OPTIMISING WASTEWATER TREATMENT & DISPOSAL CAPITAL COSTS THROUGH TARGETED INFILTRATION AND INFLOW REDUCTION

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ABSTRACT

Initial investigations for future wastewater treatment schemes in Featherston showed that infiltration and inflow (I/I), especially groundwater infiltration (GWI), was at such a level that the cost of any scheme would be highly influenced by the excessive flow volume. This project was commissioned to determine the level and extent of network rehabilitation required to achieve the lowest overall cost for future high rate treatment and land based treatment and disposal options.

The first phase of investigations was to determine the extent of GWI and the cost of addressing it. A night flow study showed that GWI was relatively isolated with 83% of the measured night flow coming from 23% of the total network pipe length (top 5 of 17 monitored sub-catchments). Flow reductions and associated rehabilitation costs were estimated for each sub-catchment using rehabilitation effectiveness estimations and current rehabilitation costs. The diminishing return on investment was clearly evident beyond the top 5 sub-catchments.

The capital costs of high rate treatment and land based treatment and disposal schemes were calculated for different levels of flow reduction achieved through I/I rehabilitation. This allowed the optimum financial solution for the complete upgrade (including I/I rehabilitation) to be found, balancing the savings on treatment and disposal against the increasing rehabilitation costs. With no I/I reduction the capital cost of a high rate treatment plant and a land based treatment and disposal scheme was estimated at $15.4M and $18.8M, respectively. The most economical high rate treatment scenario was achieved through $0.98M of network rehabilitation works which would result in a 27.5% reduction in ADWF and achieve a $2.6M capital cost saving compared with no I/I reduction. The total project net saving under this scenario was estimated at $1.62M including the cost of network rehabilitation. The most economical land disposal scenario was reached at $1.48M of network rehabilitation, resulting in a 31.4% reduction in ADWF which would achieve a $5.71M capital cost saving compared with no I/I reduction. The total project net saving under this scenario was $4.23M including the cost of network rehabilitation.

KEY WORDS

Network rehabilitation, infiltration and inflow, groundwater infiltration, treatment plant cost optimisation

1 INTRODUCTION

South Wairarapa District Council (SDWC) is currently undergoing a resource consenting process to obtain a new effluent discharge consent at the Featherston wastewater treatment plant (WWTP). As part of this process, options for high rate treatment with a continued direct discharge to water and land based treatment and disposal were evaluated. Initial investigations for options and sizing included assessing inflows to the existing WWTP. The data showed that dry weather flows were heavily influenced by season, often reaching 6 times what was expected for the population. There was also evidence of elevated flows following wet weather. It was clear that infiltration and inflow (I/I), especially groundwater infiltration (GWI), was at such a level that the cost of any treatment or disposal option would be highly influenced by the excessive flow volume. This project was commissioned to determine the level and extent of I/I remediation required to achieve the lowest overall cost for the treatment and disposal schemes.

2 METHODOLOGY

2.1 INITIAL INVESTIGATION

SDWC operate an inlet flow meter at the Featherston WWTP that has operated for a number of years. The data from this gauge was assessed to characterise the I/I issues at a township level and identify seasonal trends in flow. This assessment provided the basis for prioritising the subsequent source detection works that would eventually lead to source isolation and remediation to achieve flow reductions at the WWTP. Additional verification of conclusions was carried out by reviewing data and reports from a catchment flow monitoring study carried out in 2004.

2.2 NIGHT FLOW ISOLATION

2.2.1 Defining infiltration, night flow and GWI

For the purposes of this study GWI is defined as the component of dry weather flow that enters a wastewater network through defects submerged by seasonally stable groundwater. GWI is best observed during winter (when seasonal GW and hence submergence is greatest) in dry weather and manifests as elevated base flow for a long period of time (usually months). It differs from rain dependant infiltration (RDI), which is observed as elevated flow following wet weather when GW may temporarily increase and/or soils may become temporarily saturated with percolating rain water, causing additional submergence of the network and therefore increased infiltration. Unlike GWI, RDI recedes in days or weeks as soils drain.

A pipe with GWI issues will usually have RDI issues due to additional head of groundwater however, a pipe with RDI may not have GWI if it is well above the GW level year round. Both GWI and RDI are indicative of the same type of defects namely deteriorated or offset pipe joints; cracking in old pipes (usually earthenware, asbestos cement and concrete); defective laterals; leaking and offset manhole risers; and major pipe damage. While GWI does not usually cause dramatic issues such as overflows or surcharging, the continuous nature means that it can contribute a significant volume of excess flow over time especially if RDI also becomes a problem.

During dry weather it is difficult to separate the portion of flow that is GWI from the wastewater portion (without monitoring and subtracting inputs from individual households). For simplicity, the severity of GWI is assumed to be directly linked to the dry weather night flow which can be easily measured. Night flow includes a constant wastewater component from normal residential water use as well as GWI which can fluctuate depending on defects, GW levels, rainfall and geology. It is generally defined as the minimum hourly flow rate recorded between 01:00am and 05:00am during dry weather. As the wastewater component is assumed to be constant and limited based on population, any fluctuations in dry weather flow measured at night is deemed to be the result of GWI.

2.2.2 Night flow isolation methodology

Night flow isolation was the method used for estimating the volume of GWI entering the network and isolating sources at a detailed level. The general concept is to measure flows within small sections of pipe or mini-catchments in winter (while the network is most susceptible to being submerged by groundwater) to determine the rate of infiltration. The resulting flow rate will depend on the severity of defects, the magnitude of groundwater submergence and the groundwater flow rate through the surrounding materials (soils, trench backfill etc). The results can then be used to determine a priority for remedial work.

For the Featherston investigations the network was divided into 17 study areas (see figure 2 on the following page). The night flow from each study area was measured using a portable flow measurement weir which is installed in the inlet or inlets to a manhole (see figure 1 below). Instantaneous measurements are taken between 01:00-05:00 (night flow) to reduce the influence of domestic and commercial flows thereby isolating GWI. Dry weather is required during and prior to the study to ensure the flow is not affected by stormwater inflows. It is important to note that the measured flow is sourced from all network infrastructure upstream of the monitoring point including public mains, manholes and private laterals.

Figure 1: Portable weir installed in Featherston sewer

The study in Featherston was carried out on 7-8th October 2013 when flow to the WWTP was 2363m^3/day, which is near to the average annual daily flow rate of approx. 2600 m^3/day. This flow rate is consistent with previous recorded winters, although flows have reached up to 3000-3500 m^3/day. There was also an extended period of dry weather prior to the study eliminating interference from any stormwater inflows. The results are therefore deemed to be representative of the typical dry weather, winter, night flow contributions from the pipes measured in the study. The sections of pipe identified as having GWI issues should therefore represent the most critical for rehabilitation.

Traditional flow monitoring for I/I analysis uses similar basic methodology and equipment, the key difference being, that flow monitoring is continuous and on a much larger scale of pipe length (approx. 3km minimum). Portable weirs provide greater accuracy than traditional flow meters especially in low flow conditions typical of night flows. Rather than continuous measurement, discrete measurements are made by the field crew over a short period. The results represent a snapshot of night flow conditions hence the need for optimal timing.

For condition assessment and planning of renewals, using this technique has advantages over other methods such as CCTV as it quantifies the actual flow contribution as opposed to a perceived level of infiltration based on visual condition assessment.

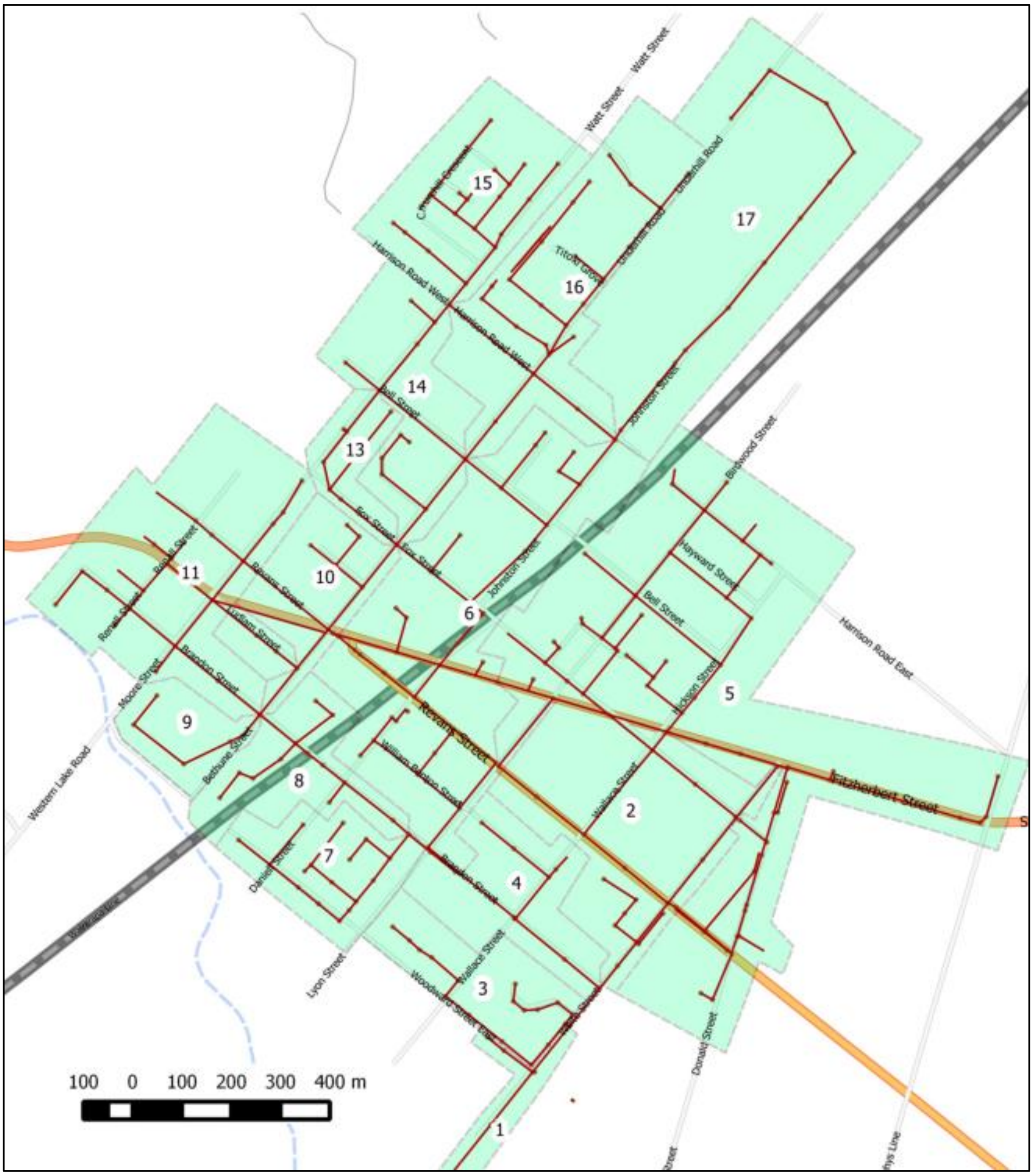

Figure 2: Study areas for night flow isolation in Featherston

2.3 INTERPRETATION OF RESULTS

To effectively compare the often very small night flow measurements in each study area, the results are normalised against pipe length to give a night flow rate in terms of m^3/km/day (L/m/day). To bring further meaning to the results additional calculations were carried out to determine what an acceptable night flow rate was for Featherston. The calculations used a total daily flow volume which comprised a fixed wastewater volume based on population and a variable night flow volume based on the measured night flow rate applied to all pipes in the network. The resulting daily volume was divided by the current population of 2340 to give a wastewater production rate (WWP) that would occur if all the 24.155km of public pipe within the network was flowing at the measured night flow rate. It was shown that if on average the night flow in Featherston was 7 m^3/km/day the WWP would be 250 L/p/day. Accepted literature and standards specify that in a residential catchment anything above 250 L/p/day is generally classified as higher than normal and indicates a GWI issue. Further categories were added to classify and compare catchments based on the WWP resulting from various measured night flow rates. The following table presents the different categories of night flow rate and the corresponding GWI inference.

Table 1: Night flow severity categories

Night flow rate (m^3/km/day)	**Equivalent Featherston WWP (L/p/d)**	**GWI inference**
< 3	< 200	Low
3 -7	200 - 250	Acceptable
7 - 16	250 - 350	High
16 - 35	350 - 550	Very High
> 35	> 550	Severe

2.4 REHABILITATION COSTING AND POST REHABILITATION FLOW REDUCTIONS

Night flow reductions were estimated for rehabilitation of public mains, manholes and private laterals. The figures are estimates based on the effectiveness of previous work carried out in New Zealand and overseas. Actual reductions achieved under the rehabilitation options are very difficult to determine due to many influencing factors. The main factors introducing variability include the unknown relative contribution of public mains and laterals; the variation in reduction between a pipe with severe and minor infiltration issues (i.e. more flow will be removed from a pipe with more infiltration); and the quality of the rehabilitation work. The key consideration for estimating potential reductions in Featherston was the extent of the existing infiltration. It was assumed that because infiltration rates were very high that significant flow reductions could be achieved by rehabilitation hence the night flow reductions under each scenario are optimistic.

Costs were attained form current industry rates for in-situ pipe relining and manhole sealing and also include CCTV and associated quality control of the work. The actual cost may vary depending on the final technique chosen for rehabilitation which can only be determined after CCTV and detailed physical assessments have been carried out. Pricing for complete pipe replacement has not been undertaken however, may be required if pipes are not structurally sound.

The table below shows the costs and estimated reductions that have been assumed for two different rehabilitation scenarios. The rates were applied to each of the 17 study areas to determine the cost of rehabilitation, the associated net flow reduction and the overall effect on ADWF in Featherston.

1) Reline all <u>public</u> mains and seal all manholes within the identified catchment
2) Reline public mains, seal manholes and reline all private laterals.

Table 2: Rehabilitation costing and flow reductions

	Rehabilitation Costs			Night flow reductions	
Level of rehabilitation	150mm - 300mm Pipe relining ($/m)	Manhole sealing ($/MH)	100mm Lateral relining ($/m)	Minimum	Maximum
1: Public only	$200-$350	$1100-$1800	na	50%	60%
2: Public and private	$200-$350	$1100-$1800	$350	65%	75%

2.5 TREATMENT COSTING

The size and cost of high rate wastewater treatment or land based treatment and disposal schemes are typically proportional to the flows treated. A higher flow rate into a treatment plant would require larger process units and higher operational costs. Similarly, higher flow rates in a land based treatment and disposal scheme would require larger land area, irrigation infrastructure and higher maintenance costs. Therefore, the second element of the I/I sensitivity costing analysis involved deriving capital costs for high rate treatment and land based treatment and disposal schemes over a range of average daily flow rates.

2.5.1 High rate treatment plant costing

A cost curve for high rate treatment plant capital cost vs. average daily flow was derived using capital cost data for a range of membrane bioreactor (MBR) and sequencing batch reactor (SBR) treatment plants that have been built in New Zealand in recent years (See Figure 3 below. Source: AWT Water/Mott MacDonald internal project database). This curve provides a high level capital cost estimate and it is recognised that local factors such as the level of treatment required, land availability, geotechnical and environmental site issues can all have a significant effect on the actual cost of individual WWTPs. In general, however, the capital costs of WWTPs increase sharply with small increases in average daily flow rates up to approximately 2000m^3/d, after which the additional cost for higher flows reduces due to the economies of scale that can be achieved with a sufficiently large project.

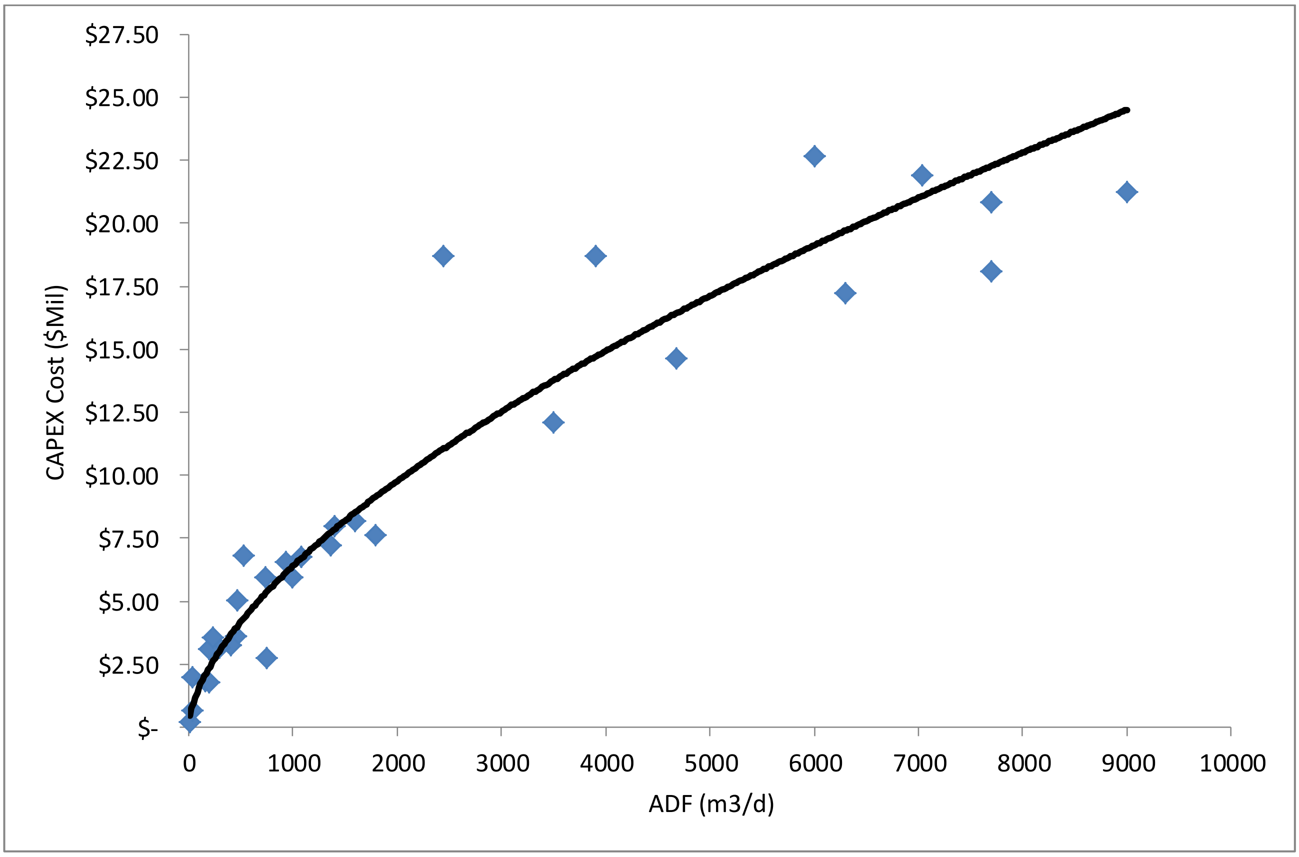

Figure 3: NZ high rate treatment plant capital costs

2.5.2 Land based treatment and disposal costing

Capital costs for a land based treatment and disposal scheme were estimated using design and costing parameters established in the land disposal scheme feasibility study and concept design work previously undertaken by AWT Mott MacDonald for South Wairarapa (AWT Water/Mott MacDonald internal project database). For each South Wairarapa town, potential land disposal sites had been identified and site-specific irrigation rates were estimated based on the soil characteristics on the site. The land disposal scheme was found to be hydraulically limited (rather than nutrient limited), so the size and cost of the irrigation area and associated infrastructure was directly proportional to the flow rates discharged from the WWTP. In addition, a high level water balance was used to estimate the potential storage volumes that would be required to store flows when discharge to land was not possible due to rainfall. Storage requirements are also directly proportional to the discharge flow rate, and in particular, would be significantly affected by peak flows (largely stormwater inflows) during wet weather events. The size and cost of reticulation infrastructure, eg. pump station and rising mains, were also sized proportional to the discharge flow rate.

2.6 I/I SENSITIVITY ANALYSIS FOR TREATMENT OPTIONS

The cost information outlined above was used to evaluate the capital cost of a high rate treatment plant or land based treatment and disposal scheme under different flow scenarios, ranging from 0% reduction in ADWF (ie. no rehabilitation work) to 50% reduction in ADWF. The corresponding cost of I/I rehabilitation works required to achieve the flow reduction was also assessed in each scenario. This method enabled the capital cost of the I/I rehabilitation works to be balanced against the capital cost reduction resulting from treating and disposing less flow. A set of capital cost curves were produced for each town and each treatment/land disposal option.

3 RESULTS

3.1 INITIAL INVESTIGATION

The daily influent volume to the Featherston WWTP from 2007 to 2012 is shown in the data plot below.

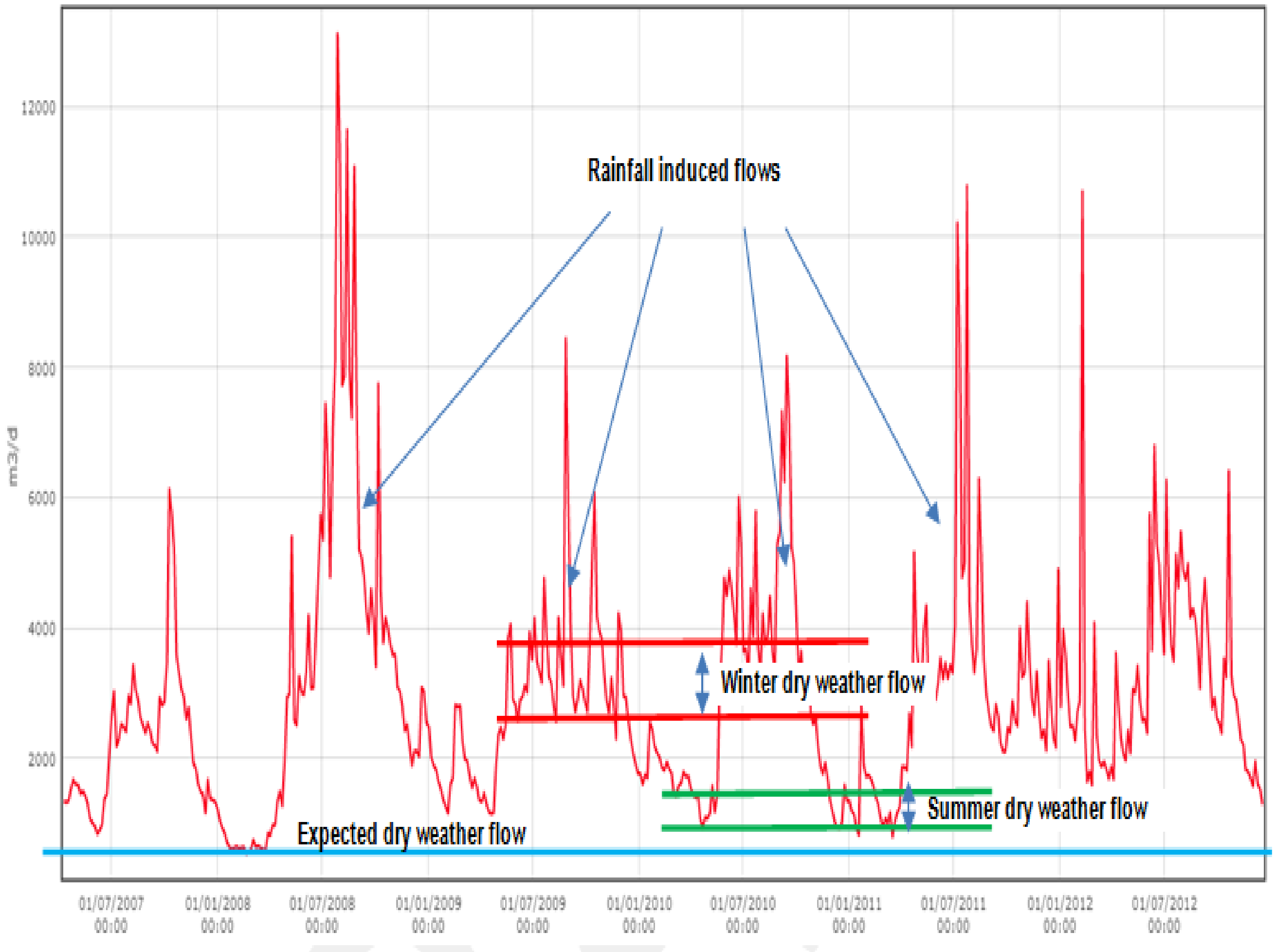

Figure 4: Historical Featherston WWTP influent data

For a population of 2340 (latest census data for Featherston) ADWF to the WWTP should be in the order of 500-600 m^3/day based on accepted per capita wastewater production rates in normal residential catchments. The data clearly shows flows well in excess of this year round with significant increases correlating with the onset of winter every year.

Indicatively, the lowest annual daily flow volume (the summer DWF) appears to be in the order of 900-1000 m^3/day which is approximately double the expected flow rate given the population. The most notable feature of the data, however, is the magnitude of the increase in DWF over winter to between 2000-2800 m^3/day (up to 1200 L/p/day). The seasonal and prolonged increase in dry weather flow i.e. not occurring as a direct result of recent rainfall, indicates a significant GWI issue. Trade waste has been ruled out as a contributor. In addition to the GWI volume, wet weather days can reach well in excess of 6,000 m^3/day (10 times expected ADWF) which is also a key consideration for WWTP design.

By its nature, GWI generally does not cause dramatic operational problems such as overflows, which are commonly associated with direct inflow, and are the traditional focus of I/I works. SWDC's current objectives however, require GWI to be at the forefront of future works due to the immediate cost for the WWTP.

3.2 NIGHT FLOW ISOLATION

The night flow isolation work was triggered as a result of GWI being shown as the primary area of concern for the design of the WWTP. The results are presented in table 3 below.

Table 3: Night flow isolation results

Rank	Study Area	Night Flow rate (m^3/km/day)	Net flow (L/s)	Pipe length (m)	Cumulative flow (L/s)	Cumulative Length (m)	Cumulative % flow	Cumulative % length
1	1	477	9.29	1682	9.29	1682	45%	7%
2	3	346	3.01	752	12.30	2434	60%	10%
3	2	144	3.18	1905	15.48	4339	75%	18%
4	4	144	1.39	837	16.87	5176	82%	21%
5	9	54	0.24	386	17.11	5562	83%	23%
6	5*	37	1.92	4501	19.03	10063	93%	42%
7	10	26	0.35	1149	19.38	11212	94%	46%
8	13	15	0.11	628	19.49	11840	95%	49%
9	6	14	0.51	3037	20.00	14877	97%	62%
10	8	14	0.12	786	20.12	15663	98%	65%
11	14	12	0.15	1052	20.27	16715	99%	69%
12	7	12	0.13	953	20.40	17668	99%	73%
13	11	3	0.06	1770	20.46	19438	100%	80%
14	17	1.6	0.02	1130	20.48	20568	100%	85%
15	16	1.2	0.03	2291	20.52	22859	100%	95%
16	15	0.8	0.01	1296	20.53	24155	100%	100%

**Due to catchment configuration and state highway access issues, study area 5 was larger than desired. It is possible that the 2543m of catchment north of Fitzherbert and Hickson St can be separated from study area 5 and given a lower priority due to showing very low I/I indicators (wet weather and GWI) in the 2004 study. For reporting purposes and calculations, study area 5 includes this lower priority area. It is worth noting the high night flow rate regardless.*

Study area 1 immediately stands out from the other areas, contributing 9.29L/s out of the total 18.75L/s of night flow measured during investigations. This catchment represents only 7% of the total network and mainly comprises of 375mm diameter concrete pipe with minimal private connections. It is the trunk main conveying flow from the town to the WWTP over farmland.

The top 5 ranked catchments overall contribute 83% of the night flow yet comprise only 23% of the total pipe length. Beyond the top 5 ranked catchments, night flow contributions become more wide spread with the remaining 17% of night flow coming from 77% of the total pipe length. Figures 5 and 6 graphically demonstrate the diminishing isolation beyond the top 5.

Figures 5 & 6 below show the distribution of night flow within the study areas using percentages and actual flow rates and pipe lengths. Results are displayed by accumulating pipe length and night flow starting from the highest ranked study areas i.e. the first point is study area 1 which contains 7% of the total pipe length and 45% of the night flow. The second ranked study area (study area 3) adds a further 3% of pipe length and takes the total located night flow to 60% and so on. The key observation is the diminishing isolation of sources beyond the top 5 areas.

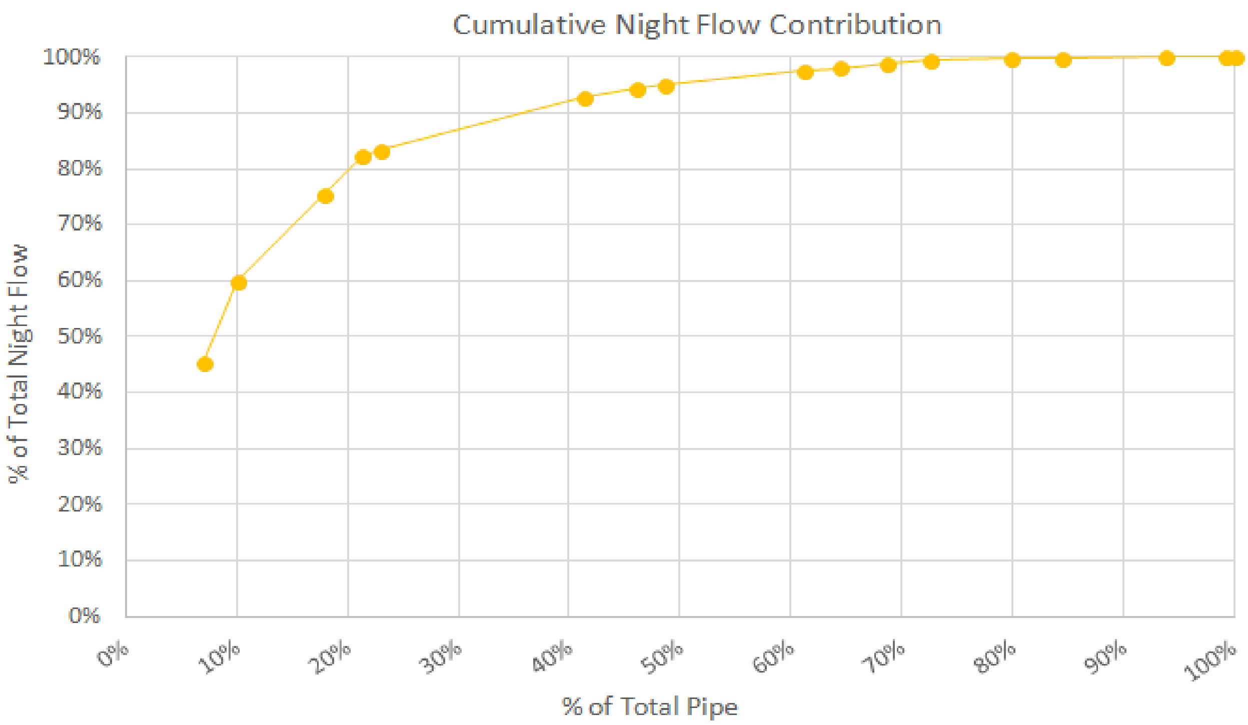

Figure 5: Cumulative night flow contributions (percentage)

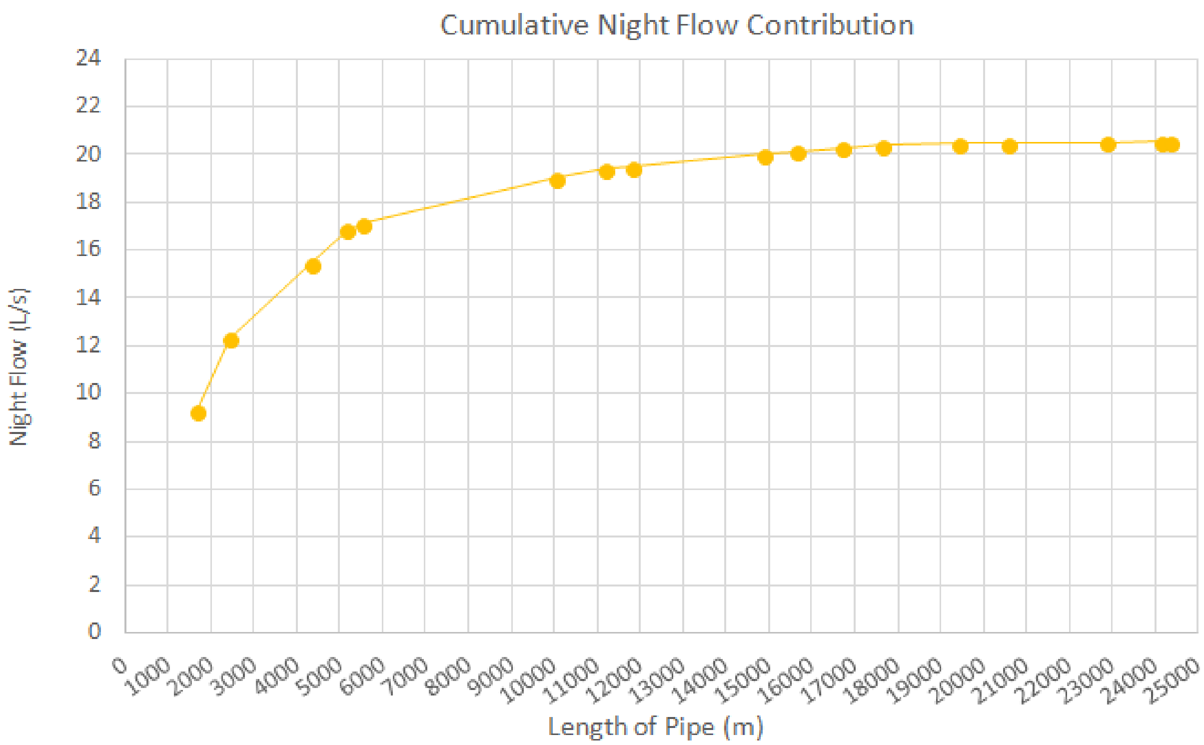

Figure 6: Cumulative night flow contributions (pipe length and flow rate)

3.3 STUDY AREA CLASSIFICATION

Each study area was classified using the method detailed in section 2.3, which relates the measured night flow rate to WWP to determine the relative severity of GWI. The following map shows the classification of each study area.

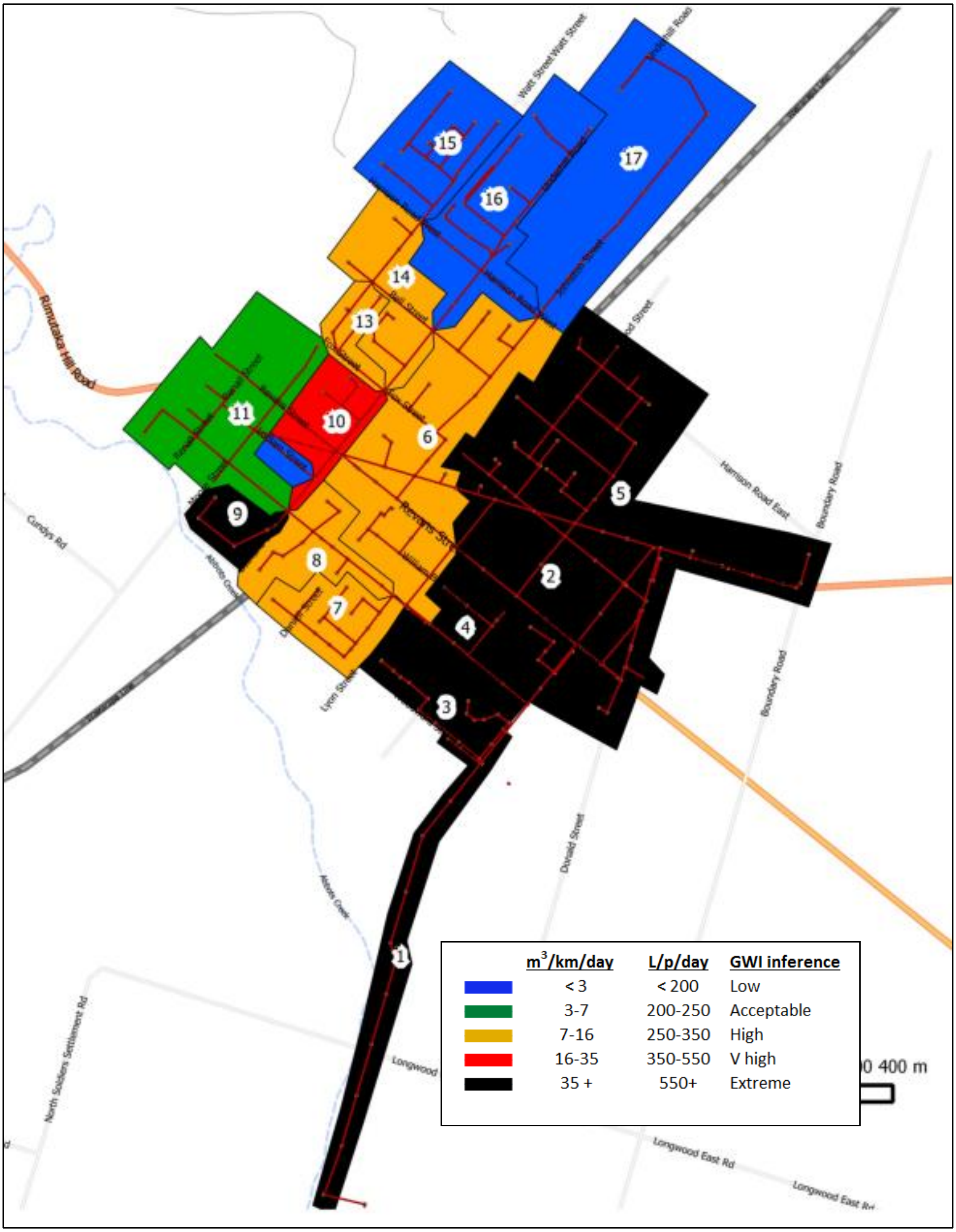

Figure 7: Classification of study areas based on night flow rate

3.4 POST REHABILITATION FLOW REDUCTIONS AND COSTS

3.4.1 Rehabilitation scenario 1: Public assets only

The table 4 below shows the estimated costs and night flow reductions assumed by undertaking rehabilitation works in each of the study areas. Table 5 uses the estimated reductions to assess the effect on ADWF in Featherston.

Table 4: Night flow reduction from relining all public mains and sealing manholes

Flow reduction estimation -Relining public mains and sealing manholes						
Study Area	Rank	Rehabilitation cost	Minimum night flow reduction (50%)		Maximum night flow reduction (60%)	
			Net night flow reduction (m3/day)	Total Featherston night flow reduction (%)	Net night flow reduction (m3/day)	Total Featherston night flow reduction (%)
1	1	$ 576,550.00	401	25%	482	30%
2	3	$ 498,750.00	137	8.5%	165	10%
3	2	$ 175,900.00	130	8.0%	156	10%
4	4	$ 220,725.00	60	3.7%	72	4.4%
5	6	$ 997,700.00	83	5.1%	100	6.1%
6	9	$ 703,150.00	22	1.3%	26	1.6%
7	12	$ 214,600.00	5.7	0.4%	6.9	0.4%
8	10	$ 175,200.00	5.2	0.3%	6.2	0.4%
9	5	$ 84,700.00	10	0.6%	13	0.8%
10	7	$ 244,800.00	15	0.9%	18	1.1%
11	13	$ 387,000.00	2.8	0.2%	3.3	0.2%
12	17	$ 47,000.00	0.0	0.0%	0.0	0.0%
13	8	$ 137,600.00	4.6	0.3%	5.5	0.3%
14	11	$ 232,500.00	6.5	0.4%	7.8	0.5%
15	16	$ 290,700.00	0.5	0.0%	0.6	0.0%
16	15	$ 497,200.00	1.4	0.1%	1.7	0.1%
17	14	$ 245,500.00	0.9	0.1%	1.0	0.1%

Table 5: Total Featherston cumulative flow reductions from relining all public mains and sealing manholes

Cumulative rehabilitation costs and resulting flow reductions - Manhole sealing and reling public mains						
Rank	Study Area	Cumulative cost	Minimum night flow reduction (50%)		Maximum night flow reduction (60%)	
			Post rehab total dry weather flow	Total dry weather flow reduction	Post rehab total dry weather flow	Total dry weather flow reduction
1	1	$ 576,550.00	1962	17%	1881	20%
2	3	$ 752,450.00	1832	22%	1725	27%
3	2	$ 1,251,200.00	1694	28%	1561	34%
4	4	$ 1,471,925.00	1634	31%	1488	37%
5	9	$ 1,556,625.00	1624	31%	1476	38%
6	5	$ 2,554,325.00	1541	35%	1376	42%
7	10	$ 2,799,125.00	1526	35%	1358	43%
8	13	$ 2,936,725.00	1521	36%	1353	43%
9	6	$ 3,639,875.00	1499	37%	1326	44%
10	8	$ 3,815,075.00	1494	37%	1320	44%
11	14	$ 4,047,575.00	1488	37%	1312	44%
12	7	$ 4,262,175.00	1482	37%	1306	45%
13	11	$ 4,649,175.00	1479	37%	1302	45%
14	17	$ 4,894,675.00	1478	37%	1301	45%
15	16	$ 5,391,875.00	1477	38%	1300	45%
16	15	$ 5,682,575.00	1476	38%	1299	45%
17	12	$ 5,729,575.00	1476	38%	1299	45%

3.4.2 Rehabilitation scenario 2: Public assets and private laterals

The table 6 below shows the estimated costs and night flow reductions assumed by undertaking rehabilitation works in each of the study areas. Table 7 uses the estimated reductions to assess the effect on ADWF in Featherston.

Table 6: Flow reduction from relining all public mains, sealing manholes and relining all laterals

Flow reduction estimation -Relining public mains, sealing manholes and relining all laterals						
Study Area	Rank	Rehabilitation cost	Minimum night flow reduction (65%)		Maximum night flow reduction (75%)	
			Net night flow reduction (m3/day)	Total Featherston night flow reduction (%)	Net night flow reduction (m3/day)	Total Featherston night flow reduction (%)
1	1	$ 755,050.00	522	32%	602	37%
2	3	$ 1,380,750.00	179	11.0%	206	13%
3	2	$ 595,900.00	169	10.4%	195	12%
4	4	$ 635,475.00	78	4.8%	90	5.6%
5	6	$ 2,730,200.00	108	6.7%	124	7.7%
6	9	$ 1,611,400.00	28	1.8%	33	2.0%
7	12	$ 713,350.00	7.5	0.5%	8.6	0.5%
8	10	$ 516,450.00	6.7	0.4%	7.8	0.5%
9	5	$ 257,950.00	14	0.8%	16	1.0%
10	7	$ 538,800.00	19.7	1.2%	22.7	1.4%
11	13	$ 1,227,000.00	3.6	0.2%	4.1	0.3%
12	17	$ 73,250.00	0.0	0.0%	0.0	0.0%
13	8	$ 405,350.00	6.0	0.4%	6.9	0.4%
14	11	$ 684,000.00	8.4	0.5%	9.7	0.6%
15	16	$ 778,950.00	0.6	0.0%	0.7	0.0%
16	15	$ 1,037,950.00	1.8	0.1%	2.1	0.1%
17	14	$ 355,750.00	1.1	0.1%	1.3	0.1%

Table 7: Total Featherston cumulative flow reductions from relining all public mains, sealing manholes and relining all laterals

Cumulative rehabilitation costs and resulting flow reductions - Manhole sealing, reling public mains and relining laterals						
Rank	Study Area	Cumulative cost	Minimum night flow reduction (65%)		Maximum night flow reduction (75%)	
			Post rehab total dry weather flow	Total dry weather flow reduction	Post rehab total dry weather flow	Total dry weather flow reduction
1	1	$ 755,050.00	1841	22%	1761	25%
2	3	$ 1,350,950.00	1672	29%	1566	34%
3	2	$ 2,731,700.00	1494	37%	1360	42%
4	4	$ 3,367,175.00	1416	40%	1270	46%
5	9	$ 3,625,125.00	1402	41%	1254	47%
6	5	$ 6,355,325.00	1294	45%	1130	52%
7	10	$ 6,894,125.00	1274	46%	1107	53%
8	13	$ 7,299,475.00	1268	46%	1100	53%
9	6	$ 8,910,875.00	1240	48%	1067	55%
10	8	$ 9,427,325.00	1233	48%	1059	55%
11	14	$ 10,111,325.00	1225	48%	1050	56%
12	7	$ 10,824,675.00	1217	48%	1041	56%
13	11	$ 12,051,675.00	1214	49%	1037	56%
14	17	$ 12,407,425.00	1213	49%	1036	56%
15	16	$ 13,445,375.00	1211	49%	1034	56%
16	15	$ 14,224,325.00	1210	49%	1033	56%
17	12	$ 14,297,575.00	1210	49%	1033	56%

3.4.3 Rehabilitation cost and flow reduction summary

The graphs in this section summarise the cost of the rehabilitation scenarios as they are applied to an increasing number of areas. The achieved reductions are presented in terms of the percentage ADWF reduction and the actual post rehabilitation ADWF.

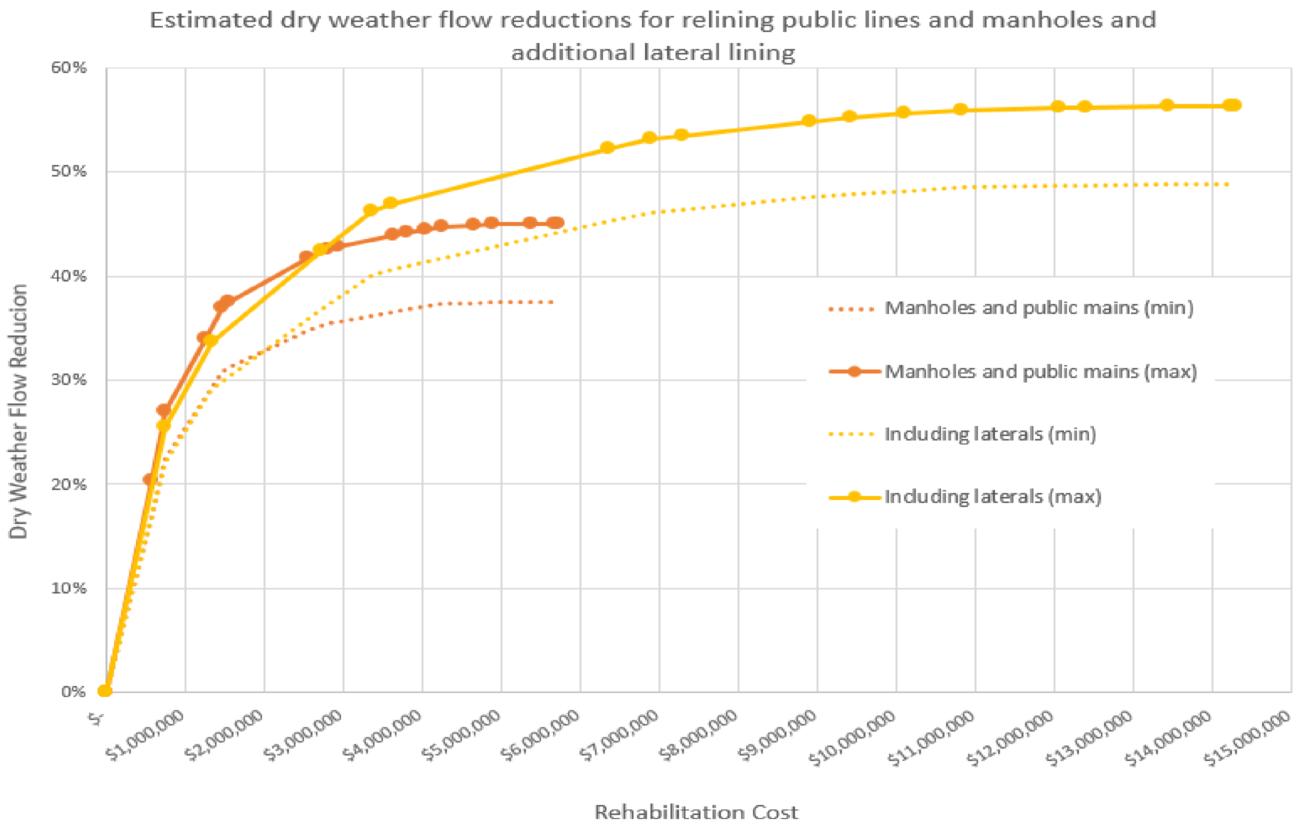

Figure 8: Cumulative costs and % average dry weather flow reductions

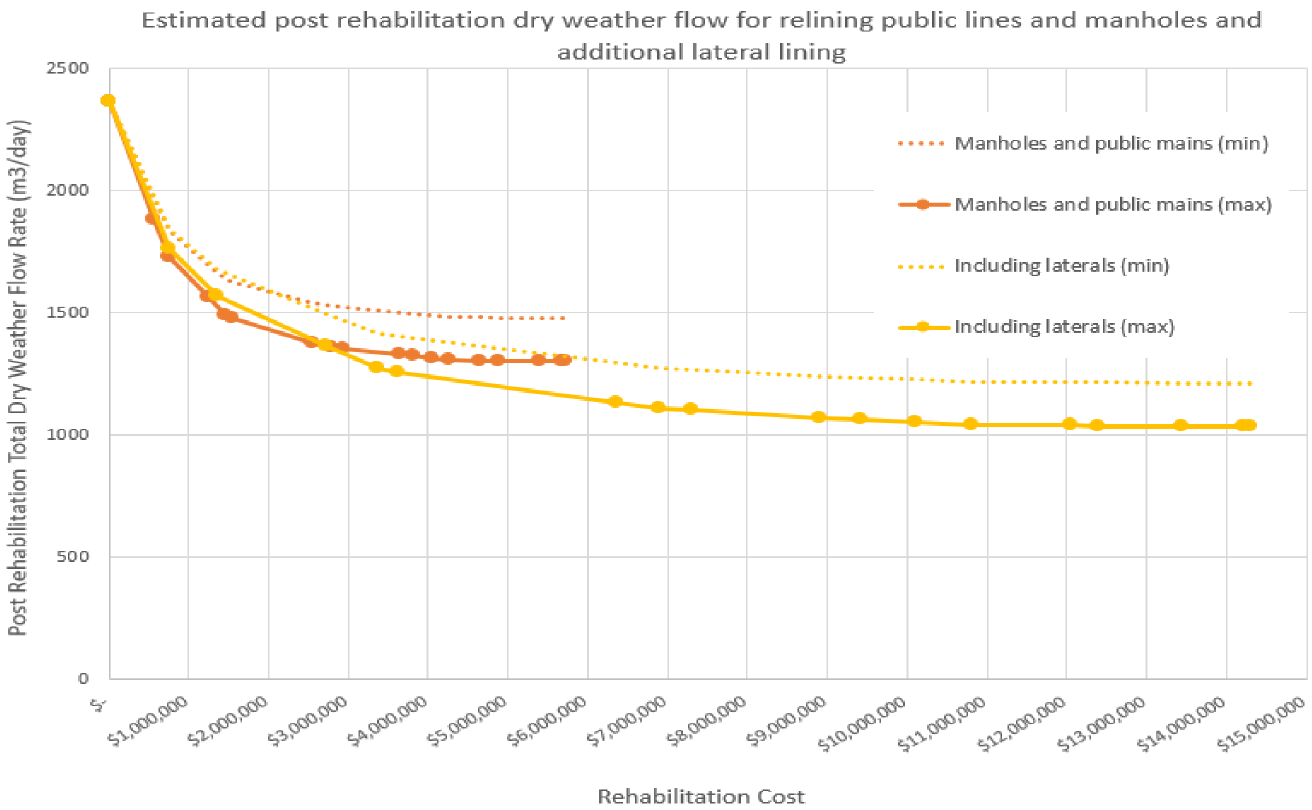

Figure 9: Cumulative costs and post rehabilitation average dry weather flow

3.5 COST SENSITIVITY OF I/I REDUCTION ON WWTP CAPITAL COST

By summing the total capital costs of high rate treatment and land based treatment and disposal schemes with varying levels of ADWF reduction, the optimum balance between I/I rehabilitation and capital infrastructure costs was found. The results are presented in the following graphs.

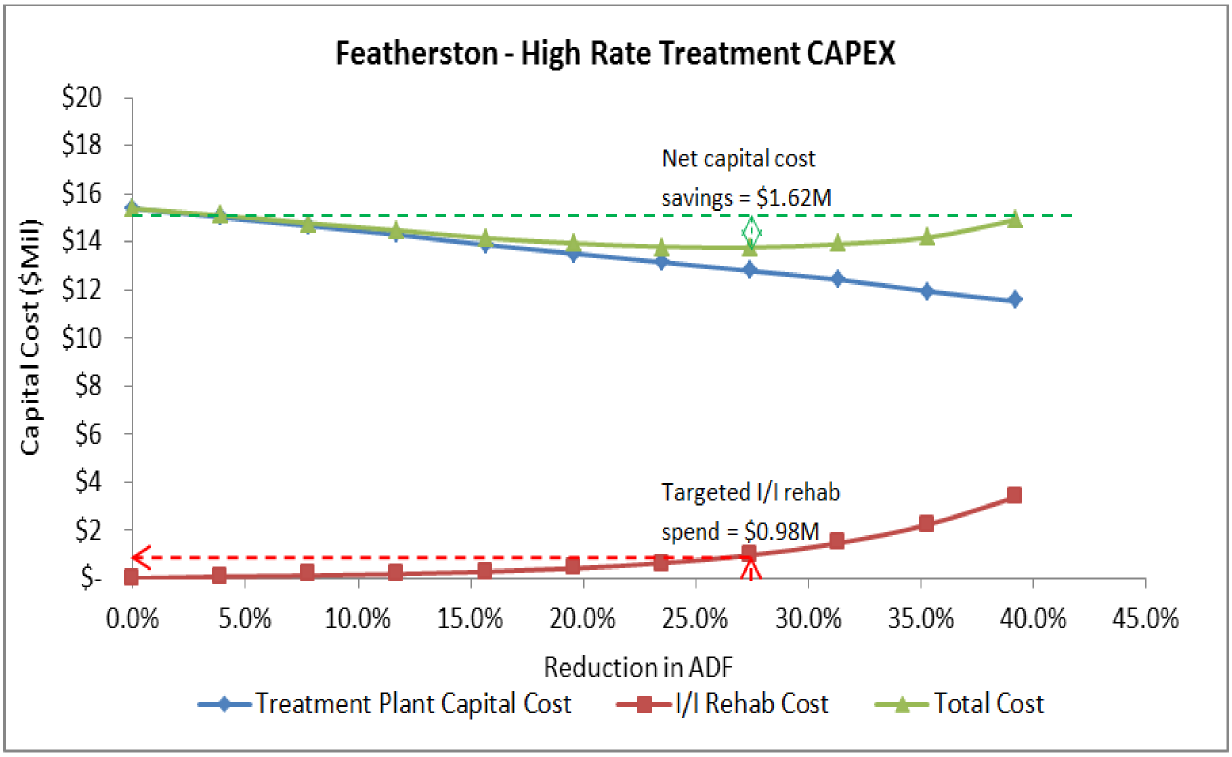

Figure 10: High rate WWTP and I/I rehabilitation total project capital costs

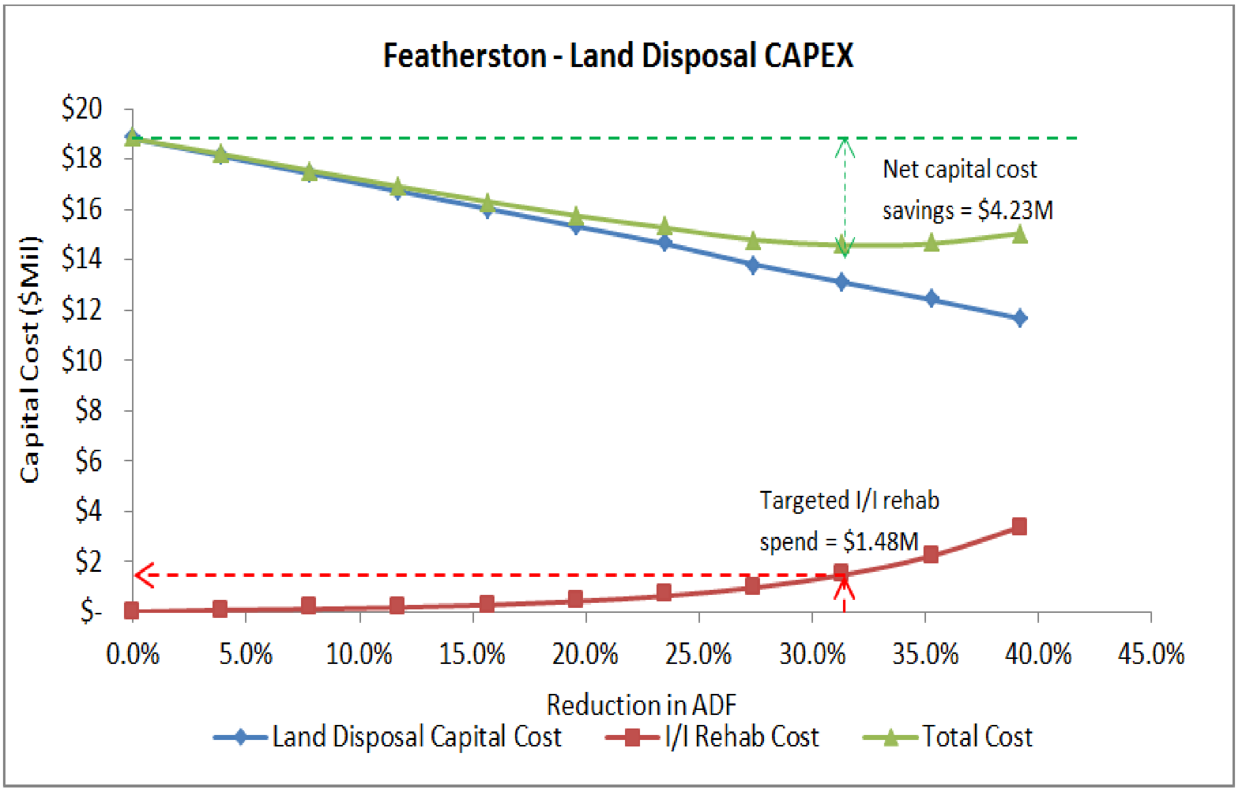

Figure 11: Land disposal and I/I rehabilitation total project capital costs

For a high rate treatment plant, the maximum net capital cost savings occurred with an ADWF reduction of 27.5%. Under this scenario $0.98M would be spent on I/I rehabilitation which would reduce the WWTP cost from $15.4M to $12.8M, a net saving of $1.62M including the cost of rehabilitation. This reduction could be achieved by rehabilitation in the top 3 study areas if public mains only were addressed or the top 1-2 study areas if private laterals were also included.

For a land based treatment and disposal scheme, the maximum net capital cost savings occurred with an ADWF reduction of 31.4%. Under this scenario $1.48M would be spent on I/I rehabilitation which would reduce the land based treatment and disposal cost from $18.8M to $13.09M, a net saving of $4.23M including the cost of rehabilitation. This reduction could be achieved by rehabilitation in the top 4 study areas if public mains only were addressed or the top 2-3 study areas if private laterals were also included.

4 CONCLUSION

The I/I sensitivity analysis and costing tool, in conjunction with the catchment-specific night flow isolation study, has provided SWDC with a robust tool for analysing the effect of I/I rehabilitation works on WWTP upgrade options. The study has shown that for a 'leaky' network prone to I/I issues, reducing infiltration and inflow could be an effective means of optimising the cost of a future high rate treatment plant or land based treatment and disposal scheme.

It is important to note that under both treatment options going beyond the optimal point will continue to reduce the land and treatment unit requirements and hence the costs of the treatment schemes. Achieving these reductions however, will cause the total project capital cost to increase. This is due to the fact that beyond the optimal point, the extent of rehabilitation required and hence cost, outweighs the savings it achieves for treatment. The minimum recommendation is to aim for this optimal level of reduction however, the decision to go beyond this point should be based on holistic network considerations rather than treatment cost alone. One of the key considerations should be reducing I/I to improve wet weather containment and level of service within the network. Additionally, network rehabilitation and replacement needs to continue as a long term asset management strategy to proactively mitigate the adverse effects of network deterioration.

In the short term, this study's findings have been used to design a targeted I/I rehabilitation works programme for Featherston, which will be carried out over the next five to ten years. During this time, influent flow monitoring at the WWTP will be undertaken to track the effectiveness of the I/I works on reducing the total flow into the WWTP, and the flow monitoring data post-rehabilitation will be used in the design of a future t upgrade.