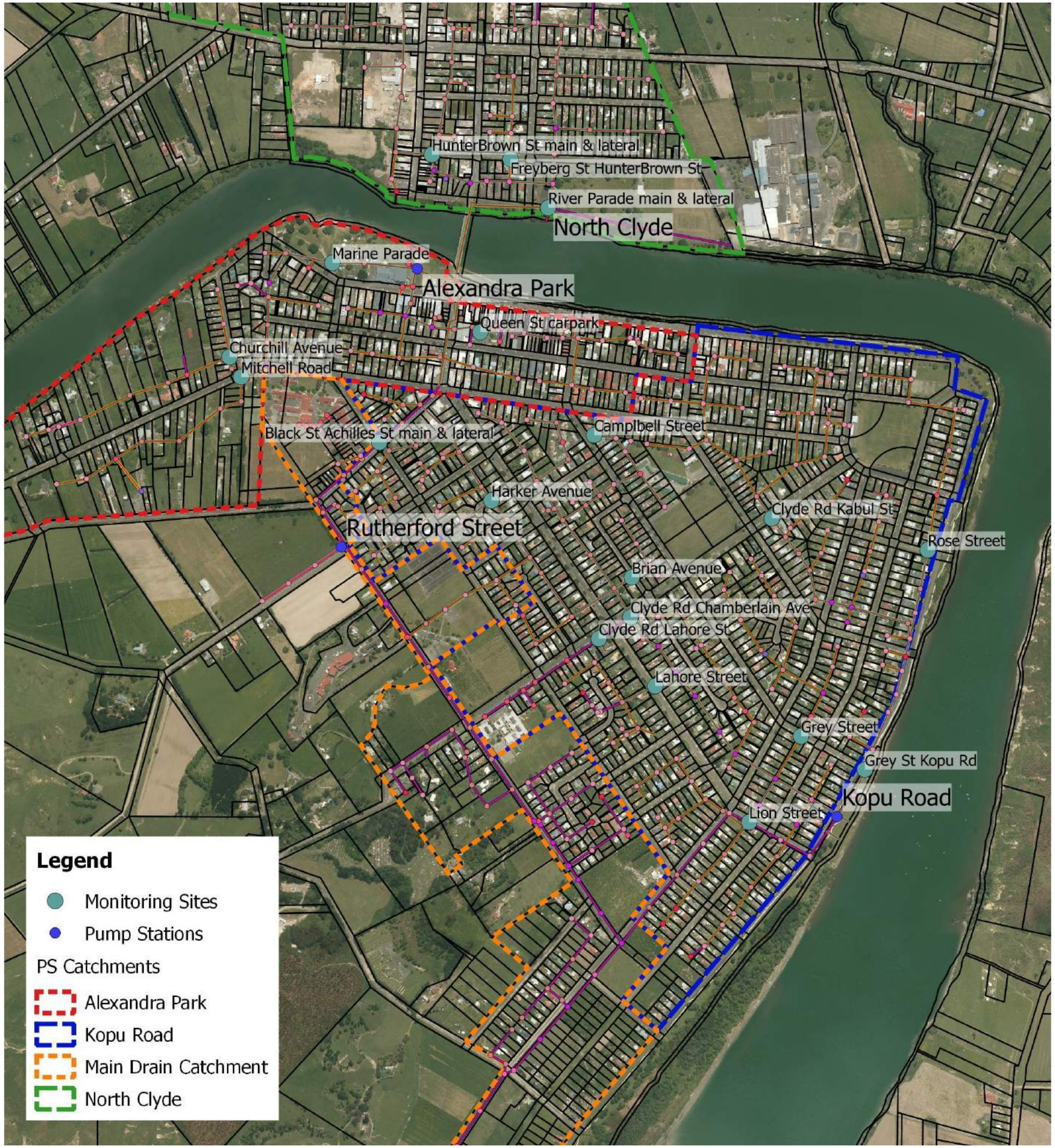

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Figure 6: Monitoring Locations

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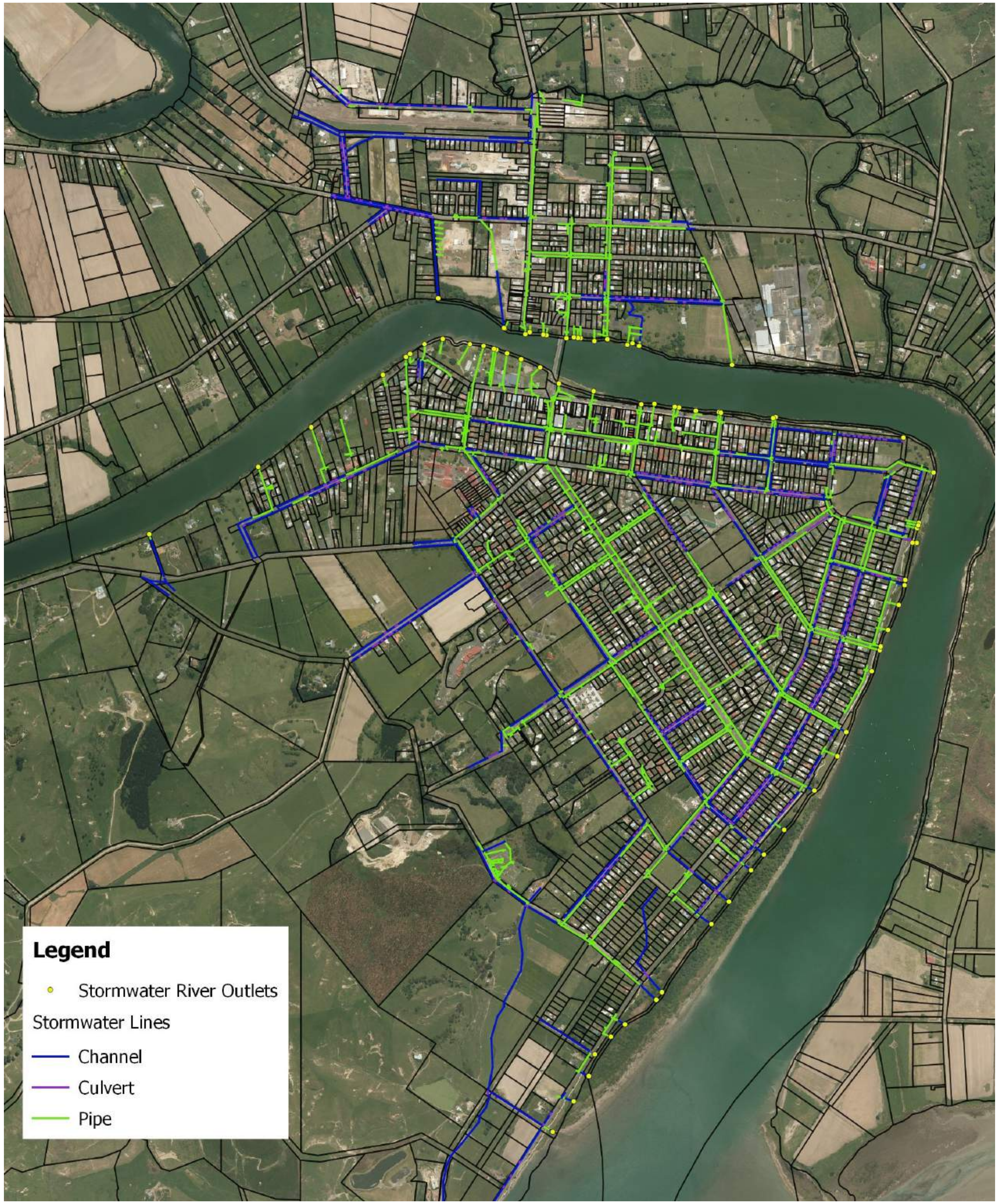

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Figure A: Stormwater Network

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FILE NAME
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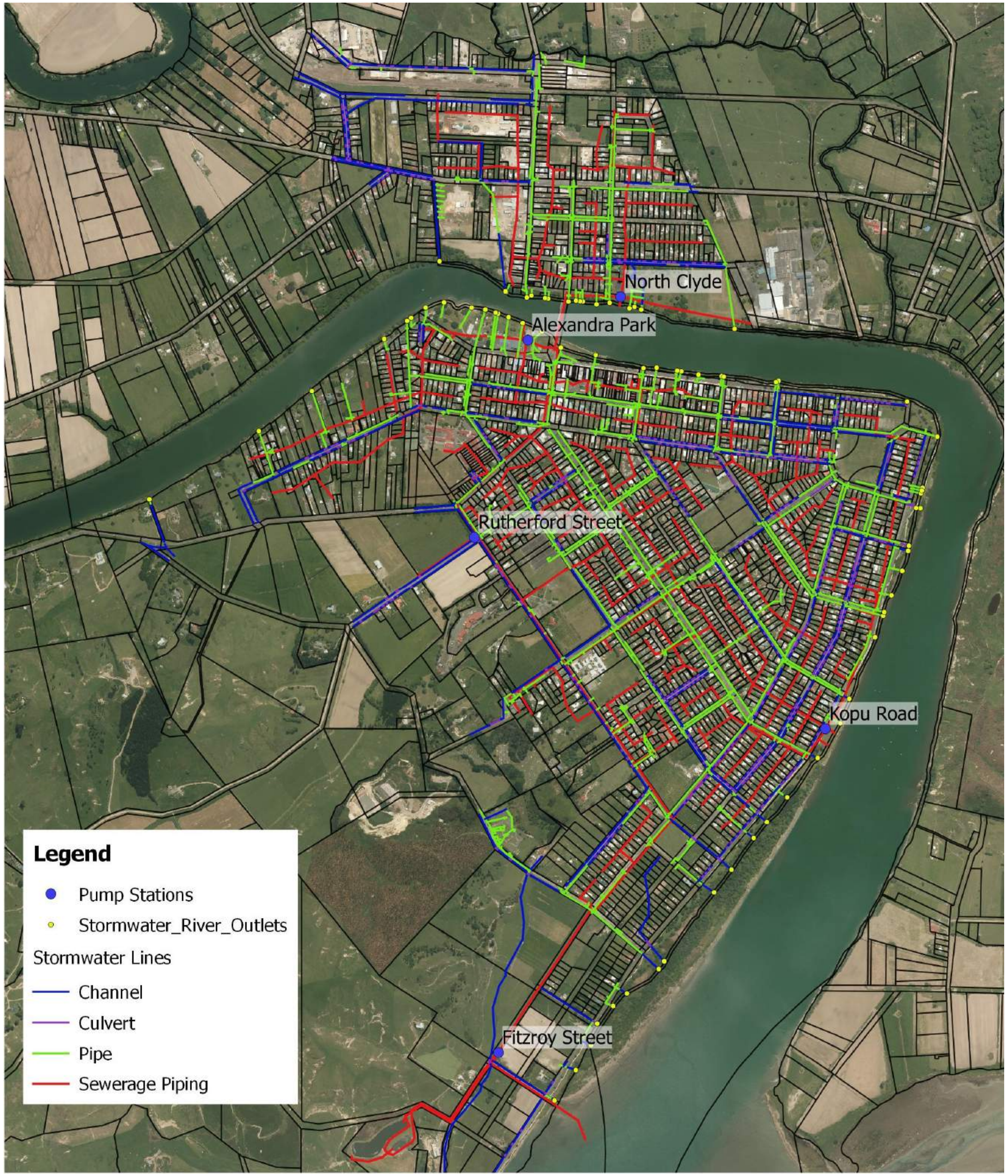

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Figure B: Stormwater and Sewerage Network

DRAWING STATUS
Draft

DATE	SCALE
19/10/2015	NTS

FILE NAME
10292-WDC-A1I1-FigB_Stormwater_and_Sewerage_Network

DRAWING TITLE		PROJECT
Figure C: Sewer Sub-catchments		Wastewater Reconsenting
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Wairoa District Council	Sian Cass	27 October 2015
SCALE	FILE NAME	
NTS	FI-10292-A1I1-FigC_Sewer_Subcatchments-151027	

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APPENDIX B

Wairoa Sewer Sub-catchments

Wairoa Sewer Sub-catchments

The Wairoa sewer network has been divided into 17 sewer network sub-catchments, for the purpose of both smoke-testing to detect stormwater entry points into the sewer, and identifying sewer flow monitoring sites. The sub-catchments are shown in Figure C in Appendix A.

Each sewer sub-catchment is described below in terms of its boundaries, with its identified monitoring point defined. Monitoring of flows from each sewer sub-catchment, both before and after stormwater ingress remedial works, will be needed for two reasons, as follows:

- To generally establish, in conjunction with the ongoing rainfall record, the peaking factor for each sub-catchment **before** any remedial works are done; and
- To assess/prove the extent to which those peaking factors have been reduced as a result of remedial works, **after** the works have been done.

The sub-catchments have been defined as all connected properties and public infrastructure upstream from a defined manhole for each sub-catchment. This way the entire flow from each sub-catchment can be monitored at the relevant manhole. The sub-catchments are described as follows.

NC1 North Clyde to the east of Freyberg Street. All flows are intercepted at the northern inlet to T-junction in manhole SMN0040.

NC2 North Clyde to the west of Freyberg Street. All flows are intercepted at the western inlet to T-junction in manhole SMN0040.

Also running into the North Clyde pump station is a sewer line draining the AFFCO meat processing plant to the east. There are few (if any) domestic connections to this line, with the bulk of the flow evidently being supplied by AFFCO staff facilities. It may be worth monitoring this flow where it joins the rest of the network, if only to confirm that no stormwater enters the sewer at AFFCO.

AP1 Alexandra Park catchment to the west of King Street, including Churchill Ave and Mitchell Rd. All flows are intercepted at manhole SMA0450.

AP2 Alexandra Park catchment to the east of King Street, including CBD, between Marine Parade and Lucknow Street, down as far as Delhi Street. All flows are intercepted at the manhole immediately south of A Park pump station, BIZ212B.

K1 Kopu Road catchment, bounded by Lion Street, McLean Street, Campbell Street, Clyde Road, Kabul Street, McLean Street, grey Street, and Kopu Road. This was the trial catchment smoke tested by/for Opus. All flows are intercepted at south-eastward outlet from 4-way sewer junction at manhole SMK0780.

K2 Kopu Road catchment, to the east of Apatu Street, and running north from Grey Street to Mansfield Street. All flows, including those from K4, are intercepted are intercepted at manhole SMK0030 at the south-east end of Grey Street.

K3 Kopu Road catchment, between Delhi Street and Mansfield Street, from Marine Parade south to Clyde Road and Kabul Street. All flows are intercepted at manhole SMK0490, just north-east down Clyde Road from the Kabul Street crossroads.

K4 Kopu Road catchment, between Clyde Road and Apatu Street, and from Lambton Square to Kabul Street. All flows are intercepted at manhole SMK0310, near Kopu Road and between Sturdee and Rose Streets, just before the pipeline connects with the sewer main coming south along Kopu Road from sub-catchment K2. K4 flows would be included with the flows from K2, meaning that K4 should be flow monitored, smoke tested, remediated, and then monitored some more, **before** sub-catchment K2 is addressed.

K5 Kopu Road catchment, bounded by Clyde Road, Lahore Street, Lucknow Street, and including Clyde Domain. Flows are intercepted at the north-western inlet to the sewer T-junction at manhole SMK1550, on the south-east side of Clyde Road, one property-length to the north-east of the Lahore Street crossroads. K5 flows **include** those from sub-catchment K6.

K6 Kopu Road catchment, between Lahore and Kitchener Streets, and from Lucknow Street to Clyde Road. All flows are intercepted at the outlet of the sewer T-junction at manhole SMK1950, between private properties to the west of the Clyde Road/Lahore Street crossroads. K6 should be worked **before** K5, because the monitoring point for K5 includes flows from K6.

K7 Kopu Road catchment, south-east of Clyde Road and extending between Campbell Street, McLean Street, Lahore Street, Jellicoe Ave, and Black Street. All flows are intercepted at the outlet from the 4-pipe junction at a manhole located between several private properties, some 4 properties to the north of the McLean Street/Lahore Street crossroads. SMK1260

K8 Kopu Road catchment, south of Kopu Road pump station. Bounded by Lion Street, Lahore Street, Jellico Ave, Black Street, McLean Street, Browne Street, and Kopu Road. Most of the flow is intercepted at the north-east running outlet pipe from the T-junction at manhole SMF0240, located one property length down Lion Street from its McLean Street crossroads. A further short length of sewer, serving the area between Apatu Street and Kopu Road, from the Kitchener Street/McLean Street corner to Lion Street, is **not** routed through SMF0240, but is captured at SMK0810, half way down Lion Street between Apatu Street and Kopu Road.

MD1 Main Drain catchment, covers the southern-most part of Wairoa nominally included in the sewer coverage. It is bounded by Kopu Road, William Street, McLean Street, Kitchener Street, Black Street, McLean Street, and Browne Street. This sub-catchment has **no sewer reticulation** and therefore does not need further consideration here.

MD2 Main Drain catchment, bounded by McLean Street, Grant Street, Scott Street, and Kitchener Street. Its flow is intercepted at manhole SMF0070, at the corner of Grant Street and McLean Street, just before it enters the main drain.

MD3 Main Drain catchment, a small L-shaped area at the south-east part of Karaka Street, between Kitchener Street and Black Street. Its flow is intercepted at the inlet to the T-junction with the main drain at manhole SMF0310 on Kitchener Street.

MD4 Main Drain catchment, covers the northern part of Karaka Street between Kitchener Street and Black Street, extending as far north as the Kowhai Place/Black Street corner. Its flow is intercepted at the inlet to the T-junction with the main drain at manhole SMF0370 on Kitchener Street.

MD5 Main Drain catchment, covers the high school and adjacent properties, bounded by Black Street, Lucknow Street, Kitchener Street and Achilles Street. Flows are intercepted at the inlet to the T-junction with the main drain at manhole SMF0750 on Achilles Street.

MD6 Main Drain catchment, covers the area south of Clyde Road and west of Kitchener Street. Its flows are intercepted at the inlet to the T-junction with the main drain at manhole SMF0470 on Kitchener Street.