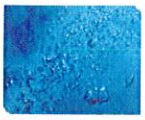
Robin Murray

martens consulting engineers

Concept Sewer Servicing Plan Options, 'Peacocks Land', Hamilton

ENVIRONMENTAL

WATER



WASTEWATER

GEOTECHNICAL

CIVIL

PROJECT MANAGEMENT

P0501285JR01_v1
July 2006

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All enquiries regarding this project are to be directed to the Project Manager.

Contents

1 Overview

1.1 Background

The purpose of this advice is to present servicing options for the sewage treatment and reclaimed water re-use for land known as 'Peakcocks Land' to the south of Hamilton. We note that the servicing options presented do not represent detailed infrastructure design, but rather are intended to assist in the decision making process.

Peacockes has been part of the city since 1989 and obstructed from any development due to the expected high costs of sewage and roading proposed by Hamilton City Council.

Since March 2006 Hamilton City Council has proposed funding of $10M for 500 homes at a cost of $20,000 per house lot.

1.2 Study Objectives

The study has the following objectives:

- To provide sewer servicing options which include the provision of one or more local sewage treatment plants (STPs) within the study area.
- To provide sewer servicing options which provide for non-potable reclaimed water for the Peacocks Land.
- The servicing options should be developed within the context of ecologically sustainable development (ESD) principles.

2 Site Description

2.1 Field Investigations

Dr Daniel Martens, principal engineer at Martens & Associates, undertook a preliminary site inspection on 3rd March 2006. Works conducted during the field inspection included:

- Review of local site topography, hydrology and geology.
- Assessment of possible infrastructure locations (ie. STPs and reclaimed water header tanks).

2.2 Location and Existing Land-use

Currently the site presents a mixture if rural and rural-residential land uses. Surrounding the site to the north (beyond the Waikato River) and west is the urban fringe of Hamilton City.

The site is located approximately 5 km south of Hamilton City CBD. Figure 1 shows the site within the context of surrounding areas.

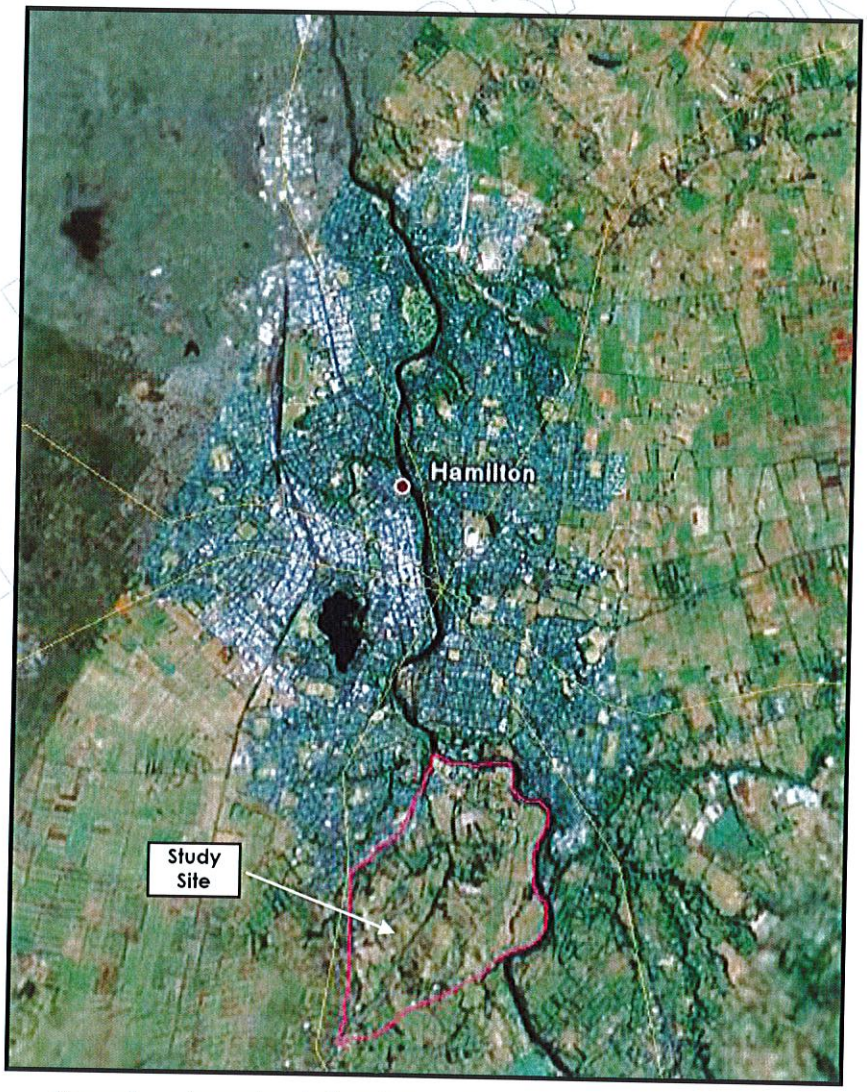


Figure 1: Approximate location of site in relation to Hamilton City.

3 Sewage Generation and Non-potable Water Demand

3.1 Data Sources

Data used to determine wastewater generation rates and non-potable water demand were obtained from the Hamilton City Council's (HCC) Development Manual (2004) and figures obtained from liaisons with HCC staff (Kathy Tao 30 June 2006).

3.2 Population Estimation Methods

On the basis of our discussions with HCC staff, an average dwelling in Hamilton contains 2.7 people (i.e. 2.7 EP). HCC (2004) recommend design population densities of 45 EP/ha in the absence of specific supportable design data and where average allotment size is of the order of 600 m^2.

3.3 Sewer Catchments

The Peacockes development covers an area of approximately 631 ha. We understand from Mr Murray that HCC have indicated that site may support between 7500 and 8000 homes and hence a population of between 20,000 and 22,000 (@ 2.7 EP/residence).

In order to undertake an assessment of the sewer servicing requirements, the site has been separated into 9 (nine) 'sewer' catchments on the basis of topography, site boundaries, existing waterways and the Waikato River (Attachment A). In order that available land for residential development could be estimated, total catchment areas are reduced by 10 % to accommodated roads and other services in each catchment.

For the purposes of this preliminary exercise, we have assumed that all wastewater generated by the development will be of a 'domestic' grade. This assumption will be subject to change in accordance with any more detailed future development proposals.

3.4 Demand for Water Resources

This concept sewer servicing plan recognises that Hamilton is presently highly dependent on the Waikato River for its water supply and that any substantial development within the Peacocks Land area will place considerable additional pressure on the existing water supply network. We understand that with a current population of 131,400 (NZ Statistics 2005) and an ever increasing population, Hamilton faces a number of planning issues with respect to meeting ever increase demand and the costs of water treatment.

Documenting some aspects of the water supply dilemma, a recent paper by Ruth *et al.* (2006) underlines the following relevant matters concerning HCC's water supply:

- Water demand is largely driven by changes in population, and not significantly affected by changes in climate.
- It is possible that HCC may face water-consent restrictions in the future as competition for water use from the Waikato River increases.
- HCC operates a single water treatment facility with a capacity of 85 ML per day. Water is drawn from the Waikato River, filtered and treated for drinking, and stored in one of eight water-storage facilities in the city with a total capacity of 90.2ML.
- Water consumption generally ranges from 10 KL/EP/month (winter) to 16 KL/EP/month (summer). Further to this we note that at present, urban water demand in Hamilton is on average is 268 L/EP/d (Tao 2006) which increase to 700 litres per person on a peak summer day.
- HCC is currently considering expanding the water treatment facility to be able to handle 100ML per day.

Further to the above, water demand can be separated into a range of categories which rely on either potable or non-potable resources. Such an approach has been undertaken for a number of large land release areas in the Sydney (Australia) region in order to determine suitable supply sources. Demand is broken up into the following categories (Tao 2006):

- Garden 35% - non-potable (higher in summer months)
- Toilet 20% - non-potable
- Laundry 15% - non-potable
- Bathroom 25% - potable
- Kitchen 5% - potable

Wastewater generation therefore represents approximately 65 % of the total supply demand. Non-potable water demand is slightly higher at 70% (garden, toilets and laundry).

4 Servicing Options

4.1 Preamble

Three (3) sewer servicing options are presented. Each option involves a treatment plant(s) capable of producing effluent of a sufficiently high quality for use as a domestic non-potable water supply and a reticulation system for non-potable water involving header tanks (storage) and delivery mains. We note that the servicing options do not represent detailed infrastructure design, but rather are intended to assist in the decision making process.

4.2 Option 1 – Individual STPs for Each Sewer Catchment

Option 1 proposes that each of the 9 (nine) catchments maintains its own STP and associated pump stations (where necessary) serving only that catchment area and population (Attachment A-Sheet 1). This will allow individual catchment areas to be developed with little dependence on other site infrastructure (except the reclaimed water supply system).

There are 4 (four) centrally located header tanks for non-potable water storage. The location of each tank is dependent on the local topography with the tanks being located on the highest point throughout the site. Each of these tanks are to receive non-potable water by individual STP's and have an average size of 1.05 ML (24 hours storage of non-potable water demand). All four tanks are positioned to gravity feed non-potable water throughout the site.

Tables 2 and 3 (Attachment B) provide wastewater generation and water demand rates for the individual catchments using both population estimate methods. Table 4 summarises estimation methods.

4.3 Option 2 – One STP for all Sewer Catchments

Option 2 consists of a single STP for the entire site located in Catchment C1 (Attachment A-Sheet 2). The sewage system would consist of major pump stations in each catchment and minor pump stations where needed. All sewage would be pumped to the single STP for treatment and the reclaimed water distribution. This option allows for all development areas to be connected to the single STP site location. It is likely the STP will have to be constructed in stages to ensure that treatment reactor volumes are adequate for the volume of influent sewage.

The 4 (four) centrally located header tanks for non-potable water storage will remain as in Option 1. Each of these tanks will receive non-potable water by the single STP located in catchment C1 and have an average operating volume of 1.05 ML. All four reclaimed water header tanks have been positioned to gravity feed non-potable water throughout the site.

Tables 5 and 6 (Attachment B) show the wastewater generation rates and water demand for the all the catchments (entire site) using both population estimate methods. Table 7 summarises estimation methods.

4.4 Option 3 – Two STPs for Sewer Catchments

Option 3 consists of a two STP's for the entire site. The sewage system would consist of major pump stations in each catchment and minor pump stations where needed. The site would be broken up into 2 areas. Catchments C1, C2, C3 and C4 would have sewage treated at the STP in C1. Catchments C5, C6, C7, C8 and C9 would have sewage treated at the STP in C8. This option would enable the STP costs to be further staged beyond that proposed in Option 2.

The 4 (four) centrally located header tanks for non-potable water storage will remain as in Option 1 and 2. Header tank 4 (H4) and Header tank 3 (H3) are to receive non-potable water from the single STP located in catchment C1 and have an average size of 1.05 ML (24 hours storage of non-potable water demand). Header tank 2 (H2) and Header tank 1 (H1) are to receive non-potable water from the single STP located in catchment C8 and have an average size of 1.05 ML (24 hours storage of non-potable water demand). All four tanks are positioned to gravity feed non-potable water throughout the site.

Tables 8 and 9 (Attachment B) show the wastewater generation rates and water demand for the all the catchments (entire site) using both population estimate methods. Table 10 summarises estimation methods.

4.5 Summary

The following summary comments are provided:

- All sewer servicing options are independent of existing HCC sewage infrastructure and therefore will not place additional pressure on existing network and infrastructure.
- Approximate potential development area of site is 529 ha. This excludes water courses, some lands adjacent to water courses and includes a nominal allowance for road infrastructure.
- Approximate number of sections (@ 700m²/section) is 7555.

- Amount of wastewater generated per sewer catchment is dependent on size of catchment.

- Wastewater generation from the site will be of the order of 3.9 ML/day, with a design ADWF of 4.4 ML/d.

- Should a single STP be chosen (option 2), then total STP reactor volume will be approximately 8.8 ML. The reactor footprint will be approximately 2,200 m^2 (which we would suggest be built in at least 4 or more staged 'cells' depending on the ultimate staging of land release areas), and we would expect the total area required for the STP and other treatment system items (under option 2) to be approximately 6000 m^2. These areas can be scaled accordingly depending on sewer catchment area serviced.

- All water demand figures were calculated using an average of 270L per person per day.

- Approximate average water demand for the total site is 6.0 ML/d.

- Approximate potential demand for reclaimed water (non-potable) for the total site is 4.2 ML/day.

- Minimum storage volume needed for non-potable water is 4.2 ML. Average size of each header tank therefore would be a minimum 1.05ML.

Table 1 below summarises the principle advantages and disadvantages of each of the sewer servicing options.

Table 1: Advantages and Disadvantages of Wastewater Management Options

Wastewater Management	Advantages	Disadvantages
Option 1 Individual Sewage Treatment Plants	o Highly staged sewer servicing strategy Implementation possible o Potential for upfront cost savings o Fewer major sewer pump stations required o More distributed site development possible	o Increased STP maintenance requirements o High ongoing scheme operating and maintenance costs o High number of staff required to operate facilities o Regular maintenance by full time STP operator for each catchment o Large dedicated land area required in each catchment o STP aesthetically unpleasing (x9) o Lack of central control on non-potable water quality and distribution o Multiple risks of mechanical and process failure o More non-potable water pump stations and distribution lines required
Option 2 Single Sewage Treatment Plant	o Centralised maintenance, operation and monitoring o Central treatment of waste stream for entire site o Single environmental impact assessment required to establish STP o Central distribution of non-potable water o Potential for land savings o Reduced staffing and labour costs	o Increased pump-station requirements o Higher up-front capital outlay for STP
Option 3 Two Sewage Treatment Plants	o Staged Implementation possible o Two environmental impact assessments required to establish STPs o Reduced distribution requirements for non-potable water supply o Potential for land savings o Reduced staffing and labour costs	o Increased pump-station requirements o Higher up-front capital outlay for STP o Lack of centralised STP management o Lack of centralised reclaimed water distribution

4.6 Recommendations

The following recommendations are made based on this preliminary assessment:

1. Option 2 is the preferred sewer servicing strategy because it provides a centralised water processing facility, good access to the river and transport whilst providing sufficient flat and suitable land to allow for staged STP reactor 'cell' development.

2. That a preliminary cost analysis be undertaken for option 2.

3. That a preliminary STP and associated infrastructure (eg. holding tanks, pump-sets, servicing road etc) layout plan be prepared for option 2. This would provide a useful planning tool to assist with planning the development of the site.

4. That a preliminary environmental impact evaluation be undertaken for option 2 to determine key constraints to the construction of the STP at the nominated location.

5. Easier potential for income and savings through non-potable water as all treatment and distribution is from the one site.

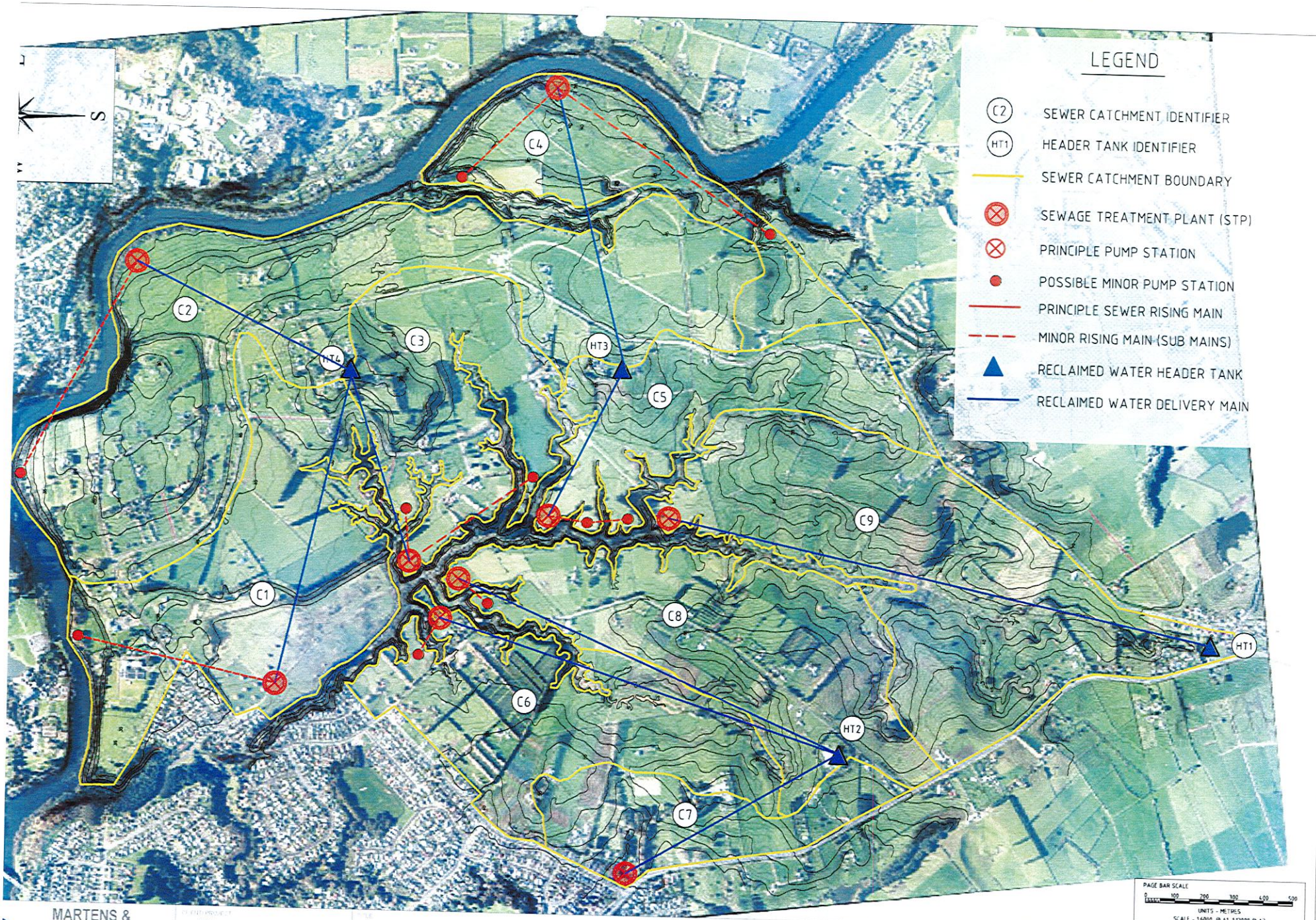
5 References

Hamilton City Council (2004) *Development Manual*

Ruth M, Bernier C, Jollands N, and Golubiewski M, (2006) *Adoption of urban Water Supply Infrastructure to Impacts from Climate and Socioeconomic Changes: The case of Hamilton, New Zealand.*

Statistics New Zealand (2006) Available at www.stats.govt.nz

6 Attachment A – Servicing Options



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CLIENT/ PROJECT
ROBIN MURRAY
CONCEPTSEWER SERVICE OPTIONS
'PEACOCKS LAND' HAMILTON

OPTION 1 -SEWER CATCHMENTS AND RECLAIMED WATER RETICULATION

PROJECT MANAGER: DR DANIEL MARTENS
DRAWING NUMBER: P050128SJD01_VS

DESIGNED: GT	DATUM: DATUM	SHEET: 1	REV: 10	DESCRIPTION: OPTION ANALYSIS - SEWER AND WATER RECLAIMATION RETICULATION	DATE: 18.07.2006	ISSUED: DDM
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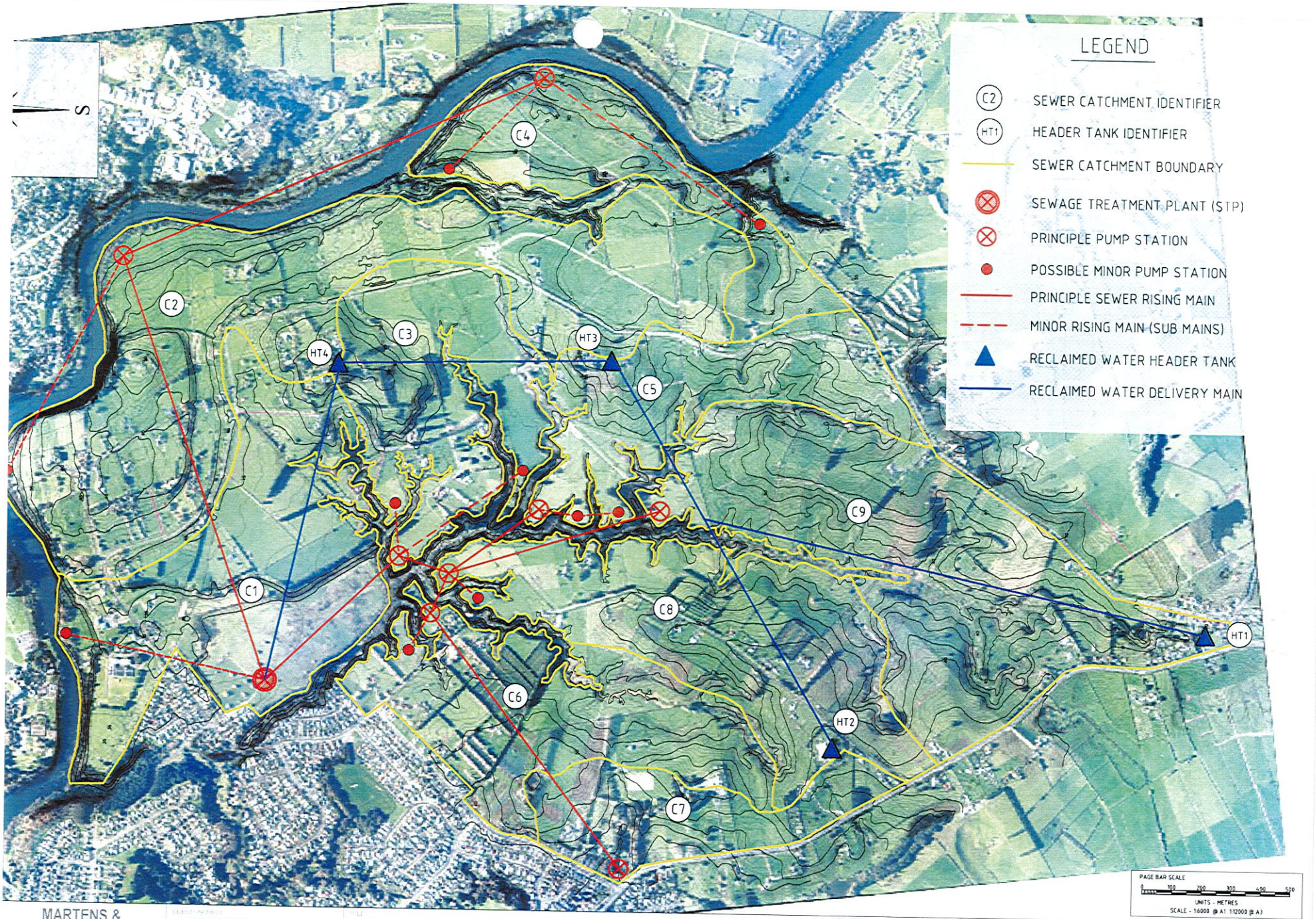
REVIEWED: DDM	VERTICAL DATUM: 1:6000 @ A1 1:12000 @ A3	PAPER SIZE: A1 / A3				



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CLIENT/PROJECT: ROBIN MURRAY
CONCEPTSEWER SERVICE OPTIONS
'PEACOCKS LAND' HAMILTON

TITLE: OPTION 2 -SEWER CATCHMENTS AND RECLAIMED WATER RETICULATION

PROJECT MANAGER: DR DANIEL MARTENS

DRAWING NUMBER: P0501285JD01_V5

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DRAWN	GT
REVIEWED	DDM
DATUM	DATUM
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VERTICAL RATIO	1:6000 @ A1 1:12000 @ A3
SHEET	2 OF 3 SHEETS
PAPER SIZE	A1 / A3

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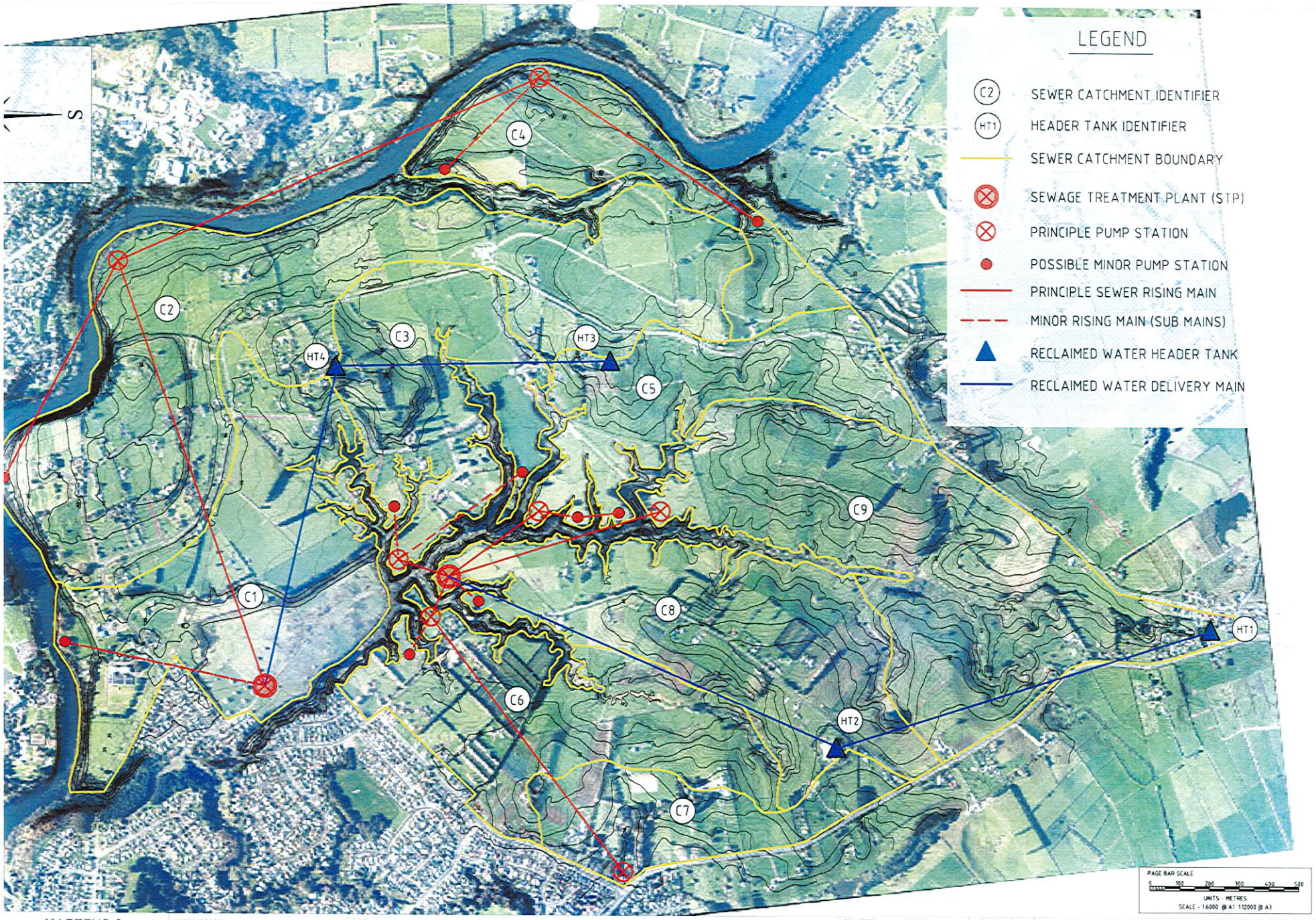

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CLIENT'S REFERENCE
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CONCEPTSEWER SERVICE OPTIONS
'PEACOCKS LAND' HAMILTON

TITLE
OPTION 3 -SEWER CATCHMENT AND RECLAIMED WATER RETICULATION

PROJECT MANAGER
DR DANIEL MARTENS

DRAWING NUMBER
P0501285JD01_V5

DESIGNED	GT
DRAWN	GT
REVISED	DDM
DATUM	DATUM
HORIZONTAL SCALE	1:6000 @ A1 1:12000 @ A3
VERTICAL RATIO	1:6000 @ A1 1:12000 @ A3
SHEET	3
OF	3 SHEETS
PAPER SIZE	A1 / A3

REV	DESCRIPTION	DATE	ISSUED
1.0	OPTION ANALYSIS - SEWER AND WATER RECLAIMATION RETICULATION	18.07.2006	DDM

7 Attachment B – Tables and Calculations

Table 2: Option 1 wastewater generation rates.

Catchment	Total Area (ha)	Available Area (ha less 10% Roads)	Section Yield (@ 700m^2)	EP (@ 2.7 EP/Section)	Wastewater Generation Rates (@ 2.7 EP/Section - KL/day)			EP (@45 EP/ ha)	Wastewater Generation Rates (@ 45 EP/ha -KL/day)		
					ADWF	PDWF	PWWF		ADWF	PDWF	PWWF
C1	78.4	70.5	1007	2720	54	157	187	3173	63	181	196
C2	130.2	117.2	1674	4519	90	261	310	5272	105	301	325
C3	48.4	43.5	622	1679	34	97	115	1959	39	112	121
C4	39.4	35.5	507	1369	27	79	94	1597	32	91	98
C5	42.5	38.2	546	1474	29	85	101	1719	34	98	106
C6	56.0	50.4	720	1944	39	112	133	2268	45	129	140
C7	29.0	26.1	372	1006	20	58	69	1173	23	67	72
C8	67.6	60.8	869	2345	47	136	161	2736	55	156	169
C9	96.3	86.7	1238	3344	67	193	229	3901	78	222	241

Table 3: Option 1 water supply demand rates.

Catchment	Available Area (ha less 10% Roads)	Average Water Usage L/EP/Day	EP (@ 2.7 EP/Section)	Total Water Demand (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)	EP (@45 EP/ ha)	Total Water Demand (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)
C1	70.5	270	2720	73	48	51	3173	86	56	60
C2	117.2	270	4519	122	79	85	5272	142	93	100
C3	43.5	270	1679	45	29	32	1959	53	34	37
C4	35.5	270	1369	37	24	26	1597	43	28	30
C5	38.2	270	1474	40	26	28	1719	46	30	32
C6	50.4	270	1944	52	34	37	2268	61	40	43
C7	26.1	270	1006	27	18	19	1173	32	21	22
C8	60.8	270	2345	63	41	44	2736	74	48	52
C9	86.7	270	3344	90	59	63	3901	105	68	74

Table 4: Option 1 average wastewater generation and water supply demand rates.

Catchment	Available Area (ha less 10% Roads)	Average Wastewater Generation Rates (KL/day)			Total Water Usage (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)
		ADWF	PDWF	PWWF			
C1	70.5	59	169	191	80	52	56
C2	117.2	98	281	318	132	86	93
C3	43.5	36	104	118	49	32	34
C4	35.5	30	85	96	40	26	28
C5	38.2	32	92	104	43	28	30
C6	50.4	42	121	137	57	37	40
C7	26.1	22	63	71	29	19	21
C8	60.8	51	146	165	69	45	48
C9	86.7	72	208	235	98	64	68

Table 5: Option 2 wastewater generation rates.

Catchment	Total Area (ha)	Available Area (ha less 10% Roads)	Section Yield (@ 700m^2)	EP (@ 2.7 EP/Section)	Wastewater Generation Rates (@ 2.7 EP/Section - KL/day)			EP (@45 EP/ ha)	Wastewater Generation Rates (@ 45 EP/ha -KL/day)		
					ADWF	PDWF	PWWF		ADWF	PDWF	PWWF
C1-C9	587.6	528.9	7555	20399	408	1180	1400	23799	476	1357	1468
TOTAL (ML)					**4.1**	**11.8**	**14.0**		**4.8**	**13.6**	**14.7**

Table 6: Option 2 water supply demand rates.

Catchment	Available Area (ha less 10% Roads)	Average Water Usage L/EP/Day	EP (@ 2.7 EP/Section)	Total Water Demand (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)	EP (@45 EP/ ha)	Total Water Demand (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)
C1-C9	528.9	270	20399	551	358	386	23799	643	418	450
TOTAL (ML)				**5.5**	**3.6**	**3.9**		**6.4**	**4.2**	**4.5**

Table 7: Option 2 average wastewater generation and water supply demand rates.

Catchment	Available Area (ha less 10% Roads)	Average Wastewater Generation Rates (KL/day)			Total Water Usage (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)
		ADWF	PDWF	PWWF			
C1-C9	528.9	442	1268	1434	597	388	418
TOTAL (ML)		**4.4**	**12.7**	**14.3**	**6.0**	**3.9**	**4.2**

Table 8: Option 3 wastewater generation rates.

Catchment	Total Area (ha)	Available Area (ha less 10% Roads)	Section Yield (@ 700m^2)	EP (@ 2.7 EP/Section)	Wastewater Generation Rates (@ 2.7 EP/Section - KL/day)			EP (@45 EP/ ha)	Wastewater Generation Rates (@ 45 EP/ha -KL/day)		
					ADWF	PDWF	PWWF		ADWF	PDWF	PWWF
C1	78.4	70.5	1007	2720	54	157	187	3173	63	181	196
C2	130.2	117.2	1674	4519	90	261	310	5272	105	301	325
C3	48.4	43.5	622	1679	34	97	115	1959	39	112	121
C4	39.4	35.5	507	1369	27	79	94	1597	32	91	98
TOTAL	**296.4**	**266.7**	**3810**	**10287**	**205**	**594**	**706**	**12001**	**239**	**685**	**740**
TOTAL (ML)					**2.1**	**6.0**	**7.1**		**2.4**	**6.8**	**7.4**
C5	42.5	38.2	546	1474	29	85	101	1719	34	98	106
C6	56.0	50.4	720	1944	39	112	133	2268	45	129	140
C7	29.0	26.1	372	1006	20	58	69	1173	23	67	72
C8	67.6	60.8	869	2345	47	136	161	2736	55	156	169
C9	96.3	86.7	1238	3344	67	193	229	3901	78	222	241
TOTAL	**291.4**	**291.4**	**291.4**	**291.4**	**291.4**	**291.4**	**291.4**	**291.4**	**291.4**	**291.4**	**291.4**
TOTAL (ML)					**2.0**	**5.8**	**7.0**		**2.4**	**6.7**	**7.3**

Table 9: Option 3 water supply demand rates.

Catchment	Available Area (ha less 10% Roads)	Average Water Usage L/EP/Day	EP (@ 2.7 EP/Section)	Total Water Demand (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)	EP (@45 EP/ ha)	Total Water Demand (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)
C1	70.5	270	2720	73	48	51	3173	86	56	60
C2	117.2	270	4519	122	79	85	5272	142	93	100
C3	43.5	270	1679	45	29	32	1959	53	34	37
C4	35.5	270	1369	37	24	26	1597	43	28	30
TOTAL			**10287**	**277**	**180**	**194**	**12001**	**324**	**211**	**227**
TOTAL (ML)				**2.8**	**1.8**	**1.9**		**3.2**	**2.1**	**2.3**
C5	38.2	270	1474	40	26	28	1719	46	30	32
C6	50.4	270	1944	52	34	37	2268	61	40	43
C7	26.1	270	1006	27	18	19	1173	32	21	22
C8	60.8	270	2345	63	41	44	2736	74	48	52
C9	86.7	270	3344	90	59	63	3901	105	68	74
TOTAL			**10113**	**272**	**178**	**191**	**11797**	**318**	**207**	**223**
TOTAL (ML)				**2.7**	**1.8**	**1.9**		**3.2**	**2.1**	**2.2**

Table 10: Option 3 average wastewater generation and water supply demand rates.

Catchment	Available Area (ha less 10% Roads)	Average Wastewater Generation Rates (KL/day)			Total Water Usage (KL/d)	Wastewater Generated (KL/d)	Reclaimed Water Demand (KL/d)
		ADWF	PDWF	PWWF			
C1	70.5	59	169	191	80	52	56
C2	117.2	98	281	318	132	86	93
C3	43.5	36	104	118	49	32	34
C4	35.5	30	85	96	40	26	28
TOTAL		**223**	**639**	**723**	**301**	**196**	**211**
TOTAL (ML)		**2.2**	**6.4**	**7.2**	**3.0**	**2.0**	**2.1**
C5	38.2	32	92	104	43	28	30
C6	50.4	42	121	137	57	37	40
C7	26.1	22	63	71	29	19	21
C8	60.8	51	146	165	69	45	48
C9	86.7	72	208	235	98	64	68
TOTAL		**219**	**630**	**712**	**296**	**192**	**207**
TOTAL (ML)		**2.2**	**6.3**	**7.1**	**3.0**	**1.9**	**2.1**