WATER AND WASTEWATER PLANNING STUDIES - 2030

WASTEWATER FINAL REPORT

Prepared for:

GLADSTONE CITY COUNCIL
Civic Centre
101 Goondoon Street
Gladstone Qld 4680

Prepared by:

Kellogg Brown & Root Pty Ltd
ABN 91 007 660 317
555 Coronation Drive, TOOWONG QLD 4066
Telephone 07 3721 6555, Facsimile 07 3721 6500

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Executive summary

INTRODUCTION

The purpose of this consultancy is to review and update the previous planning for the two Gladstone sewerage schemes, building an up-to-date network analysis model and preparing a new planning report. This planning report will identify the timing and costs associated with the proposed infrastructure, which will allow the calculation of infrastructure charges.

SEWERAGE SCHEMES

Gladstone City is serviced by two sewerage treatment plants (STPs), located on the Calliope River at Callemondah and at South Trees Inlet. These STPs serve two major catchment areas in which sewerage is transported via a conventional combined gravity/pumped system.

The Calliope River STP receives all influent via four sewage pumping stations (SPSs) and associated pressure mains. SPS S1 and A1 service the two major subcatchments, each of which currently contribute approximately 50% of average dry weather flow at the STP. SPS D1 and a smaller SPS servicing the NRG power station provide a small amount of additional flow. In total, there are 46 SPSs within the Calliope River scheme.

The South Trees STP also receives all influent from pumped flows via the combined pressure main from SPS T1 and SPS T2. In total, there are five SPSs within the South Trees scheme.

STUDY AREAS AND OBJECTIVES

The study area for this investigation comprises the existing and planned reticulated sewerage service areas of the Calliope River and South Trees sewerage schemes.

The primary objective of this study is to update the previous planning study for the sewerage schemes by addressing, in particular, the following:

- Effectively planning for the future development of Gladstone City in accordance with Local and State Government planning requirements.
- Identify any existing areas currently receiving a sub-standard service.

- Identify development constraints and barriers to development which will limit the potential capacity of the area to provide residential land to accommodate the growth of the City.
- Recommend improvements and extensions to the trunk sewerage system within each scheme that are necessary to service future development.
- Identify the current capacity and recommended upgrades for Calliope River STP and South Trees STP.
- Form part of Council's Strategic and Total Management Plans.
- Be used as the basis for infrastructure charging pursuant to the *Integrated Planning Act 1997* and, so far as is known, enable compliance with the draft regulation under that Act in respect to Priority Infrastructure Plans.
- Be used as the basis for capital works loan and subsidy applications.

An additional objective of the study is to undertake an Environmental Audit of the sewerage schemes to comply with the Environmental Protection Agency's Environmental Management Program entitled 'Prevention of Raw Sewage Overflows to Waters'. This component of the study is documented in a separate report entitled *Water and Wastewater Planning Studies—2030: Environmental Audit Report* (KBR 2004b).

PLANNING PERIOD AND POPULATION GROWTH ASSESSMENT

This study was undertaken to analyse Gladstone City's sewerage infrastructure under existing and future foreseeable demands to the year 2030.

The existing equivalent populations for the sewerage schemes were derived from the water supply demand model, which was developed as part of a concurrent study focussing on Gladstone City's water supply infrastructure. Population growth estimates were developed by PIFU and allocated in five yearly increments to year 2021. A growth estimate for the years 2021—2030 were extrapolated from previous year's growth.

Estimates were also made as to the extent of non-residential equivalent population figures utilising industry standard growth figures and applied in five growth areas as identified by Council and highlighted below:

- along Hanson Road
- industrial area surrounding Blain Drive and Red Rover
- Callemondah industrial area
- South Trees industrial area

- infill in the Toolooa industrial estate.

SEWERAGE LOADING MODEL

The water supply demand model developed as part of the Water Supply Study was used as the basis for the sewerage loading model. Dry weather loading was based on ET loads derived from the water supply demand model, which are converted to inflows through specification of an average water consumption rate (refer below) and sewer return factor for each modelled subcatchment. A peak wet weather flow of five times average dry weather flow was adopted for the purposes of the study, in consultation with Gladstone City Council, which represents industry-standard practice for sewerage system planning.

CONSUMPTION ASSESSMENT

The unit consumption for the water supply network was undertaken using monthly consumption data for years 1994 to 2004. Following an analysis of this data and discussions with Council the following average day consumption figures have been adopted:

- Zone A—1200 L/ET/d
- Zone BC—1300 L/ET/d
- Other (including Zone D)—1400 L/ET/d.

Each sewerage subcatchment was allocated a corresponding water supply zone and average day consumption figure for the purpose of determining sewer loads (refer above).

DESIRED STANDARDS OF SERVICE

Desired standards of service have been developed which specifically form the basis for system planning.

The sewerage network has also been planned and designed in accordance with Design Criteria which have been specifically developed to achieve a system capable of providing high quality services to customers. The QDNR Guidelines were reviewed together with current and previous approaches to system planning implemented by both KBR and Gladstone City Council.

NETWORK ANALYSES AND MODEL VALIDATION

The Calliope River and South Trees sewerage schemes have been analysed using MOUSE 2003 to model the significant gravity sewers, pump stations and pressure mains which form the trunk network in each system.

The following cases were run to first assess existing system performance, and then identify, evaluate and select planning options for system extensions, upgrades and augmentations:

- existing (2004) conditions
- future (2016 and 2030) planning scenarios.

EXISTING SYSTEM PERFORMANCE

Calliope River STP:-

Modelling indicates that the trunk system has sufficient capacity to transport existing dry weather flows. No dry weather overflows are predicted to occur.

Analysis of pipe flows indicates that a number of sewer sections are currently running at, or greater than, pipe-full capacity under 2004 ADWF conditions.

In terms of flow velocity under ADWF conditions, the proportion of gravity sewers below the desirable minimum velocity to maintain self-cleansing and prevent siltation is high at 37%.

In terms of storage capacity of the 12 modelled SPSs, only two (C2 and S4) satisfy the current nominated design requirement of four hours emergency storage under ADWF conditions.

Modelling indicates that a number of SPSs are currently operating with a station capacity less than the nominated design criteria (ie. inflow under PWWF conditions).

South Trees STP:-

Modelling indicates that the trunk system has sufficient capacity to transport existing dry weather flows with no dry weather overflows predicted to occur. A significant proportion of Line T1, however, currently runs at less than 0.6 m/s under 2004 ADWF conditions.

Modelling predicts the occurrence of overflows under existing PWWF conditions at SPS T5. The modelling also predicts surcharge above ground level at two manholes (MH1 and MH2) on Line T2-30.

Modelling indicates that one SPS (T5) is currently operating with a station capacity less than the nominated design criteria (ie. inflow under PWWF conditions).

FUTURE SYSTEM REQUIREMENTS

Revised system planning has resulted in the following recommendations for the Calliope River sewerage scheme:

Revised system planning has resulted in the following recommendations for the South Trees sewerage scheme:

Marina pumping system:-

The cost to re-direct the existing marina pumping system to an alternative discharge point into the scheme, thus minimising the risk of discharge into the existing Auckland Creek, is of the order of $1.4 million.

SEWERAGE TREATMENT PLANTS

Calliope River STP:-

The existing plant is not considered suitable for conversion to a BNR process.

Three options were considered for the development of the Calliope River STP including an NPV analysis for each. Option 1 - the refurbishment of the biological filter by 2006 is clearly the most advantageous option to Council, on an NPV basis.

Additionally, it is recommended that flow meters be installed at the inlets to the two process trains of the treatment plant to allow operations personnel to more accurately divide the flows between the two process trains and thereby maintain a higher effluent quality.

South Trees STP:-

Two options were considered for the development of the South Trees STP including an NPV analysis for each. On an NPV basis, both options were considered of equal cost to Council.

Due to the proposed EPA wastewater treatment policy, it will only become more difficult to discharge effluent to waterways, esp. to marine environments, in the future, Option 1 - Transport of treated effluent to QAL, is thus considered the more appropriate option.

INFLOW/INFILTRATION

Gladstone City Council has an Inflow/Infiltration Management Plan as part of its TMP documentation.

From the data obtained for the two rainfall periods, August 2003 and January 2004, it would appear that the inflow/infiltration component of the sewage flow is highest in the catchments A10 and A1.

This would thus be considered the starting point for a condition assessment program of existing trunk sewerage assets within Gladstone City.

TRADE WASTE

It is recommended that Council prepare and implement an environmental plan about trade waste management in accordance with the Environmental Protection (Water) Policy 1997.

It is anticipated that the Gladstone Port Authority will introduce holding tank/pump-out facilities at the Marina which will make provision for sewage discharge from ships entering/berthing at the Marina facility. An assessment of nearby existing sewage infrastructure indicates that sewage disposal from this facility would be most cost-effective by conveying sewage directly into the existing Council sewerage scheme, possibly via gravity.

GREY WATER REUSE

The Queensland State Government has advised that legislation will be introduced in early 2005 to allow householders to reuse domestic grey water for irrigating gardens and lawns.

Grey water reuse would appear to be a future significant demand management tool available to Councils state-wide and, through proper ratepayer awareness programs and advertising, would provide benefits to both ratepayers and Council alike.

QAL REUSE

In Council's third party agreement with QAL, up to 5% of the effluent reused by both QAL and NRG has been allowed to be used by Council for irrigation of sporting fields. The quality of the effluent is considered to be Class C.

It is recommended that the disposal via irrigation of this Class C effluent be only in a **controlled** public access environment. e.g. man-proof fencing and lockable gates.

The provision of package treatment plants incorporating filtration and further disinfection (to also reduce the high phosphorus load in the treated effluent) at various sites at, or in close proximity to the sporting fields, would produce a Class A effluent which would be suitable for disposal via irrigation in an **uncontrolled**, public access environment.

Council, in consultation with the relevant sporting bodies, would need to assess the alternative options of Class A and Class C effluent quality and the associated cost and non-cost implications of both.

RECOMMENDATIONS

It is recommended that Gladstone City Council:

- Adopt this report and the capital works program for both the Calliope River and South Trees sewerage schemes with approximate capital expenditure of **$32,900,000**.

- Use this report as the basis for the development of the Priority Infrastructure Plans.

- Use the outcomes of a catchment-wide flow monitoring program to revisit the adopted sewer loading model and assess the likely impact on system planning.

- Undertake a detailed review of information retained on existing wastewater system assets and develop an asset register with comprehensive details of existing sewage pump stations and system overflow points.

- Prepare and implement an environmental plan about trade waste management in accordance with the Environmental Protection (Water) Policy 1997.

- Continues to actively apply and encourage demand management initiatives, including grey water reuse.

- Forward this report to NRM&E for approval as a planning report.

- Consult with the relevant sporting bodies to assess the alternative options of Class A and Class C effluent quality for disposal of treated effluent on sporting fields.

1 Introduction

1.1 COMMISSIONING

Kellogg Brown & Root Pty Ltd (KBR) was commissioned by Gladstone City Council (Council) to undertake a Planning Study for wastewater infrastructure, which includes:

- Assessment of trunk infrastructure needs to meet existing and future demands to year 2030.
- Preparation of logical calculations, including building a network analysis model, to be used as the basis for the determination of infrastructure charges.
- Preparation of a planning report fully documenting the process and outcomes.
- Presentation of findings to Council.

The study was to be undertaken in accordance with the Council's Consultancy Brief (Quotation No: Q03/04 E03).

1.2 INTRODUCTION

The purpose of this consultancy is to review and update the previous planning for the two Gladstone sewerage schemes, to develop a current network analysis model for each scheme, and to prepare a new planning report. This planning report will identify the timing and costs associated with the proposed infrastructure, which will allow the calculation of infrastructure charges.

2 Description of schemes and previous planning

2.1 GLADSTONE CITY SEWERAGE SCHEMES

2.1.1 Overview

Gladstone City is serviced by two sewage treatment plants (STPs), located on the Calliope River at Callemondah and at South Trees Inlet. These STPs serve two major catchment areas in which sewerage is transported via a conventional combined gravity/pumped system.

The Calliope River sewerage scheme collects and treats sewage from the well-established localities of Barney Point, Callemondah, Clinton, Gladstone City (incorporating the CBD), Kin Kora, New Auckland, South Gladstone, Sun Valley, Telina, Toolooa and West Gladstone. Current average dry weather flow (ADWF) into the Calliope River STP is approximately 7.5 ML/d.

The South Trees sewerage scheme collects and treats sewage from more recent development within the localities of Glen Eden and South Trees, to the south east of Gladstone City. The South Trees scheme is much smaller than Calliope River, and current ADWF into the South Trees STP is around 160 kL/d.

2.1.2 Calliope River sewerage scheme

An overview of the Calliope River scheme is provided in Figure B.1 (refer Appendix B), with more detailed drawings of the existing sewerage infrastructure provided in Appendix A (Figures A.1 through A.6). Major pump station catchment subcatchments are shown in Figure C.1 (refer Appendix C).

The Calliope River STP receives all influent via four sewage pumping stations (SPSs) and associated pressure mains. SPSs S1 and A1 service the two major subcatchments, each of which currently contribute approximately 50% of ADWF at the STP. SPS D1 and a smaller SPS servicing the NRG power station provide a small amount of additional flow.

Asset data for the existing gravity trunk and reticulation network within the Calliope River sewerage scheme, as determined from GIS data provided to KBR, is presented in Table 2.1.

Further information regarding the Calliope River STP is provided in Chapter 11 of this report.

Table 2.1 Calliope sewerage scheme pipe diameter profile

Nominal diameter (mm)	Length of reticulation (m)	% of reticulation	Length of trunk main (m)	% of trunk main
150 (or less)	239,235	99.9	—	—
225	329	0.1	20,258	50.0
300	—	—	9,649	23.9
375	—	—	3,726	9.2
450	—	—	3,447	8.5
525	—	—	1,781	4.4
600	—	—	1,306	3.2
825	—	—	284	0.7
Total	**239,564**	**100**	**40,451**	**100**

Southern catchment

SPS S1 (265 L/s current station duty) services the southern part of the Calliope River scheme, receiving flow from the 825 mm (max.) Line A trunk main. Extending further back upstream, the trunk system runs primarily under gravity. SPSs C1 (45 L/s) and C2 (42 L/s) within Clinton are the two major pump stations, with smaller stations including SPSs C3, S2, S3, S4, S5 and S9.

Northern catchments

SPS A1 (300 L/s) services the northern and eastern part of the scheme, receiving flow from the 600 mm (max.) Line 1A trunk main. Extending back upstream, the major branch of the trunk system is characterised by a series of interconnected pumped and gravity sections. This configuration begins with SPS A18 (10.5 L/s), which pumps to A5 (58.3 L/s), then to A6 (68 L/s), then to A2 (102 L/s) and finally to A1.

The other major SPS within the A1 subcatchment is A10 (50 L/s). This delivers flow to the Line 1B trunk main, which then connects to Line 1A.

A series of smaller SPSs service the marina area (A34-41), port and coal wharf areas (A3, A14-16, A42) and the light industrial area bordered by Auckland Inlet (A17, A21-29, A33). All the above SPSs ultimately deliver flow to SPS A1 via Lines 1F and 1D.

SPS D1 (16 L/s) services the industrial subcatchment to the west of A1, between Auckland Inlet and Red Rover Road, and pumps directly to the STP. The small trunk system upstream of SPS D1 drains under gravity.

2.1.3 South Trees sewerage scheme

An overview of South Trees scheme is provided in Figure B.2 (refer Appendix B), with more detailed drawings of the existing sewerage infrastructure provided in Appendix A (Figure A.6). Major pump station catchment subcatchments are shown in Figure C.1 (refer Appendix C).

The South Trees STP also receives all influent from pumped flows via the combined pressure main from SPS T1 (23.5 L/s current station duty) and SPS T2 (31 L/s). The three other existing (and smaller) SPSs within the South Trees scheme are T5, T7 and T8.

Asset data for the existing gravity trunk and reticulation network within the South Trees sewerage scheme, as determined from GIS data provided to KBR, is presented in Table 2.2.

Table 2.2 South Trees sewerage scheme pipe diameter profile

Nominal diameter (mm)	Length of reticulation (m)	% of reticulation	Length of trunk main (m)	% of trunk main
150 (or less)	11,398	100	—	—
225	—	—	632	100
Total				**100**

Further information regarding the South Trees STP is provided in Chapter 11 of this report.

2.2 PREVIOUS PLANNING

The most recent planning study for the Gladstone City sewerage schemes was undertaken by McIntyre & Associates in 1997. This study examined the capacity of both schemes under (then) current conditions to determine the adequacy of existing infrastructure to cater for future residential and industrial growth. The study also identified upgrade and augmentation works considered necessary to cater for this growth and the expansion of existing serviced areas.

The McIntyre & Associates study established spreadsheet-based static models to:

- determine sewer flows based on allotment counts, estimated average dry weather sewer loading rates and infiltration rates estimated from records of pumped flows and rainfall;
- determine the capacity of trunk sewer mains, based on theoretical grade-limited flows, to assess the need for additional capacity and extensions to service growth areas;
- determine the existing capacity of pump stations, assess storage requirements and assess the need for pump station upgrades; and
- determine the existing capacity of pressure mains, assess their ability to cope with pump station upgrades and assess the need for pressure main upgrades or augmentations.

The study also estimated the cost of additional headworks to upgrade the existing level of service and cater for future servicing of urban and industrial growth within the two sewerage schemes.

Council now wish to review the planning outcomes of this previous study due to changes in predicted growth levels and patterns, and to incorporate development of a network analysis model that will assist current planning but also facilitate ongoing system analysis and planning needs.

3 Study areas and objectives

3.1 STUDY AREAS

The study areas for this investigation are the existing and planned reticulated sewerage service areas of the Calliope River and South Trees sewerage schemes. An overview of the two schemes is provided in Section 2, with detailed plans of the existing and ultimate service areas presented in Appendix A.

Network analysis and future planning for each scheme was limited to consideration of the trunk sewerage collection and transport system. The model build process for the development of MOUSE (Version 2003, Danish Hydraulic Institute) hydraulic models representing each trunk system is described in Appendix B, with plans showing the extent of sewer modelled within each scheme.

3.2 CHARACTER OF STUDY AREA

The Gladstone City Council displays a wide diversity of land use within the catchment including residential, light and heavy industry and multi-purpose centres (e.g. caravan parks, RSL clubs and schools) through to green space. A high proportion of the city however, is industrial with several major industries including QAL, Gladstone Port Authority and the NRG power station.

Gladstone City Council is bounded by Calliope Shire to the South and West and the ocean to the North and East. It contains the suburbs of Gladstone City, Barney Point, West Gladstone, South Gladstone, Clinton, Kin Kora, Sun Valley, New Auckland, Telina, Toolooa and Glen Eden. The most elevated site in the area is 130 m AHD, north of Philip Street, although this area is not yet developed. The elevation to the south drops down to an average of approximately 30 m AHD with a peak in Clinton of 85 m AHD, a peak in New Auckland of 55 m AHD and a peak in Glen Eden of 115 m AHD.

3.3 STUDY OBJECTIVE

The primary objective of this study is to update the previous planning study for the Calliope River and South Trees sewerage schemes by addressing, in particular, the following:

- Effectively planning for the future development of the City in accordance with Local and State Government planning requirements.
- Identify any existing areas currently receiving a sub-standard service.

- Identify development constraints and barriers to development which will limit the potential capacity of the area to provide residential land to accommodate the growth of the City.
- Recommend improvements and extensions to the trunk sewerage system within each scheme that are necessary to service future development.
- Identify the current capacity and recommended upgrades for Calliope River STP and South Trees STP.
- Form part of Council's Strategic and Total Management Plans.
- Be used as the basis for infrastructure charging pursuant to the *Integrated Planning Act 1997* and, so far as is known, enable compliance with the draft regulation under that Act in respect to Priority Infrastructure Plans.
- Be used as the basis for capital works loan and subsidy applications.

An additional objective of the study is to undertake an Environmental Audit of the sewerage schemes to comply with the Environmental Protection Agency's Environmental Management Program entitled 'Prevention of Raw Sewage Overflows to Waters'. This component of the study is documented in a separate report entitled *Water and Wastewater Planning Studies—2030: Environmental Audit Report* (KBR 2004b).

3.4 SCOPE OF WORK

The scope of work undertaken by KBR includes:

- network analysis model construction;
- demand establishment, assignment and development of a sewerage loading model;
- determination of augmentation requirements, costs and staging for each sewerage scheme;
- integration with the environmental audit component of the study;
- preparation of draft planning report; and
- preparation of a final planning report and workshop presentation incorporating all aspects of the study.

4 Planning period and population growth assessment

4.1 PLANNING PERIOD

This study was undertaken to analyse Gladstone City's sewerage infrastructure under existing and future foreseeable demands to 2030.

The following section regarding population growth projections and distribution is also documented in the planning report prepared for a concurrent study to analyse Gladstone City's water supply infrastructure.

4.2 POPULATION GROWTH PROJECTIONS AND DISTRIBUTION

Residential population growth was initially to be adopted from the Gladstone Growth Management Initiative, 2002, SKM report. However, discussions with Council have indicated that these figures are most likely conservatively on the high side. As provided by Council, updated population forecasts from the Department of Local Government's Planning Information and Forecast Unit (PIFU) were allocated to areas suitable for greenfield growth and redevelopment within Gladstone City Council. The PIFU model was utilised in conjunction with the 2004 CBD study to ensure that demand was appropriately allocated to the system including an allowance for the redevelopment of the CBD area. The areas to which population has been allocated were determined in conjunction with Council staff.

The Equivalent Tenement (ET) figures for 2004 were calculated using the method described in Section 6.1. Growth projections from the PIFU model growth areas, as shown in Figure 4.1, were obtained and then added to the 2004 ET figures to generate population projections up to the year 2030. A summary of the population projections is provided in Table 4.1.

The population was converted to ET by dividing the Equivalent persons (EP) by 2.8 persons per household.

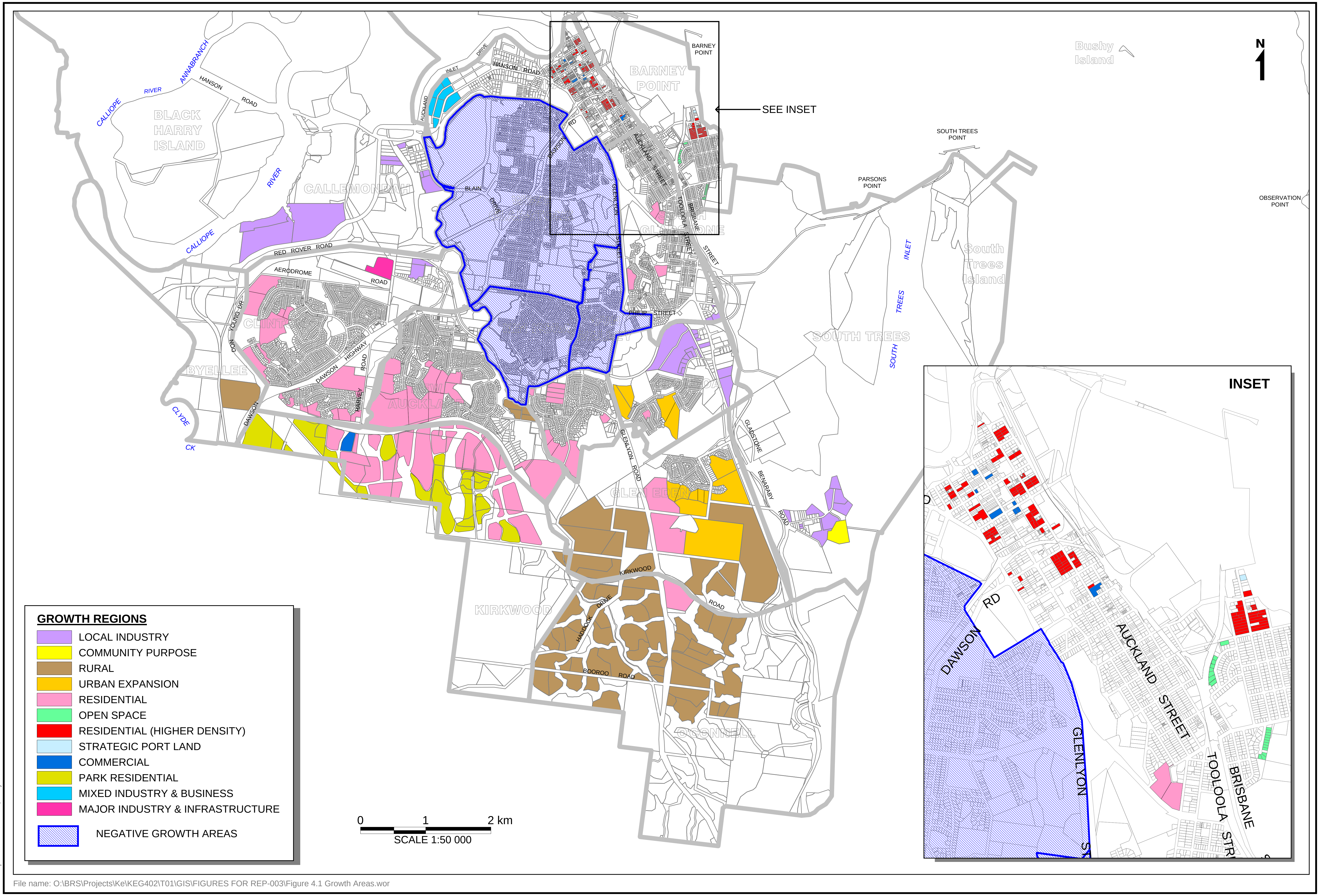

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Figure 4.1
GROWTH AREAS

Table 4.1 Residential population projections for Gladstone City

Locality	Water supply zone	2003 (EP)	2006 (EP)	2011 (EP)	2016 (EP)	2021 (EP)	2030 (EP)	Total growth (EP)	Total growth (ET)
Barney Point	A	1,360	1,402	1,507	1,668	1,828	2,116	756	270
Byellee	D	10	10	20	30	40	58	48	17
Callemondah	F	50	50	50	60	60	60	10	4
Clinton	D	5,430	6,030	6,980	7,090	7,210	7,426	1,996	713
Gladstone	A	1,330	2,066	2,322	2,578	2,834	3,296	1,966	702
Glen Eden	D	880	1,290	2,620	3,610	4,965	6,043	5,163	1,844
Kin Kora	D	2,410	2,370	2,320	2,270	2,250	2,214	-196	-70
Kirkwood	D	50	743	1,910	3,076	4,243	6,330	6,280	2,243
New Auckland	D	3,110	3,380	5,250	5,830	6,000	6,306	3,196	1,141
O'Connell	D	110	290	950	1,430	1,600	1,906	1,796	641
South Gladstone	A	3,060	3,140	3,450	3,400	3,380	3,344	284	101
South Trees	D	60	60	60	60	140	284	224	80
Sun Valley	D	1,460	1,410	1,380	1,350	1,340	1,322	-138	-49
Telina	D	2,030	2,040	2,090	2,260	2,520	2,943	913	326
Toolooa	D	1,300	1,310	1,400	1,610	1,890	2,045	745	266
West Gladstone	BC	5,080	5,050	5,050	5,010	5,000	4,982	-98	-35
Harbour & Islands	D	40	40	60	80	180	164	124	44
Gladstone		**27,770**	**30,681**	**37,419**	**41,412**	**45,410**	**50,839**	**23,069**	**8,238**

Industrial growth was not provided for in the PIFU model. The SKM 2004 report stated that industrial growth was being encouraged to the north of Gladstone City where existing heavy industry is currently located, e.g. Stuart Oil Shale Project, ACL, Ticor, Orica, Gladstone Port and the NRG Power Station. The State Government was also encouraging industry to develop in the Aldoga-Yarwun area in the Calliope Shire.

Following discussions with Council, the following five primary areas were adopted for future industrial growth:

- along Hanson Road
- industrial area surrounding Blain Drive and Red Rover Road
- Callemondah industrial area
- South Trees industrial area
- infill in the Toolooa industrial estate.

Based on existing industrial densities, as well as acknowledged industry standards, a density of 15 EP/ha was adopted for the industrial growth areas.

The industrial growth per annum was determined utilising land take-up rates for the past four years. This historical information indicated that there has been a maximum growth rate of 165 EP/a and a minimum growth rate of 45 EP/a. Given the variation in growth over the past four years a conservative growth rate should be adopted. Following discussions with Council, 120 EP/a has been adopted. The calculated figures for industrial growth are presented in Table 4.2.

Table 4.2 Industrial growth figures

	Water supply zone	2006 (EP)	2011 (EP)	2016 (EP)	2021 (EP)	2030 (EP)	Growth (EP)	Growth (ET)
Along Hanson Road	A	120	120	—	—	—	240	86
Industrial area surrounding Blain Drive and Red Rover Road	F	120	28	300	300	574	1,322	472
Callemondah industrial area	D	—	—	235	—	—	235	84
South Trees industrial area	D	—	451	70	—	—	521	186
Infill in the Toolooa industrial estate	D	—	—	—	302	512	814	291
Totals		**240**	**599**	**605**	**602**	**1,086**	**3,132**	**1,119**

5 Demand and loading models

5.1 OVERVIEW

Development of a loading model to support the network analysis of the Calliope River and South Trees sewerage schemes was based on the water supply demand model developed for the concurrent study of Gladstone City's water supply infrastructure.

The following section outlines the process by which the water supply demand model was generated. The subsequent section then outlines the development of the sewerage system loading model.

5.2 WATER SUPPLY DEMAND MODEL

The water supply demand model was developed from an analysis of existing water supply consumption trends and from the existing Watsys water supply model. The demand from the Watsys model totalled an average day demand of 36.5 ML/d (including supply to Calliope Shire).

The review of the demands within the model was undertaken through a comparison of the input, the rates database information (1990 to 2004) and the daily flows from the Gladstone Water Treatment Plant.

Residential water meter readings were obtained from the rates database for the years 1992 to 2003. Consumptions less than 50 kL/a were removed, and then an average consumption per dwelling (L/ET/d) was calculated.

The Watsys model was developed as a L/s model. However, the H_2ONet model developed as part of the concurrent water supply study was developed as an ET model. Therefore the original Watsys demand input was converted to an ET demand input. This was undertaken using the average consumption developed from the rates database. The L/s applied on each node in the Watsys model was divided by the average consumption to obtain the ET as shown in Table 5.1.

Table 5.1 Existing water supply demand distribution

Demand type	A (ET)	BC (ET)	D (ET)	F (ET)	X (ET)	Total (ET)
Residential	1,604	1,807	5,678	—	2,284	10,601
Commercial	1,633	82	240	—	—	1,716
Light Industry	1,344	2,290	1,990	1,691	—	6,960
Heavy Industry	331	—	237	3,227	335	4,083
Special facilities inc. child care centres	—	139	129	—	—	258
Special facilities inc. hospitals	51	30	101	—	—	173
Totals	**4,964**	**4,348**	**8,376**	**4,918**	**2,619**	**23,851**

For the future model, the growth areas provided by PIFU were added as a digital layer to the existing DCDB and, using GIS-based queries, the future demand added to the existing demand. The demand nodes with their projected ET demands were imported into the 2030 water supply network in H_2ONet.

5.3 SEWERAGE LOADING MODEL

The water supply demand model described above formed the basis for the dry weather component of the sewerage loading model. Development of the loading model followed the process outlined below:

- Sewerage system subcatchment discretisation and mapping, which geographically incorporated the sewerage system service areas, as well as the demand nodes from the H_2ONet water supply demand model.
- Populating sewerage system subcatchments with ET demand input for the various land uses through a series of GIS-based queries.
- Importing subcatchment data into MOUSE and assigning model loading points.
- Specification of dry weather and wet weather inflows based on subcatchment ET loads.

5.3.1 Dry weather inflows

Generation of dry weather model inflows from ET loads is achieved within MOUSE through specification of an average water consumption rate and sewer return factor for each subcatchment.

Average water consumption rates were assigned to each subcatchment based on the revised water supply zones, and ranged from 1,200 to 1,400 L/ET/d.

Sewer return factors were determined from analysis of ET loads and recorded daily flows for the Calliope River STP, supported by limited daily flow data available for the major SPSs within the Calliope River system. Separate return factors were estimated for both residential usage and for non-residential usage (incorporating commercial, light/heavy industrial and special usage), and include an additional reduction factor to incorporate allowance for Unaccounted for Water (UFW), which is estimated to be approximately 15% of total demand from the Gladstone Water Treatment Plant.

Residential return to sewer was determined to be approximately 60%, which reduced to 51% when the reduction for UFW was applied. Based on a conversion of 2.8 EP per ET, this translates to average daily sewage flows of 219 and 255 L/EP/d for areas with an estimated water consumption of 1,200 and 1,400 L/ET/d respectively.

Non-residential return to sewer was determined to be approximately 49% based on the following assumptions:

- large water users return zero water to the sewer;
- 30% of all non-residential water users (evenly distributed throughout each system) return zero water to the sewer; and
- remaining non-residential water users (70% of total) return 70% of water to the sewer.

Specific large water users considered to return effectively zero water to the sewer were NRG, QAL, Barney Point Coal, Clinton Coal, Gladstone Port Area and the Tondoon Botanical Gardens. Two further non-standard water users were also individually accounted for—the Gladstone Marina Area was considered to return 10% of water to the sewer and an allowance of 120 kL/d (direct to sewer) was added to account for wasted backwash water (sourced from raw water supply) at the Gladstone Water Treatment Plant.

A summary of the adopted sewer loads is provided in Table 5.2, broken by subcatchments contributing to each modelled pump station. Where shown, ‘total’ figures represent the combined contribution of the local subcatchment and all upstream subcatchments. The subcatchment layouts for both schemes are shown in Figure C.1.

Table 5.2 Adopted sewer loads

SPS	Year 2004		Year 2016		Year 2031	
	Res. (ET)	Non-res. (ET)	Res. (ET)	Non-res. (ET)	Res. (ET)	Non-res. (ET)
Calliope River						
C1	698	16	708	16	718	16
C2	510	0	818	0	964	0
C3	0	316	0	400	0	400
S4	433	0	855	0	1,029	0
S1 (local)	4,162	809	6,519	809	6,929	951
S1 (total)	5,803	1,141	8,900	1,225	9,640	1,367
A5	328	998	356	998	356	1,161
A7	99	0	1,006	966	1,203	966
A6 (local)	893	966	1,006	966	1,203	966
A6 (total)	1,320	1,964	1,473	1,964	1,670	2,127
A2 (local)	338	986	432	986	618	986
A2 (total)	1,658	2,950	1,905	2,950	2,288	3,113
A10	1,208	130	1,208	130	1,208	130
A1 (local)	1,389	3,846	1,728	4,054	1,852	4,054
A1 (total)	4,255	6,926	4,841	7,134	5,348	7,297
D1	0	1,397	9	1,449	9	1,454
D2*	0	0	0	107	0	213
D3*	0	0	0	0	0	205
Total**	**10,058**	**9,464**	**13,750**	**9,915**	**14,997**	**10,536**
South Trees						
ST3*	0	0	342	0	490	0
ST4*	0	0	16	0	960	0
ST6*	0	0	0	0	89	0
T2 (local)	282	39	1,129	39	1,373	39
T2 (total)	282	39	1,487	39	2,912	39
T5	54	70	259	70	259	70
ST1* (local)	0	0	59	0	493	0
ST1* (total)	0	0	1,805	109	3,664	109
T1	0	464	0	583	0	583
Total***	**336**	**573**	**1,805**	**692**	**3,664**	**692**

** Denotes future pump station catchments*

*** Total for Calliope River comprises sum of S1 (total), A1 (total), D1, D2 and D3*

**** Total for South Trees comprises sum of ST1 (total) and T1*

The generation of dry weather inflows from the adopted loading model produces flows that are higher than those currently experienced at the Calliope River STP (7.5 ML/d approx.) and South Trees STP (160 kL/d approx.). Detailed analysis of water consumption rates and usage trends over the past five years (refer to KBR 2004a) shows that Gladstone is currently in a period of recovery following the severe water restrictions of 2002–2003, which ultimately dropped total water usage to around 50% of pre-restriction levels. Given that usage over the 2003–2004 financial year had lifted only to around 75% of pre-restriction levels, further rebound is considered likely to occur over the ensuing one to two years. The flow-on effect of restrictions on sewerage flows, as a result of reduced water demand, is highlighted in Figure 5.1 which shows daily flows for the Gladstone Water Treatment Plant (output) and the Calliope River STP (combined pumped inflow) for the period 2000-2004.

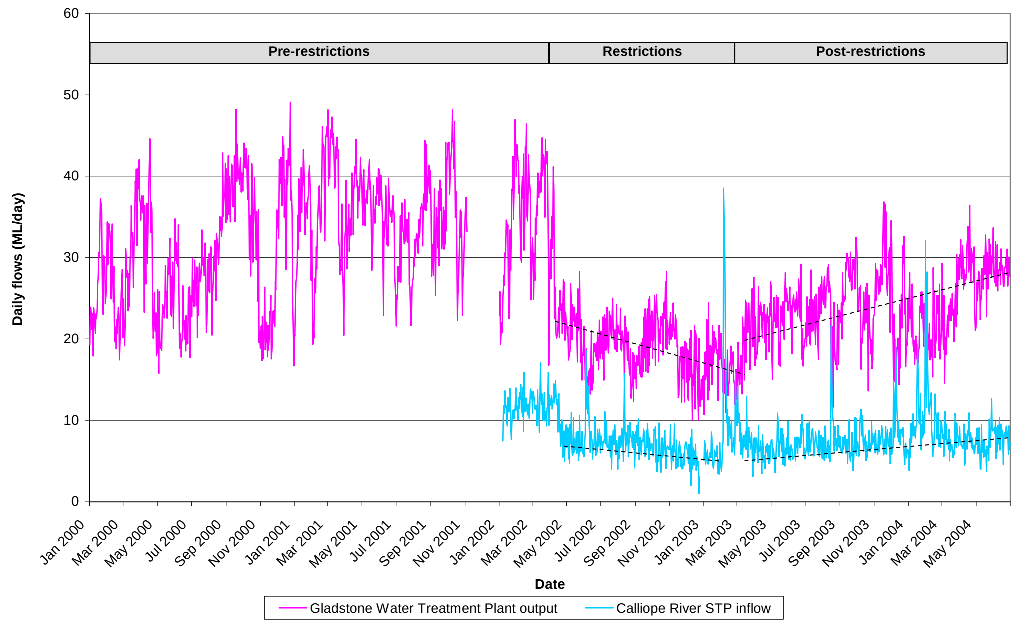

Figure 5.1
IMPACT OF RESTRICTIONS ON WATER DEMAND AND SEWERAGE FLOWS

Thus it is likely that further recovery of water demand will result in further increases to sewerage flows, which is a scenario that is catered for by the adoption of slightly conservative sewer loadings.

5.3.2 Wet weather inflows

A peak wet weather flow (PWWF) of five times ADWF was adopted for the purposes of the study, in consultation with Council, which represents industry-standard practice for sewerage system planning.

5.3.3 Model inflows for future planning scenarios

Dry weather inflows for future planning scenarios were based on future ET demand inputs, which were either added to existing sewerage system subcatchments (in the case of infill development) or captured within new subcatchments representing future expansion and growth areas. The spatial and temporal distribution of the adopted residential (based on PIFU data) and non-residential growth (based on Council projections) was as agreed with Council.

6 Consumption assessment

6.1 WATER SUPPLY SYSTEM UNIT CONSUMPTION

A consumption assessment was undertaken over a period of years to review the Watsys demand input, determine average residential consumption and to determine the peaking factors. The following data was utilised:

- Watsys demand input;
- monthly consumption data based on the treatment plant output for the years 2000 to 2004; and
- water meter readings for each individual property for the years 1992 to 2004.

The water meter readings were used to determine the residential average consumption trend and this is shown in Figure 6.1. It should be noted that 50% water restrictions were applied in April 2002 and were lifted in February/March 2003. It should also be noted that the year 1994/1995 was a dry year with very high demand occurring in January.

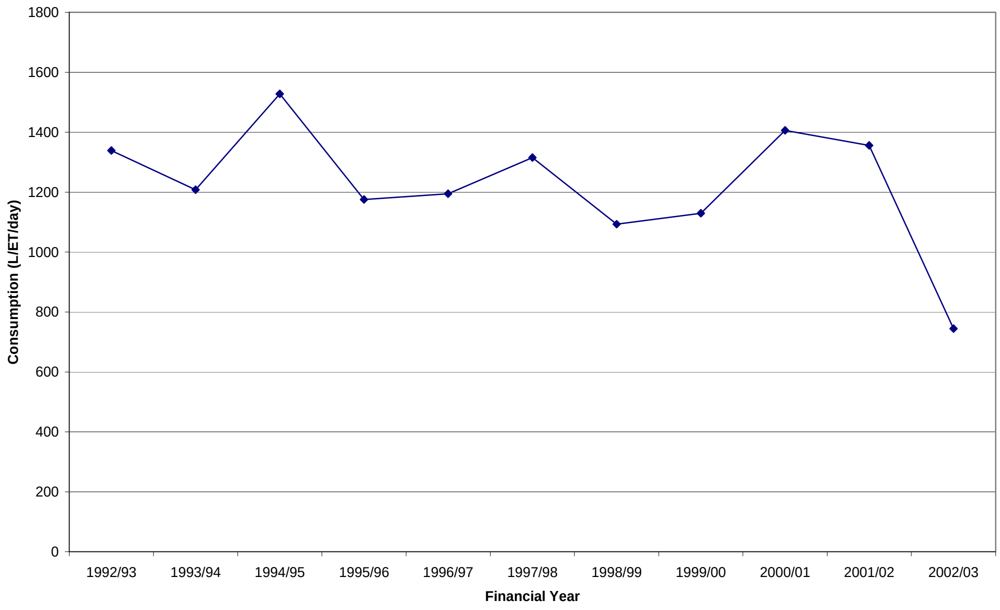

Figure 6.1
AVERAGE RESIDENTIAL CONSUMPTION

As is evident, the average consumption has remained constant except in the two exceptional years as mentioned above. It would be expected that following the lifting of the water restrictions the average consumption would recover.

Following discussions with Council the average day consumption was determined for Zone A, BC and D as shown in Figure 6.2.

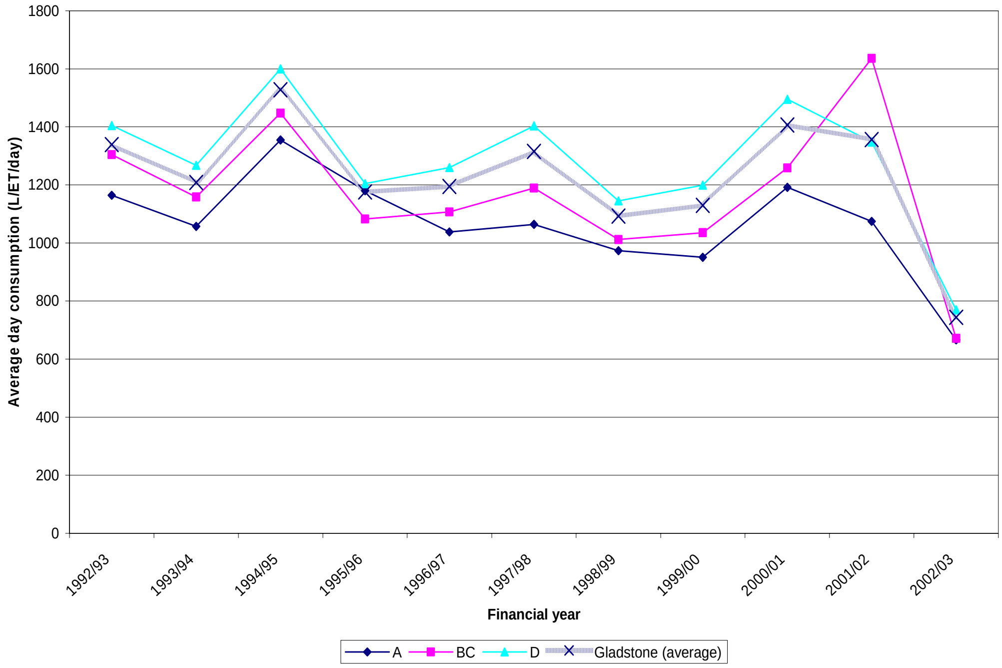

Figure 6.2
AVERAGE RESIDENTIAL CONSUMPTION

Following this analysis and discussions with Council the following figures have been adopted:

- Zone A—1,200 L/ET/d
- Zone BC—1,300 L/ET/d
- Zone D—1,400 L/ET/d

An analysis of the total consumption was undertaken. Figure 6.3 is a comparison of the Gladstone Water Treatment Plant flows and the consumption obtained from the water metering data. It must also be noted that the residential consumption for the year 2003/2004 is a theoretical figure only. It was obtained by interpolating the 2003/2004 connections from the meter data and then converted to ML/d. This is as a result of the 2003/2004 metering data not differentiating between residential and industrial/commercial meters. It must also be noted that for the years 1978/1979 to year 1993/1994, the average day (AD), mean day maximum month (MDMM) and maximum day (MD) information was obtained from McIntyre & Associates (1997).

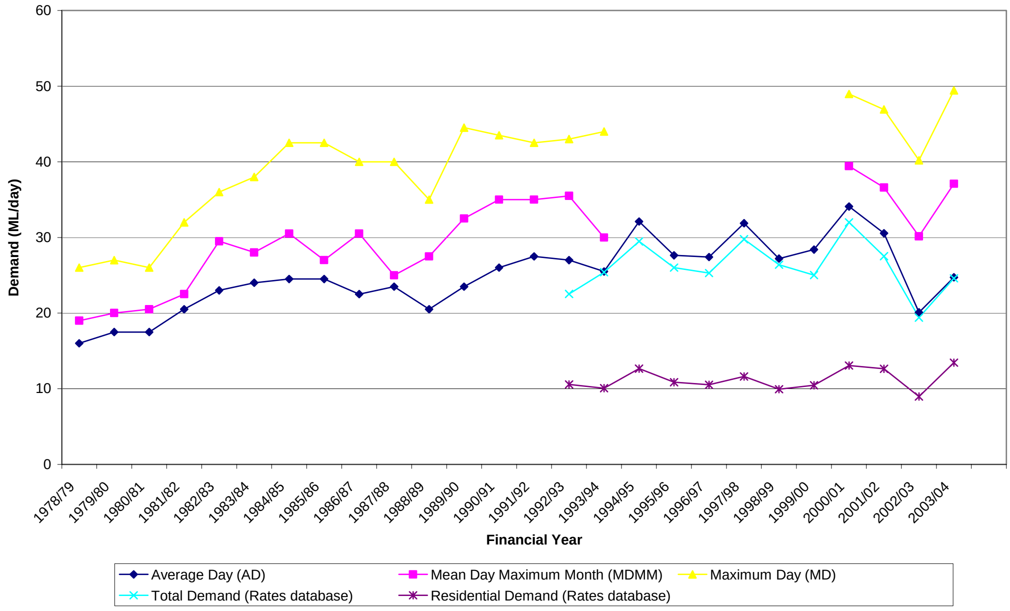

Figure 6.3
GLADSTONE WATER TREATMENT FLOWS AND WATER METER INFORMATION

Figure 6.3 indicates that the amount of UFW is approximately 15%. UFW is water that is lost in the water supply network. It can be as a result of leaks in the trunk mains, reticulation and connections or stolen water and delivery measurement error. That is, not all of the water that is output from the water treatment plant will reach the consumer because some will be lost along the way. This is the UFW, and it estimated by the difference between the treatment plant output and the sum of water usage in the rates database.

The final two years indicate an UFW of 0%, which is not realistic. This could be as a result of inaccuracies in the data including the metered information and the treatment plant information.

This value of UFW has been assumed for planning purposes only. It is an average over an extended period of time.

A trend analysis (which neglects the exceptional years) as shown in Figure 6.4 shows the continual increase in water consumption. The water restrictions that were applied in the year 2002/2003 would also impact on the water consumption of the following year and this is supported in the trend analysis. The trend analysis has shown that the average day demand is 34 ML/d.

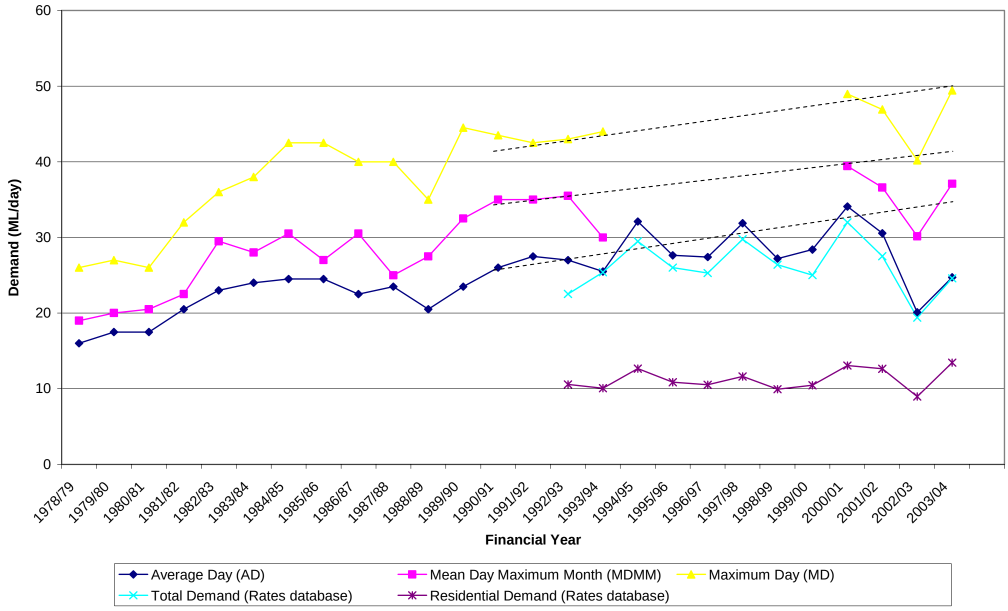

Figure 6.4
TREND ANALYSIS OF WATER TREATMENT FLOWS AND METER DATA

The demand that was input into Watsys is shown in Table 6.1 in comparison with the data obtained from the rates database.

Table 6.1 Watsys demand—existing system

	AD (ML/d)	Actual 2003/04 Consumption Data (inc. UFW) (ML/d)
Residential	18.5	15.5 *
Industrial/Commercial	18.5	18.0
Total	**36.9**	**33.5**

** Extrapolated from previous years data*

From this table it is evident that although the industrial/commercial demand of the Watsys model is a good representation of current demand trends. However, the residential demand assumption of the Watsys model is slightly high. Therefore the residential demand of the Watsys model has been factored by 90% to give the input to the H_2ONet model, as is shown in Table 6.2.

Table 6.2 Adopted H2Onet demand — existing demand

	AD (ML/d)
Residential	16
Industrial/Commercial	18
Total	**34**

6.2 WATER SUPPLY SYSTEM PEAKING FACTORS

The peaking factor analysis was undertaken using residential consumption only, as industrial and commercial water consumption is much more uniform across the year. There was only information available regarding the daily output of the Gladstone Water Treatment Plant for the year 2000/01 to the year 2003/04, therefore the analysis was undertaken utilising trend analysis (refer Figure 6.5).

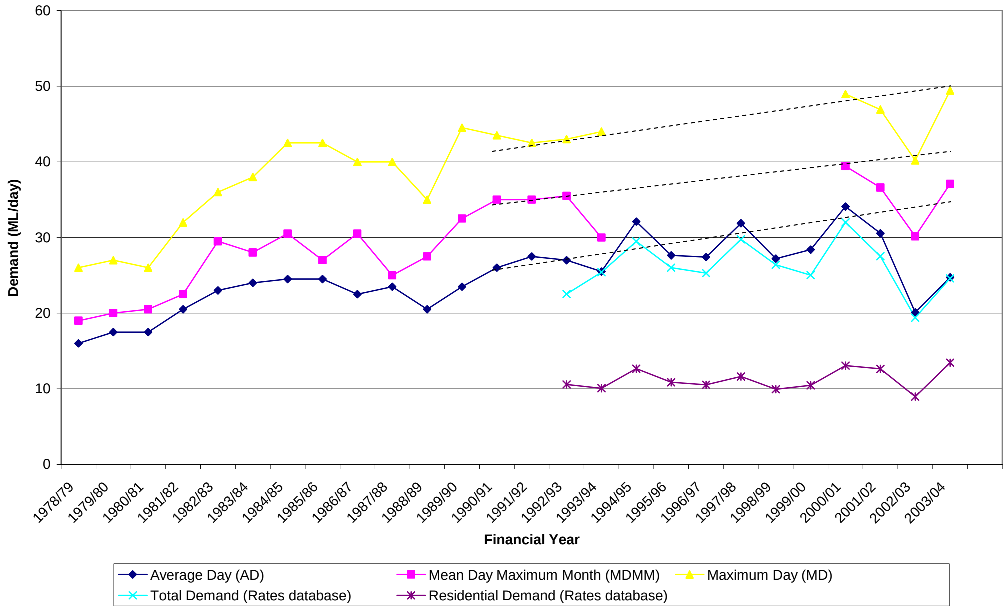

Figure 6.5
TREND ANALYSIS OF GLADSTONE WATER TREATMENT FLOWS AND WATER METER INFORMATION

As mentioned previously, the trend analysis shows the continual increase in water consumption. The water restrictions that were applied in the year 2002/2003 would also impact on the water consumption of the following year and this is supported in the trend analysis. It has shown that the AD demand is 34 ML/d, the MDMM demand is 41 ML/d and the MD demand of 50 ML/d.

The proportion of industrial demand in Gladstone City is very high and will remain constant. As a result the peaking factor analysis has been undertaken on assessment of the residential demand only. The residential demand component is approximately 16 ML/d (AD), 24 ML/d (MDMM) and 32 ML/d (MD).

As a result the following peaking factors have been adopted:

- MDMM/AD = 1.5
- MD/AD = 2.0

These figures are consistent with the previous McIntyre & Associates (1997) report and also consistent with adopted peaking factors for other Councils in Queensland.

6.3 WATER SUPPLY SYSTEM TOTAL CONSUMPTION

The adopted consumption for the Gladstone water supply scheme for 2004 has been summarised below in Table 6.3.

Table 6.3 Adopted consumption for year 2004

	AD (ML/d)	MDMM (ML/d)	MD (ML/d)
A	5.9	6.9	7.9
BC	5.7	6.8	8.0
D	11.7	15.7	19.7
F	6.9	6.9	6.9
X	3.7	5.3	6.9
Total	**33.9**	**41.0**	**50.0**

7 Desired standards of service

7.1 OVERVIEW

Desired Standards of Service have been developed for the Calliope River and South Trees sewerage schemes, which specifically form the basis for planning of the respective schemes for the purposes of the ICP. These Desired Standards of Service are outlined in the following sections.

7.2 CUSTOMER SERVICE PROVISION

As part of the Desired Standards of Service, it is necessary to consider the balance between the user benefits which will be obtained and the likely environmental effects. The qualitative measure of these Standards is given in Table 7.1.

Table 7.1 Desired standards of service

Ref No.	Performance indicators	Target
EFFECTIVE TRANSPORT OF WASTE EFFLUENT (SEWERAGE ONLY)		
1	Total sewage overflows per 100 km of main per year	30
2	Number of sewage overflows to customer property per 1000 rateable properties per year	10
3	Number of odour complaints per 1000 rateable properties per year	4
4	Response time to all events	6 hours
CONTINUITY IN THE LONG TERM—SEWERAGE		
5	Number of sewer main breaks and chokes per 100 km of main per year	40
6	Sewer inflow/infiltration—ratio of peak day flow to average day flow	5

7.3 DESIGN CRITERIA

The design criteria to be adopted for modelling purposes are as detailed in the following table.

Table 7.2 Design criteria

Design criteria	Value
SEWERAGE LOADING	
Average Dry Weather Flow (ADWF)	255 L/EP/day (residential)
Peak Wet Weather Flow (PWWF)	5 x ADWF
GRAVITY SEWER DESIGN	
Flow calculation approach	Manning’s equation
Manning’s ‘n’	0.013
Minimum velocity at PDWF	0.6 m/s
Depth of flow at PWWF - existing system	Up to 1.0 m below cover level
Depth of flow at PWWF - proposed sewers	Calculation based on pipe full capacity
PUMPING STATION DESIGN	
Wet Well storage requirements	0.9 x Q/N where N = 12 for ≤ 50 kW and 5 for > 50 kW
Emergency storage	4 hours x ADWF
Single pump capacity	3.5 x ADWF
Total PS capacity	5 x ADWF
PRESSURE MAIN DESIGN	
Flow equation	Hazen-Williams
Friction Factors	100–300 mm diameter, top water level, C = 100 100–300 mm diameter, bottom water level, C = 100 > 300 mm diameter, top water level, C = 120 > 300 mm diameter, bottom water level, C = 120
Minimum velocity (on a daily basis)	0.75 m/s
Preferred minimum velocity (all pumps)	1.2 m/s
Maximum velocity	2.0 m/s

8 Network analyses and model validation

8.1 SEWERAGE SYSTEM NETWORK ANALYSIS

The Calliope River and South Trees sewerage schemes have been analysed using MOUSE 2003 to model the significant gravity sewers, SPSs and pressure mains which form the trunk network in each system. The primary objectives of the modelling were:

- to assist in understanding the existing operation of each system and identifying system deficiencies; and
- to provide a basis for subsequent system planning to address deficiencies and accommodate the future growth of both schemes.

An individual model was developed for each scheme, based on the current (2004) asset data contained within Council's GIS and supplemented with further data and information supplied by Council.

A summary of the model build process, including more detailed information regarding modelled system components and figures showing the extent of sewer modelled within each scheme, is provided in Appendix B.

The following cases were run to first assess existing system performance, and then identify, evaluate and select planning options for system extensions, upgrades and augmentations:

- existing (2004) conditions
- future (2016) planning scenario
- future (2030) planning scenario.

Each design scenario simulated a 24 hour period of steady-state peak wet weather flow (PWWF) conditions, which is consistent with the design criteria established in the previous chapter.

8.2 VALIDATION OF SEWERAGE SYSTEM MODELS

Validation of the sewerage models was undertaken by a comparison of daily flows into the STPs and limited SCADA data from pumping stations. To ensure continuity in the models, a check was undertaken to ensure that the flows that were being generated in the results file were representative of the applied dry weather loading. However, it should be noted that the sewerage loading model developed to represent existing (2004) conditions represents a 'design' scenario, based on the adopted water supply demand, and therefore does not reflect actual daily flows currently experienced at either STP. For comparison, the current daily flow experienced at the Calliope

River STP under dry weather conditions is approximately 7.5 ML/day, and the modelled dry weather flow is approximately 11.8 ML/day.

Despite this, the methodology adopted for determination of sewer loads is considered to be a significant improvement on previous planning undertaken for Gladstone City. Previous work undertaken by MacIntyre & Associates (1997) adopted the following basis for estimation of sewer loading:

- Residential—existing population derived from census data, with a flat growth rate of 1.4% taken from a University of Queensland study of local government areas in Queensland.
- Non-residential—existing and future commercial and industrial loadings derived from allotment counts and standard loading factors (per allotment and per hectare loading rates).

The current study was able to apply detailed data regarding the distribution of water usage throughout Gladstone City, which was originally sourced from rates database information. Estimation of the proportion of water usage that is returned to the sewer is clearly a key parameter in this process, and could only be estimated based on comparison of bulk flows at with the information currently available. Further investigation supported by gauging of sewer flows would provide a much improved understanding of water usage practices, particularly for commercial and industrial areas, and consequently provide a much improved understanding of sewer flow distribution throughout each scheme.

9 Existing system performance

9.1 CALLIOPE RIVER SEWERAGE SCHEME

9.1.1 Dry weather performance

System capacity

Modelling indicates that the Calliope River trunk system has sufficient capacity to transport existing dry weather flows. No dry weather overflows are predicted to occur.

Analysis of pipe flows indicates that a number of sewer sections are currently running at or greater than pipe-full capacity under 2004 ADWF conditions. There are six main areas of concern, as shown in Table 9.1, all of which coincide with sections of gravity sewer that effectively become pressurised as they receive pumped flows from upstream pump stations.

Table 9.1 Sewers running at or greater than pipe-full capacity—Calliope River

Line ref.	Max. % pipe-full in ADWF	Location
6B	> 100	Downstream of pressure main from SPS A5
6A	> 100	Downstream of pressure main from SPS A7
1B	> 100	Downstream of pressure main from SPS A10
CA	> 100	Downstream of combined pressure main from SPS C1 and C2
2A	100	Downstream of pressure main from SPS A6
1A	98	Downstream of pressure main from SPS A2

Although these sewers do not compromise service standards under current dry weather conditions, results indicate the potential for capacity problems to occur during wet weather. These sewers may also present constraints to future expansion and augmentation of the system.

A peak dry weather flow scenario, while not modelled, is unlikely to highlight further performance issues due to the influence of pumped flows in the above six locations. No capacity-related issues were identified for sections of gravity main not subject to pumped flows, which are typically in the range of 20% to 40% pipe-full under ADWF conditions.

Reports of documented system overflows since January 2002, of which there have been five in total, do not assist further assessment of system capacity since all documented overflows relate to operational issues, chokes or mechanical/electrical failures.

Council is, however, aware of a number of sections of sewer that experienced surcharge problems during substantial rainfall in February 2003, including:

- Line 1C-2, Manholes 1-3 (Dawson Highway, Gladstone City)
- Line 1A, Manhole 16 (Railway Street, Gladstone City)
- Line 10B-1, Manhole 6 (Palm Drive, West Gladstone)
- Line A, Manholes 4-5 (West Gladstone)
- Line CC, Manholes 6-7 (Wilson St, New Auckland).

The modelled results for PWWF conditions are consistent with the observations around Railway Street (Lines 1C-2 and 1A), but do not support observations of surcharge in the other noted locations. The two most likely scenarios that contributed to the observed surcharge behaviour are localised areas of higher than average inflow/infiltration and downstream pipe blockages.

Flow velocity

In terms of flow velocity, modelling predicts that a significant proportion (approximately 58%) of trunk gravity sewer within the Calliope River system is currently running at less than 0.6 m/s under 2004 ADWF conditions. Note that the minimum PDWF velocity nominated in Table 7.2 for design purposes is 0.6 m/s. Assuming a typical reduction in flow velocity of 20% from PDWF to ADWF, the desirable minimum velocity to maintain self-cleansing and prevent siltation reduces from 0.6 m/s to around 0.5 m/s. The proportion of gravity sewer below this revised threshold is still high at 37%.

Figure 9.1 shows the distribution of modelled flow velocity for all gravity sewers under ADWF conditions. Note that almost all low flow velocities are predicted to occur in gravity sewers that are not subject to pumped flows, a result which is to be expected.

Sewage pumping station performance

To assess the ability of the existing system to accommodate total loss of individual pump station capacity under dry weather conditions, a number of pump-shutdown scenarios were simulated to determine approximate emergency detention storage times for each modelled SPS. The results of this analysis are presented in Table 9.2.

The storage times are estimated based on filling of the SPS wet well and upstream system between the pump start level and first point of overflow from the system (overflow trigger). This typically corresponded to either overflow level in the wet well or cover level at an upstream manhole where spillage is predicted to occur prior to activation of the SPS overflow. In cases where the extent of the modelled system upstream of an SPS was insufficient to represent the actual storage that would be available, the trigger level was conservatively adopted as the obvert level at the limit of the upstream modelled network. The reported storage times for these cases are likely to be extremely conservative, although the SPSs affected are minor station only.

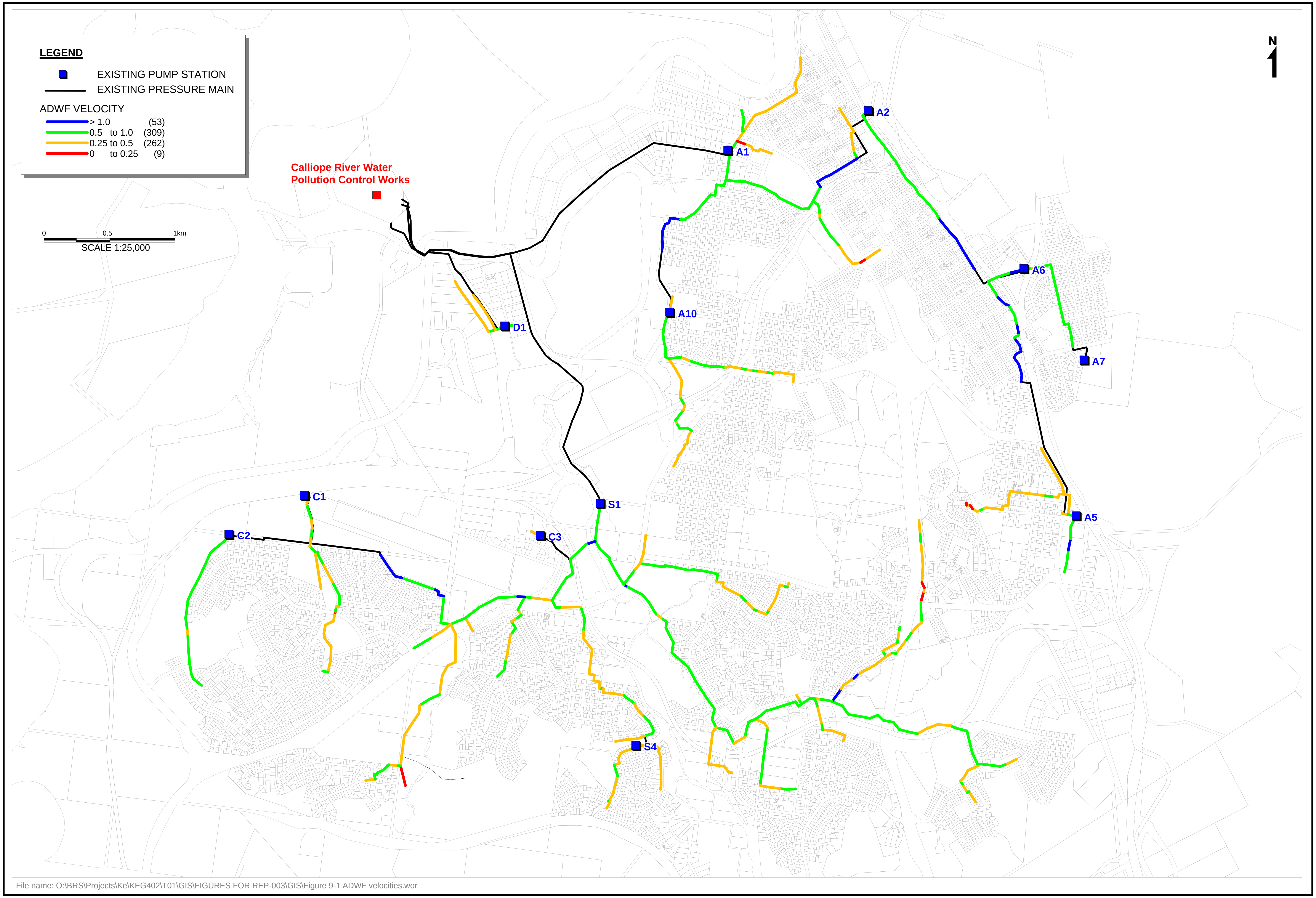

Figure 9.1
ADWF VELOCITY (EXISTING)
CALLIOPE RIVER

Table 9.2 SPS emergency storage—Calliope River

SPS	Pump-affected inflow	Emergency detention storage		Overflow details	
		Time (mins)	% of design criteria*	Trigger location	Level (m)
A1	Yes	150	63%	Manhole spillage	1.3
A2	Yes	150	63%	SPS overflow level	2.0
A5	Yes	90	38%	SPS overflow level	2.6
A6	Yes	60	25%	SPS overflow level	1.1
A7	No	45	19%	Obvert of u/s sewer	0.8
A10	No	150	63%	SPS overflow level	1.3
C1	No	120	50%	SPS overflow level	9.4
C2	No	240	100%	SPS overflow level	14.7
C3	No	45	19%	Obvert of u/s sewer	2.1
D1	No	150	63%	Obvert of u/s sewer	1.1
S1	Yes	180	75%	Manhole spillage	3.5
S4	No	270	113%	SPS overflow level	11.6

** Nominated design criteria is four hours (refer Table 7.2)*

The analysis indicates that only two (C2 and S4) of the 12 modelled SPSs satisfy the current nominated design requirement of four hours emergency storage under ADWF conditions.

9.1.2 Wet weather performance

System capacity

Modelling predicts the occurrence of overflows under existing PWWF conditions at five pump stations—A2, A6, C3, D1 and S4. This indicates that these five pump stations do not have sufficient station capacity to cope with PWWF under the 2004 design loading scenario. Pump station performance is discussed in further detail in the following section.

The modelling also predicts surcharge above ground level at two manholes (MH3 and MH11) on Line 1B between the A10 pressure main and SPS A1. These manhole locations represent low points along this branch of the trunk system, and the predicted surcharge is a result of downstream hydraulic constraints within the system rather than a lack of capacity in Line 1B.

Figure 9.2 presents an overview of the existing system under PWWF conditions. This shows the model-predicted pipe types for all gravity sewers, based on assessment of modelled flows and depths against estimated pipe-full capacity and pipe diameters. The results indicate that 24 of the 633 (4%) modelled sewer sections have flows exceeding pipe-full capacity (shown in red and blue). These sections, as well as the five SPSs with insufficient station capacity, operate as hydraulic constraints to the upstream system, resulting in a large proportion of depth-limited sewer (shown in orange).

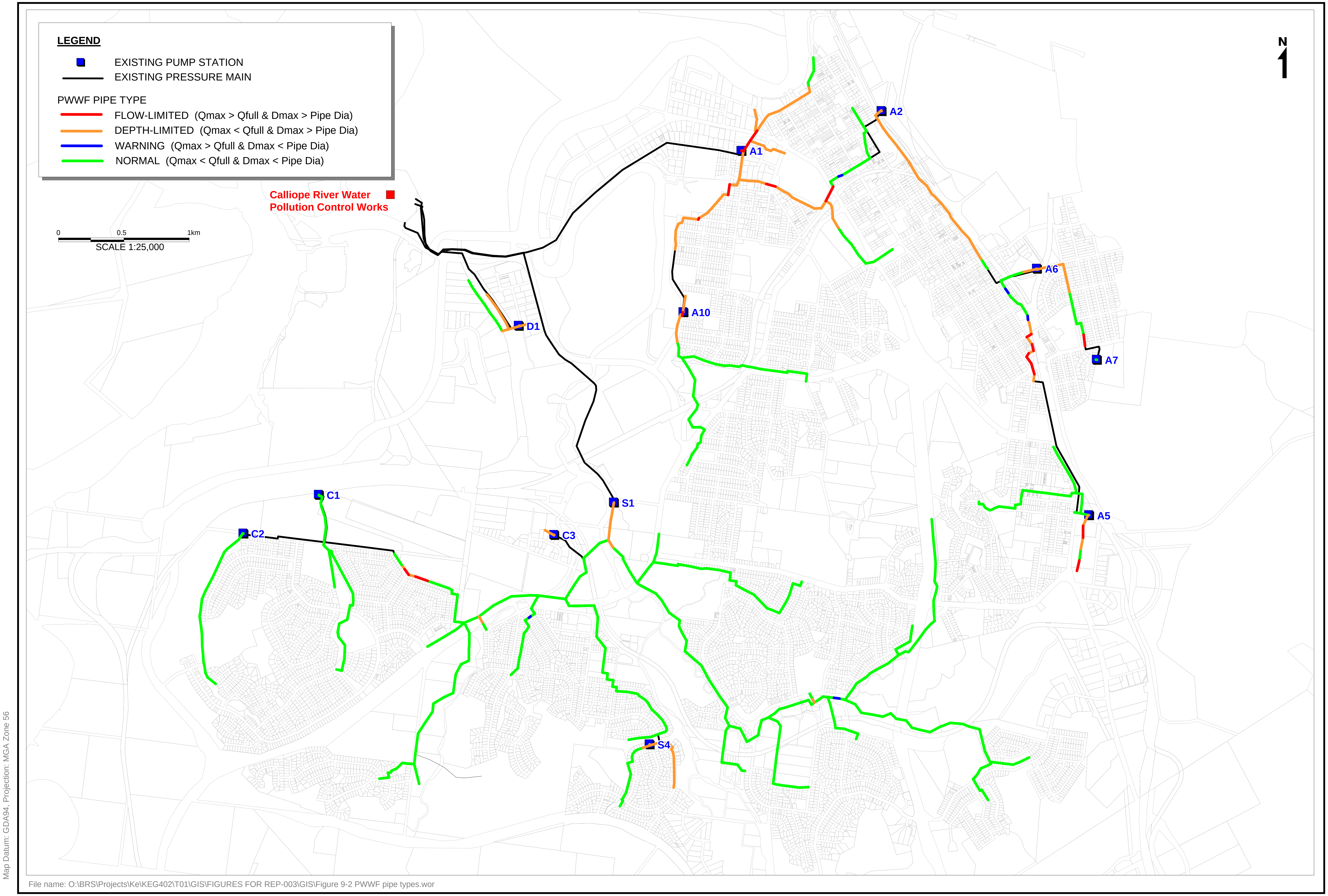

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Figure 9.2
PWWF PIPE TYPES (EXISTING)
CALLIOPE RIVER

Sections of sewer with modelled flows exceeding pipe-full capacity occur on the following trunk lines:

- Line CA—Aerodrome Road, Clinton
- Line CC—Wilson Street, New Auckland
- Line A—Mercury Street, Sun Valley
- Line 5B—French Street, South Gladstone
- Line 10A—Palm Drive, West Gladstone
- Lines 6A-8 and 6B—Wood Street, Barney Point and Toolooa Street, South Gladstone
- Lines 1A, 1B and 1E—Gladstone City and West Gladstone.

Sections of depth-limited sewer occur on the following trunk lines:

- Line CA—Aerodrome Road, Clinton
- Line CD—Dawson Highway, Clinton
- Lines S4-1 and S4-2—Clarence Drive and Emmadale Drive, New Auckland
- Line C—Pacific Way, Kin Kora
- Line 5B—French Street, South Gladstone
- Line S5—Neil Street, Clinton
- Line A—Auckland Creek, West Gladstone
- Lines D1, D1-1 and D1-3—Callemondah
- Lines 10A and 10B—Palm Drive, West Gladstone
- Lines 6A and 6B—Wood Street, Barney Point and Toolooa Street, South Gladstone
- Line 2A—Gladstone City
- Lines 1A, 1B, 1C, 1D, 1E and 1E-1-1—Gladstone City and West Gladstone.

'Normal' pipes (shown in green), with modelled flow less than pipe-full capacity and modelled depth less than pipe height, comprise 75% of the system.

Consideration of system upgrades and/or augmentations to address these issues focuses on providing pipe or pump capacity to remove hydraulic constraints and maintain flow behaviour within the acceptable design criteria for depth of flow (refer Table 7.2).

Sewage pumping station performance

Modelling indicates that a number of SPSs are currently operating with a station capacity less than the nominated design criteria (ie. inflow under PWWF conditions). Table 9.3 provides a summary of existing SPS performance based on a direct comparison of modelled station duty against the peak modelled inflow.

Table 9.3 Assessment of existing SPS performance—Calliope River

SPS	Modelled station duty (L/s)	Modelled head (m)	Modelled PWWF inflow (L/s)	Station capacity shortfall (L/s)	(%)
Surplus capacity					
A5	58	22	47	-	-
A7	20	47	4	-	-
C1	45	27	29	-	-
C2	42	29	21	-	-
At capacity					
A1	300	25	305	5	2
A10	50	10	51	1	2
S1	265	21	271	6	2
Insufficient capacity					
A2	102	14	111	9	9
A6	68	16	116	48	71
C3	8	4	11	3	38
D1	16	16	48	32	200
S4	10	9	18	8	80

It should be noted that the peak inflow shown in Table 9.3 is, in some cases, limited by the modelled pump operation and/or other system constraint and therefore does not represent the actual station capacity requirement to meet the current system design criteria. This reflects the nature of the *system*, where individual components are functionally dependent on both receiving and contributing components. This issue is particularly relevant in the case of SPSs A1 and A2, which are located downstream of large SPSs (A2 and A6, respectively) that have identified capacity deficiencies.

Having identified the SPS deficiencies shown in Table 9.3, the system planning process then seeks to optimise upgrade requirements by taking a system-wide approach, and ensures that receiving system components have sufficient capacity to cater for upgrade requirements.

SPS upgrade requirements must also take account of existing pressure main configurations and performance, which are presented in Table 9.4.

Table 9.4 Existing pressure main performance—Calliope River

SPS	Modelled station duty (L/s)	Pressure main configuration * Dia (mm)	Length (m)	Modelled velocity (m/s)
A1	300	600 / 450	1,855 / 1,340	1.1 / 1.9
A2	102	375	487	0.9
A5	58	300	1,234	0.8
A6	68	300	467	1.0
A7	20	100	224	2.5
A10	50	250	511	1.0
C1	45	250 / 250	390 / 553	0.9 / 1.8
C2	42	200 / 250	632 / 553	1.3 / 1.8
C3	8	150	285	0.5
D1	16	300	1,314	0.2
S1	265	600	3,377	0.9
S4	10	100	129	1.3

** A1 pressure main reduces from 600 mm to 450 mm west of the Auckland Creek crossing.*
C1 and C2 pressure mains join to form a common 250 mm main along Aerodrome Road.

Chapter 10 outlines the recommended SPS upgrades in conjunction with consideration of future growth projections, constraints on system planning and associated trunk gravity main augmentations.

9.2 SOUTH TREES SEWERAGE SCHEME

9.2.1 Dry weather performance

System capacity

Modelling indicates that the South Trees trunk system has sufficient capacity to transport existing dry weather flows. No dry weather overflows are predicted to occur.

Analysis of pipe flows indicates that gravity sewers are typically in the range of 20% to 40% pipe-full under ADWF conditions.

Flow velocity

Figure 9.3 shows the distribution of modelled flow velocity for all gravity sewers under ADWF conditions.

The modelling predicts that a significant proportion of Line T1, which services the South Trees industrial area and delivers flow to SPS T1, is currently running at less than 0.6 m/s under 2004 ADWF conditions.

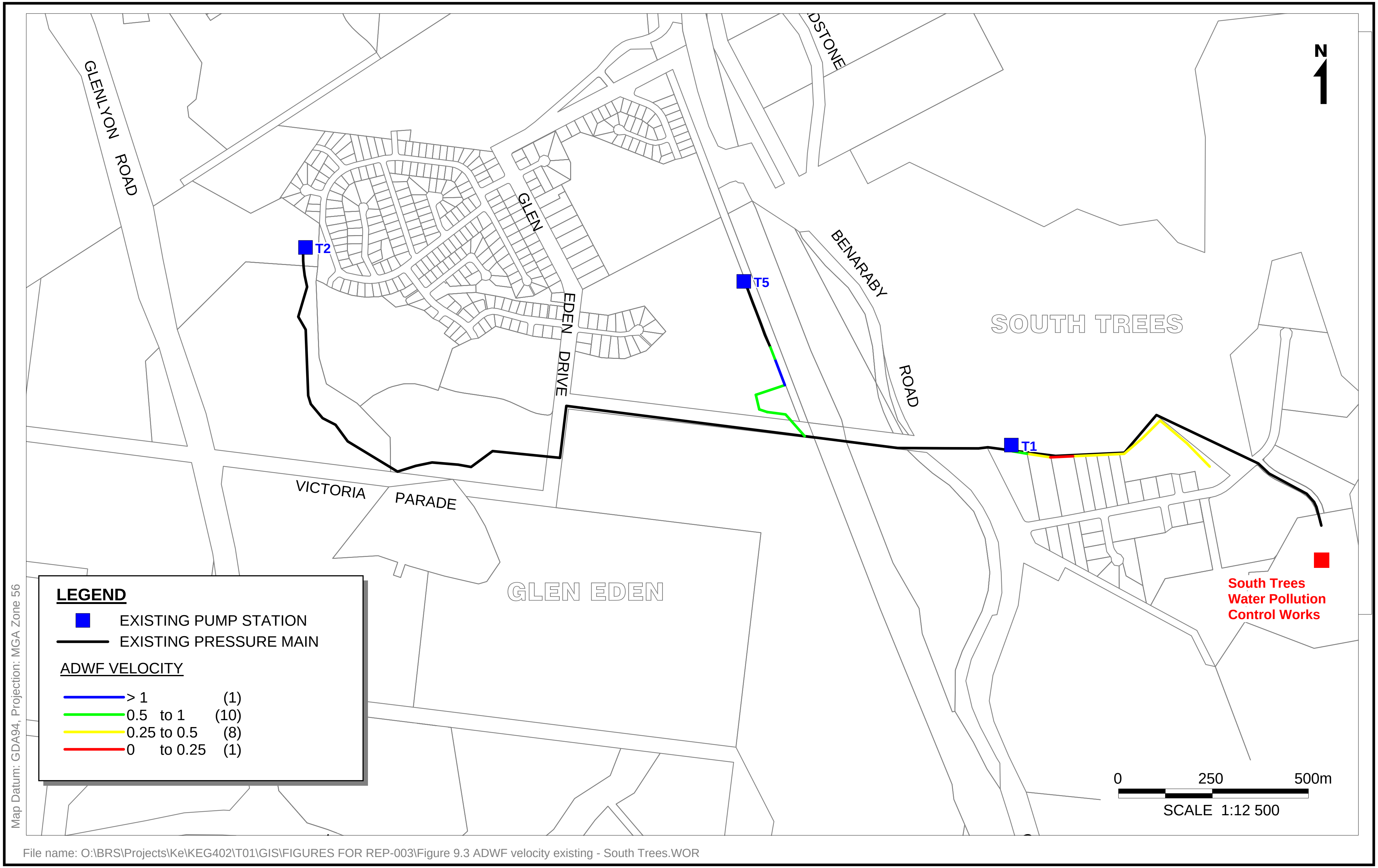

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Figure 9.3
ADWF VELOCITY (EXISTING)
SOUTH TREES

Sewage pumping station performance

To assess the ability of the existing system to accommodate total loss of individual pump station capacity under dry weather conditions, a number of pump-shutdown scenarios were simulated to determine approximate emergency detention storage times for each modelled SPS. The results of this analysis are presented in Table 9.5.

Table 9.5 Assessment of SPS emergency storage—South Trees

SPS	Pump-affected	Emergency detention storage		Overflow details	
		Time (mins)	% of design criteria*	Trigger location	Level (m)
T1	No	285	119%	Manhole spillage	2.1
T2	No	15	6%	Obvert of u/s sewer	24.3
T5	No	45	19%	Obvert of u/s sewer	8.4

** Nominated design criteria is four hours (refer Table 7.2)*

Note that the reported storage times for SPSs spilling at the upstream extent of modelled sewer are extremely conservative.

9.2.2 Wet weather performance

System capacity

Modelling predicts the occurrence of overflows under existing PWWF conditions at SPS T5. This indicates that this pump station does not have sufficient station capacity to cope with PWWF under the 2004 design loading scenario. Pump station performance is discussed in further detail in the following section.

The modelling also predicts surcharge above ground level at two manholes (MH1 and MH2) on Line T2-30. This trunk main connects the T5 pressure main to the T2 pressure main via direct gravity discharge into a section of the T2 pressure main effectively running under gravity. This surcharge is a result of high hydraulic head being transmitted up the gravity line from the T2 pressure main.

Figure 9.4 presents an overview of the existing system under PWWF conditions, which shows the model-predicted pipe types for all gravity sewers based on assessment of modelled flows and depths against estimated pipe-full capacity and pipe diameters.

Sections of sewer with modelled flows exceeding pipe-full capacity occur on the following trunk lines:

- Line T2-8—Glen Eden

Depth-limited sewer also occurs on this trunk line as a result of the flow limitation.

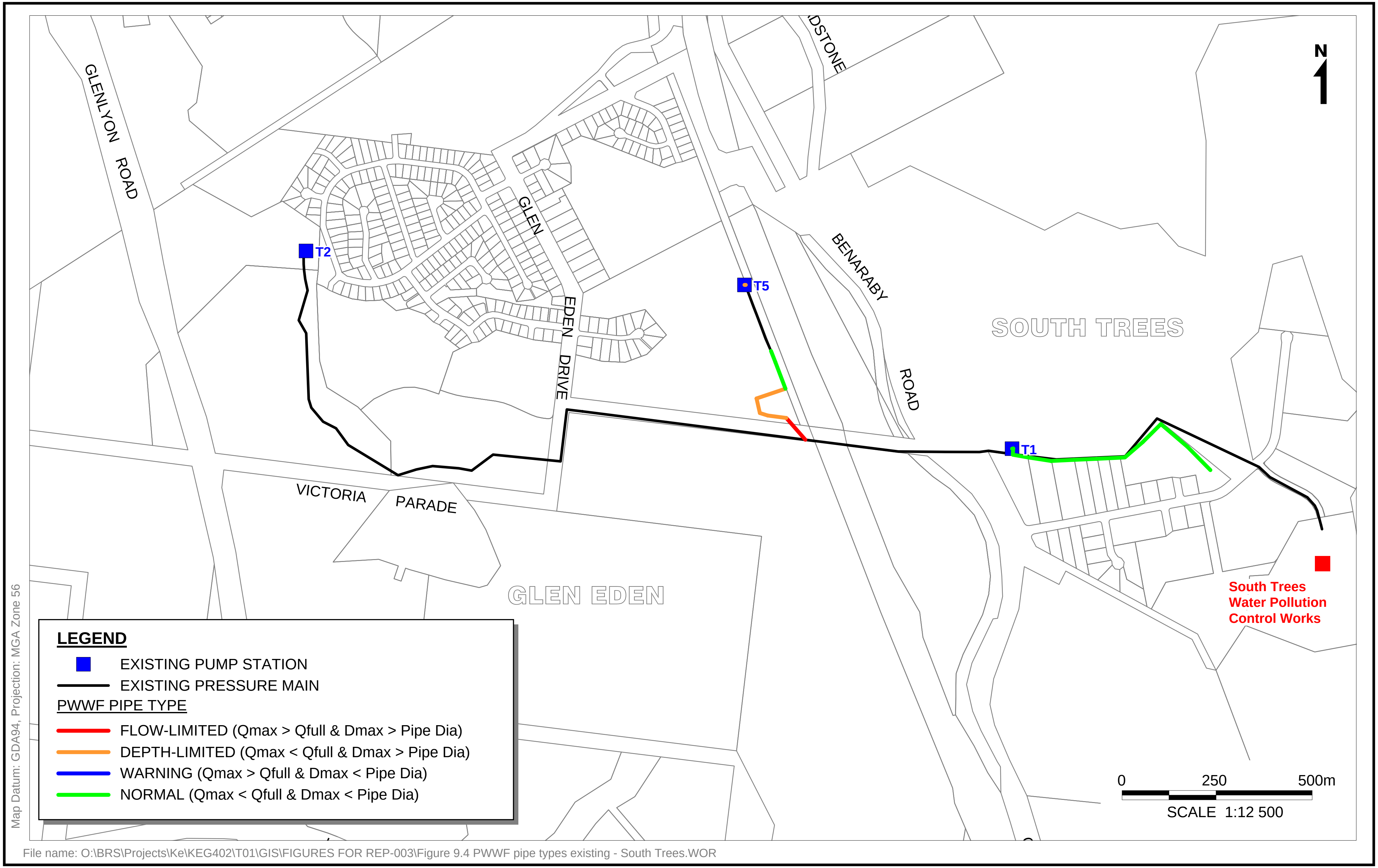


Figure 9.4
PWWF PIPE TYPES (EXISTING)
SOUTH TREES

Sewage pumping station performance

Modelling indicates that one SPS (T5) is currently operating with a station capacity less than the nominated design criteria (ie. inflow under PWWF conditions). Table 9.6 provides a summary of existing SPS performance based on a direct comparison of modelled station duty against the peak modelled inflow.

Table 9.6 Assessment of existing SPS performance—South Trees

SPS	Modelled station duty (L/s)	Modelled head (m)	Modelled PWWF inflow (L/s)	Station capacity shortfall (L/s)	Station capacity shortfall (%)
T1	24	14	16	—	—
T2	31	31	13	—	—
T5	4	15	5	1	25

SPS upgrade requirements for future planning scenarios will also take account of existing pressure main configurations and performance, which are presented in Table 9.7.

Table 9.7 Existing pressure main performance—South Trees

SPS	Modelled station duty (L/s)	Pressure main configuration * Dia (mm)	Pressure main configuration * Length (m)	Modelled velocity (m/s)
T1	24	225	956	0.6
T2	31	225 / 200	1,347 / 1,142	0.8 / 2.0
T5	4	100	178	0.5

** T2 pressure main reduces from 225 mm to 200 mm at the point where it switches to gravity operation near Glen Eden Dr.*

10 Future system requirements

10.1 OVERVIEW

The majority of growth in Gladstone City Council is to occur in the three suburbs of Kirkwood, Glen Eden and O'Connell. These suburbs are largely undeveloped and therefore significant infrastructure will be required to service these areas. It is proposed to incorporate the majority of Kirkwood within the Calliope River scheme, while Glen Eden and O'Connell will form part of a much expanded South Trees scheme. The other significant expansion of the Calliope River scheme will occur to the west within Callemondah, with the establishment of light industrial areas on the northern side of Red Rover Road.

10.2 CALLIOPE RIVER SEWERAGE SCHEME

For the purpose of presenting the approach and recommendations for system planning, the Calliope River sewerage scheme has been divided into two main regions:

- Northern catchments – this incorporates the entire region currently serviced by SPS A1, as well as the smaller industrial catchment to its west serviced by SPS D1.
- Southern catchments – this incorporates the entire region currently serviced by SPS S1, as well as the future industrial catchments to its west.

10.2.1 Northern catchments

Projected growth

Projected future growth in the northern catchments will comprise both infill development and redevelopment of existing service areas. Furthermore, no significant expansions to the existing service areas have been identified. Growth will be accommodated by either increasing the size of connections to the existing trunk sewerage system or through an increased density of connections.

Constraints on system planning

A number of constraints are seen to impact on system planning, including the natural topography, the existing built environment and existing sewerage system development, particularly the general lack of excess capacity in major trunk gravity sewers and SPSs. Due to this lack of spare capacity within the existing system, there is little opportunity for exploring flow transfers or diversions to redistribute loadings and remove pressure from system components that are currently or will in future be stressed.

In the context of identified deficiencies with the existing system and projected growth levels, the following present particular constraints to system planning:

- the linear nature of the main trunk branch connecting SPSs A1, A2 and A6, which limits the ability to consider flow transfers or diversions; and
- limited capacity of trunk lines 2A and 1A to receive increased pumped flows from SPS A6 and SPS A2, respectively.

Planning for the northern catchments therefore adopts an 'upgrade and replace' philosophy that necessarily considers:

- identified system deficiencies under current conditions;
- the flow-on effect that upgrades or augmentations to upstream system components have on components further downstream; and
- the timing of projected growth up to 2030.

All three factors influence the staging of the required system upgrades that have been identified.

Sewage pumping station capacity requirements

Based on modelling scenarios to assess current and future (2016 and 2030) system requirements, the need to upgrade station capacity at four existing SPSs within the northern catchments has been identified. These comprise SPS A1, A2, A6 and D1. Duty and delivery requirements for each station are presented in Table 10.1, with more detailed discussion provided below.

Existing SPS A1

Although the theoretical existing shortfall at SPS A1 (2%) is not significant, the requirement for substantial upgrades at SPS A6 and A2 in the short-term drive the need for priority upgrading SPS A1 to cater for the resulting increase in flows at the bottom of the system. Current information regarding operating conditions at SPS A1 indicates a peak station output of 300 L/s at 35 m head, which is generated from two pumps working alternately due to a station configuration that does not allow simultaneous operation.

Upgrading the current station capacity at SPS A1 could reasonably be achieved in two ways:

- Option 1—upgrade the current pumps to meet existing and future design requirements.
- Option 2—reconfigure the current station set-up to allow simultaneous operation of the two existing pumps.

Option 2 is clearly preferable provided that the combined pump duty that could be achieved satisfies the identified station capacity requirement(s) and can be delivered against the required head.

Table 10.1 SPS requirements – Calliope River northern catchments

SPS	Current configuration				Year 2004 requirement			Year 2016 requirement			Year 2030 requirement		
	Pump duty	Max. head	Pressure main		Duty	Head	Vel.	Duty	Head	Vel.	Duty	Head	Vel.
	(L/s)	*(m)*	*Dia. (mm)*	*Vel. (m/s)*	*(L/s)*	*(m)*	*(m/s)*	(L/s)	(m)	(m/s)	(L/s)	(m)	(m/s)
A1	300	37	600 / 450	1.1 / 1.9	365	47	1.3 / 2.3	390	51	1.4 / 2.5	420	57	1.5 / 2.6
A2	102	14	375	0.9	160	16	1.4	170	16	1.5	190	19	1.7
A5	58.3	21	300	0.8	No upgrade required								
A6	68	16	300	1.0	120	21	1.7	125	22	1.8	135	23	1.9
A7	19.7	46	100	2.5	No upgrade required								
A10	50	10	250	1.0	No upgrade required								
D1	16	15	300	0.2	48	19	0.7	50	19	0.7	50	19	0.7

Table 10.2 SPS requirements – Calliope River southern catchments

SPS	Current configuration				Year 2004 requirement			Year 2016 requirement			Year 2030 requirement		
	Pump duty	Max. head	Pressure main		Duty	Head	Vel.	Duty	Head	Vel.	Duty	Head	Vel.
	(L/s)	*(m)*	*Dia. (mm)*	*Vel. (m/s)*	*(L/s)*	*(m)*	*(m/s)*	(L/s)	(m)	(m/s)	(L/s)	(m)	(m/s)
C1	45	27	250 / 250	0.9 / 1.8	No upgrade required								
C2	42	29	200 / 250	1.3 / 1.8	No upgrade required								
C3	8	4	150	0.5	11	5	0.6	14	5	0.8	14	5	0.8
D2	Future SPS				-	-	-	4	16	0.2	15	34	0.8
D3	Future SPS				-	-	-	-	-	-	7	28	0.9
S1	265	21	600	0.9	285	22	1.0	415	31	1.5	450	34	1.6
S4	10	9	100	1.3	To be decommissioned								

This option requires further consideration and evaluation based on a detailed assessment of the current station set-up and pump specifications that is beyond the scope of the current study. However, it is recommended that this option be explored prior to committing funds for a capital works program due to the significant cost savings that may be realised over Option 1, particularly in the short-term and in light of the recent (2001) replacement of Pump No. 2 at SPS A1.

For the purposes of costing capital works requirements, this study has adopted Option 1 for the SPS A1 upgrade based on providing a structure that is compatible with the ultimate requirement of 420 L/s in 2030, and provision of variable speed drives to allow for ramping up of station capacity as needed from 365 L/s in 2004.

No upgrade of the existing A1 pressure main is proposed based on the modelled flow velocities presented in Table 10.1. However, it should be noted that the remaining section of 450 mm diameter main on the western side of Auckland Creek contributes a significant proportion of the total head requirement at SPS A1. Retention of the current pressure main configuration (600 mm reducing to 450 mm) may therefore need to be reconsidered (the alternative being to augment the original and remaining 450 mm section to 600 mm) depending on the feasibility of simultaneous pump operation and the ability of the existing pumps to operate against the required head.

Existing SPS A2

Upgrading of station capacity at SPS A2 is required to meet both existing and future design flows at this point in the system. Current information regarding operating conditions at SPS A2 indicates a peak station output of 102 L/s, which is generated from two pumps working on a duty/standby configuration.

The upgrade of SPS A2 would provide a structure that is compatible with the ultimate requirement of 190 L/s in 2030, and provision of variable speed drives to allow for ramping up of station capacity as needed from 160 L/s in 2004.

No upgrade of the existing A2 pressure main is proposed based on the modelled flow velocities presented in Table 10.1.

Augmentation works on the receiving trunk main (Line 1A) will be required in conjunction with these station capacity upgrades, as discussed below.

Existing SPS A6

Upgrading of station capacity at SPS A6 is required to meet both existing and future design flows at this point in the system. Current information regarding operating conditions at SPS A6 indicates a peak station output of 68 L/s, which is generated from two pumps working on a duty/standby configuration.

The upgrade of SPS A6 would provide a structure that is compatible with the ultimate requirement of 135 L/s in 2030, and provision of variable speed drives to allow for ramping up of station capacity as needed from 120 L/s in 2004.

No upgrade of the existing A6 pressure main is proposed based on the modelled flow velocities presented in Table 10.1.

Augmentation works on the receiving trunk main (Line 2A) will be required in conjunction with these station capacity upgrades, as discussed below.

Existing SPS D1

Upgrading of station capacity at SPS D1 is required to meet both existing and future design flows at this point in the system. Current information regarding operating conditions at SPS D1 indicates a peak station output of 16 L/s, which is generated from two pumps working on a duty/standby configuration.

The upgrade of SPS D1 would provide a structure that is compatible with the ultimate requirement of 50 L/s in 2030, and provision of variable speed drives to allow for ramping up of station capacity as needed from 48 L/s in 2004.

It is relevant to note that although SPS D1 is identified with a significant shortfall (200%) based on existing design flows, it is recognised that operational staff have not experienced any problems with this station to date. This suggests that the adopted design loading on SPS D1 is conservative. It is therefore recommended that upgrade works at SPS D1 be delayed until the need is more clearly established through observation and operational feedback.

No upgrade of the existing D1 pressure main is proposed based on the modelled flow velocities presented in Table 10.1.

Gravity trunk main extension requirements

Due to a lack of projected growth outside of existing sewerage service areas there are no gravity trunk main extension requirements for the northern catchments.

Gravity trunk main augmentation requirements

Line 1A

Line 1A is located within Gladstone City, running generally along William Street, Railway Street, Side Street and Lord Street before discharging into SPS A1. Line A1 receives flow from the pressure main for SPS A2. The size of this trunk main increases from 225 mm at the top end to 600 mm. A short section of 375 mm main acts as a throttle prior to discharge into SPS A1.

Modelling indicates that Line 1A contains a number of sections running at greater than pipe-full capacity under existing conditions. A substantial length of the line is also subject to downstream hydraulic constraint as a result of the current station capacity of SPS A1 (which will be significant following upgrades to A6 and A2) and the 375 mm throttle immediately upstream of the pump station. However, no spillage is predicted to occur under existing conditions.

In the short-term, upgrading SPS A1 to provide a minimum station capacity of 365 L/s (the 2004 requirement) will relieve the hydraulic constraint on Line 1A. However, the increased flow in Line 1A which will result from the proposed upgrade of SPS A2 (2004 requirement of 160 L/s) is predicted to cause spilling unless the 375 mm throttle is removed. Replacement of this short section of 375 mm with a new 750 mm line is therefore recommended in conjunction with works to upgrade station capacity at SPS A1. This would need to be undertaken prior to the upgrade of SPS A2.

In the longer term duplication of Line 1A, between the A2 pressure main injection point (MH24) and SPS A1, with a new 375 mm trunk main will be required to accommodate subsequent increases in the station capacity of SPS A2. This would need to be undertaken prior to ramping up the duty at SPS A2 to 170 L/s in 2016. This duplication would also provide sufficient capacity in Line 1A for later ramping up to 190 L/s in 2030.

Line 2A

Line 2A is located predominantly in Gladstone City, running parallel to and west of the railway line, and receives flow from the pressure main for SPS A6. The size of Line 2A increases from 300 mm at the top end to 450 mm for most of its length.

Modelling indicates that the capacity of Line 2A is adequate under existing conditions (up to 85% pipe-full flow) and that surcharge predicted in this line is the result of downstream hydraulic constraint caused by insufficient station capacity at SPS A2. Spilling is not predicted to occur on this line under existing conditions.

In the short-term, upgrading SPS A2 to provide a minimum station capacity of 160 L/s (the 2004 requirement) will relieve current the hydraulic constraint on Line 2A. However, the increased flow in Line 2A which will result from the proposed upgrade of SPS A6 (2004 requirement of 120 L/s) is predicted to cause spilling at the top end of the line where the pipe diameter is 300 mm. Duplication of a short section of this existing 300 mm main with a new 375 mm main is therefore recommended, between MH18 and MH19. This would need to be undertaken prior to the upgrade of SPS A6.

In the longer term, duplication of a much longer section of existing 450 mm main with a new 375 mm main (extending from MH12 down to SPS A2) will be required to accommodate subsequent increases in the station capacity of SPS A6. This would need to be undertaken prior to ramping up the duty at SPS A6 to 125 L/s in 2016. This duplication would also provide sufficient capacity in Line 2A for later ramping up to 135 L/s in 2030.

Line 6B

Line 6B is located in South Gladstone, running generally parallel and between the railway line and Toolooa Street, and receives flow from the pressure main for SPS A5. The size of this trunk main increases from 225 mm at the top end to 300 mm for most of its length.

While no spilling is predicted under existing conditions, there is limited freeboard (approx. 200 mm) available at the top end of the line where the pipe diameter is 225 mm. Although duplication of the 225 mm section of Line 6B would resolve this, existing development over the line is considered to constrain this option. It is therefore recommended that two manholes (MH21 and MH22) are sealed to ensure that spilling does not occur in this area.

No upgrade requirement for SPS A5 has been identified and, accordingly, a similar level of freeboard is predicted in this location up to 2030.

10.2.2 Southern catchment

Projected growth

Future growth in the southern catchments comprises a combination of infill development, redevelopment and greenfield development. Greenfield development will require substantial expansion of the existing service area, primarily to encompass residential and park residential growth within Kirkwood, south of Kirkwood Road. Other significant greenfield sites will include urban expansion within Toolooa, residential areas within Clinton and New Auckland and light industry within Callemondah.

Constraints on system planning

A number of the same constraints that impact the northern catchments are seen to impact on system planning in the southern catchment, including the natural topography, the existing built environment and existing sewerage system development.

In the context of identified deficiencies with the existing system, identified expansion areas and projected growth levels, the following present particular constraints to system planning:

- limited capacity in gravity Line CB to accommodate upgrades to SPS S4, and limited scope for augmentation of Line CB due to development constraints; and
- limited capacity in gravity line CE5 (Harvey Road branch) to accommodate future development within Kirkwood.

Sewage pumping station capacity requirements

Existing SPS S1

While the theoretical existing shortfall at SPS S1 (2%) is not significant, upgrading of station capacity will be required to meet future design flows at this point in the system. Current information regarding operating conditions at SPS S1 indicates a peak station output of 265 L/s, which is generated from two pumps working alternately due to a station configuration that does not allow simultaneous operation. The larger pump is rated at 265 L/s and is in satisfactory condition. The smaller pump is rated at 165 L/s and is in poor condition.

Council has advised that the smaller pump will require replacement in the current financial year at an estimated capital cost of $170,000.

Future upgrading of the current station capacity could reasonably be achieved in two ways:

- Option 1—upgrade the current pumps to meet the identified future design requirements.
- Option 2—reconfigure the current station set-up to allow simultaneous operation of the two existing pumps.

Option 2 is clearly preferable provided that the combined pump duty that could be achieved satisfies the identified station capacity requirement(s) and can be delivered against the required head. This option requires further consideration and evaluation based on a detailed assessment of the current station set-up and pump specifications that is beyond the scope of the current study.

For the purposes of costing capital works requirements, this study has adopted Option 1 for the SPS A1 upgrade based on providing a structure that is compatible with the ultimate requirement of 450 L/s in 2030, and provision of variable speed drives to allow for ramping up of station capacity as needed.

No upgrade of the existing S1 pressure main is proposed based on the modelled flow velocities presented in Table 10.1.

Existing SPS S4

Upgrading of station capacity at SPS S4 is required to meet both existing and future design flows at this point in the system. Current information regarding operating conditions at SPS S4 indicates a peak station output of 10 L/s, which is generated from two pumps working on a duty/standby configuration.

However, capacity constraints on the receiving trunk main (Line CB) limit ultimate pumped flows from SPS S4 to around 27 L/s without augmentation of Line CB. The required augmentation works would be heavily constrained by existing residential development within New Auckland.

It is recommended that an option to transfer flow from the entire catchment upstream of SPS S4 (under both existing and future conditions) to Line A be adopted to avoid the need for upgrading both SPS S4 and the downstream trunk system.

SPS S4 and the existing 100 mm pressure main connecting to Line CB would be decommissioned following installation of this new gravity transfer line.

Due to the identified deficiency in station capacity under current conditions, as well as the poor condition of the existing pumps in SPS S4 (as advised by Council), the transfer line is considered to be a short-term need and should be pursued for the 2005 financial year.

Future SPS D2 and SPS D3

Future pump stations D2 and D3 will be required to service future industrial development in Callemondah, located on the northern side of Red Rover Road.

Two options were assessed with regard to these pump stations, which reassessed the previous planning of this future industrial region and the suburb of Clinton that was undertaken by MacIntyre & Associates (1997).

Option 1 involved establishing future SPS D2 and D3 in isolation to existing elements of the Calliope River scheme, with SPS D2 pumping directly to the Calliope River STP. The ultimate duty requirement for SPS D2 under this scenario is 15 L/s in 2030, with a 150 mm pressure main.

Option 2 involved establishing future SPS D2 and D3 in the same location and servicing the same future subcatchments, but also involved redirecting existing subcatchments served by SPS C1 and C2 to drain into SPS D2. This would involve abandoning SPS C1, constructing a gravity diversion from SPS C1 under the railway, and redirecting the C2 pressure main to discharge into Line C1 and drain north to SPS D2.

The estimated total capital cost for Options 1 and 2 was $1,951,000 and $2,389,000 respectively.

NPV analyses based on preliminary capital works programs and year 2004 costs, including estimated power and maintenance costs, were performed to rank the options on a financial basis. At a 6% discount rate the NPV of Option 1 is $1,366,000, which is substantially lower than $1,512,000 for Option 2. On this basis, Option 1 was adopted as the preferred scenario.

Based on current growth predictions, SPS D2 will be required in 2016 with SPS D2 required in 2026.

Gravity trunk main extension requirements

The following extensions of existing gravity trunk mains are required to service future growth areas in the suburbs of Kirkwood and New Auckland:

- Extension of Line CE5 (Harvey Road trunk main)—300 mm trunk main required for year 2010.
- Extension of Line CE5-1 (Kaleentha trunk main)—225 mm trunk main required for year 2007/2010.
- Extension of Line CB—150 mm trunk main required for year 2007.
- Extension of Line S4-1 (Clarance Drive trunk main)—225 mm trunk main required for year 2006.
- Extension of Line S4-2 (Emmadale Drive trunk main)—225 mm trunk main required for year 2006.

The timing of all extensions identified above are based on current growth predictions but should be regarded as development-driven.

The other significant extension of the existing gravity main in the southern catchment is the proposed transfer line between SPS S4 and Line A. This option will involve construction of a 300 mm trunk gravity line, connecting to Line S4-1 (225 mm) just upstream of SPS S4 and to Line A (450 mm) just downstream of the Line A39 connection. The transfer line will require two piered creek crossings and pipe-jacking under the railway line.

Gravity trunk main augmentation requirements

The existing gravity trunk system has sufficient capacity to transport current (2004) PWWF in accordance with the nominated design criteria. Further, augmentations will not be required in conjunction with other works identified for implementation in the short-term.

However, augmentations will be required to accommodate population growth and predicted expansion of the southern catchments. Three locations have been identified and these are discussed below.

Line CE5

Duplication of Line CE5 (Harvey Road trunk main) is required to accommodate the future residential growth south of Kirkwood Road. This population is to be serviced by a 300 mm extension to Line CE5, as discussed above.

Based on current growth projections the duplication will be needed around 2010, and prior to development south of Kirkwood Road contributing to this trunk main. The proposed duplication will require approximately 670 m of 300 mm sewer to augment the existing 300 mm line.

Line CE5-1

Duplication of Line CE5-1 (Kaleentha trunk main) is also required to accommodate the future residential growth south of Kirkwood Road. This population is to be serviced by a 225 mm extension to Line CE5-1, as discussed above.

Based on current growth projections the duplication will be needed around 2010, and prior to development south of Kirkwood Road contributing to this trunk main. The proposed duplication will require approximately 560 m of 225 mm sewer to augment the existing 225 mm line.

Line CA

Line CA forms one of two major trunk sewers (the other being Line A) draining to SPS S1. Duplication of a section of Line CA is required to accommodate future growth in Clinton, New Auckland and Kirkwood that will be delivered via Line CE5.

The section of Line CA requiring duplication runs adjacent to and to the west of the Dawson Highway, between the junction with Line CE5 at Aerodrome Road and the junction with Line CC at the Briffney Creek crossing. The proposed duplication will require approximately 620 m of 300 mm sewer to augment the existing 450 mm line.

10.3 SOUTH TREES SEWERAGE SCHEME

Projected growth

The southern suburbs of Glen Eden and O’Connell represent one of the largest predicted growth areas of Gladstone over the next 25 years. Development will mainly comprise residential and rural residential through greenfield sites, with some infill around Glen Eden and further industrial development at South Trees. Significant expansions to the existing area serviced by the South Trees scheme have been identified to accommodate this growth. Regions of future residential development within Kirkwood, New Auckland and Telina will also form part of a much expanded South Trees sewerage scheme.

Constraints on system planning

A number of constraints are seen to impact on system planning, including the natural topography, the existing built environment and existing sewerage system development. Due to the relatively small size of the existing scheme there is little opportunity to explore flow transfers or diversions to redistribute loadings and remove pressure from system components that are currently or will in future be stressed.

In the context of identified deficiencies with the existing system and projected growth levels, the following present particular constraints to system planning:

- the limited capacity of the existing common pressure main configuration from SPS T2 to South Trees STP, which picks up a gravity injection from SPS T5 and pumped injection from SPS T1; and
- the limited capacity of trunk line T2-30 (downstream of SPS T5) to receive increased pumped flows from SPS T5.

Sewage pumping station requirements

Based on modelling scenarios to assess current and future system requirements, the need to upgrade station capacity at two existing SPSs within the South Trees scheme has been identified. These comprise SPS T2 and T5. In addition, four additional SPSs will be required to service new development areas. Duty and delivery requirements for each station are presented in Table 10.3, with more detailed discussion provided below.

Table 10.3 SPS requirements – South Trees scheme

SPS	Current configuration				Year 2004 requirement			Year 2030 requirement		
	Pump duty *(L/s)*	Max. head *(m)*	Pressure main Dia. *(mm)*	Pressure main Vel. *(m/s)*	Duty *(L/s)*	Head *(m)*	Vel. *(m/s)*	Duty (L/s)	Head (m)	Vel. (m/s)
T1	24	14	225	0.6	No upgrade required					
T2	31	31	225 / 200	0.8 / 2.0	No upgrade required			125	31	1.8
T5	4	15	100	0.5	5	15	0.6	13	24	1.7
ST1	Future SPS				-	-	-	160	20	1.4
ST3	Future SPS				-	-	-	21	72	1.2
ST4	Future SPS				-	-	-	40	39	1.3
ST6	Future SPS				-	-	-	4	8	1.3

Existing SPS T1

The existing station capacity at SPS T1 will be sufficient up to the year 2030 without the need for upgrade. Current information regarding operating conditions at SPS T1 indicates a peak station output of 24 L/s, which is generated from two pumps working on a duty/standby configuration.

Currently, SPS T1 injects into a common pressure main running from SPS T2 to South Trees STP. It is proposed to alter this arrangement from 2010 onwards when SPS T2 is intercepted by the new SPS ST1. The section of common pressure main between Glen Eden Drive and SPS T1 would then be decommissioned.

The remaining section of common pressure main would then continue to be utilised solely by SPS T1, pumping directly to the STP. No change to the existing pressure main downstream of SPS T1 is proposed based on the modelled flow velocities presented in Table 10.3.

Existing SPS T2

SPS T2 will ultimately receive flows from future SPSs ST3 (via an extension to the Glenlyon Road trunk main), ST4 and ST6. SPS T2 will then pump to future SPS ST1 via a duplicated and extended pressure main.

Upgrading of existing station capacity at SPS T2 is required to meet future design flows at this point in the system, although the existing station capacity is sufficient for current loading conditions.

Current information regarding operating conditions at SPS T2 indicates a peak station output of 31 L/s, which is generated from two pumps working on a duty/standby configuration.

The upgrade of SPS T2 would provide a structure that is compatible with the ultimate requirement of 125 L/s in 2030.

The existing 225 mm pressure main would need to be duplicated with a 200 mm line up to Glen Eden Road, from where a single 300 mm extension would deliver flow to the ST1 trunk gravity main.

Existing SPS T5

Upgrading of station capacity at SPS T5 is required to meet both existing and future design flows at this point in the system. Current information regarding operating conditions at SPS T5 indicates a peak station output of 4 L/s, which is generated from two pumps working on a duty/standby configuration.

The upgrade of SPS T5 would provide a structure that is compatible with the ultimate requirement of 13 L/s in 2030.

No upgrade of the existing T5 pressure main is proposed based on the modelled flow velocities presented in Table 10.3.

Augmentation works on the receiving trunk main (Line T2-30) will be required in conjunction with this station capacity upgrade, as discussed below.

Future SPS ST1

SPS ST1 will form the major pump station in the South Trees scheme, ultimately receiving flows from the entire catchment east of the South Trees industrial area. This will include existing SPSs T2 and T5, in addition to future SPSs ST3, ST4 and ST6. SPS ST1 will also be required to service new development within eastern Glen Eden, located north of Kirkwood Road and west of the railway, which can be gravitated to the pump station.

Based on current growth projections, SPS ST1 and associated pressure main and gravity trunk main would not be required until 2016 to service the local subcatchment. However, SPS ST1 will be required earlier than this in order to facilitate the future connection of the upgraded SPS T2. The installation of SPS ST4 would provide a station that is compatible with the ultimate requirement of 165 L/s in 2030.

SPS ST1 will pump directly to the South Trees STP via a new 375 mm pressure main, the alignment of which would closely follow the existing T1 pressure main.

Existing SPS ST3

SPS ST3 will be required to service new development in O'Connell, located south of Kirkwood Road and west of Glen Lyons Road in the vicinity of Haddock Drive.

SPS ST3 will pump to the east across Glen Lyons Road, discharging into an extension of the existing Glenlyon Road trunk main and flowing north to existing SPS T2.

Based on current growth projections, SPS ST3 and associated 150 mm pressure main and gravity trunk main will be required for 2011. The installation of SPS ST3 would provide a station that is compatible with the ultimate requirement of 21 L/s in 2030.

Existing SPS ST4

SPS ST4 will be required to service new development in the south-eastern portion of Kirkwood (west of Kirkwood Road), southern areas of New Auckland and Telina, and north-western part of Glen Eden.

SPS ST4 will pump to the east and ultimately discharge into an upgraded SPS T2. The proposed pressure main alignment would cross Woodstock Road and generally follow Dickey Road and Glenlyon Road. The 200 mm pressure main would support future injection of an additional pump station SPS ST6, to be located adjacent to Dickey Road.

Based on current growth projections, SPS ST4 and associated pressure main and gravity trunk main will be required for 2016. The installation of SPS ST4 would provide a station that is compatible with the ultimate requirement of 40 L/s in 2030.

Existing SPS ST6

SPS ST6 will be required to service new development in the small, topographically isolated area of Glen Eden that lies between the future SPS ST4 subcatchment and an expanded SPS T2 subcatchment, bounded to the north by Dickey Road and to the south by Kirkwood Road.

SPS ST6 will inject directly into the 200 mm ST4 pressure main, pumping to the east and ultimately discharging into an upgraded SPS T2.

Based on current growth projections, SPS ST6 will be required for 2030 with an ultimate requirement of 4 L/s.

Gravity trunk main extension requirements

Extension of the existing gravity trunk main system will be required within each future pump station subcatchment, as discussed in the previous section. The proposed location of this future gravity trunk main is shown on Figures A.5—A.7.

In addition, extension of the existing 375/300 mm Glenlyon Road trunk main (parts of which are currently under construction or have recently been completed) will be required to:

- service south-eastern O’Connell (the area south of Kirkwood Road and east of Glenlyon Road); and
- accommodate future connection of the 150 mm pressure main from SPS ST3.

The timing of the Glenlyon Road trunk main extension is driven by the need for SPS ST3 in 2011. The extension is required to be 225 mm below the pressure main, extending further south at 150 mm to pick up additional development.

10.4 CONFIRMATION OF UPGRADE NEEDS AND TIMING OF WORKS

As previously discussed in Chapter 5 and in Section 8.2, the estimation of sewer loads for planning purposes was based on water usage distribution data sourced from Council’s existing water supply model. Due to its heritage from rates database information, this forms the best available source of load distribution since it provides real, measured data and relates to both residential and non-residential land uses.

However, in light of the significant system upgrades identified, which are clearly dependent on the sewer loading adopted for planning, it is considered prudent to confirm modelled flows in the system under current conditions through a catchment-wide flow monitoring program. This should be commenced as soon as possible.

10.5 AUGMENTATION SCHEDULES

Schedules of the proposed works for the Gladstone City Council sewerage schemes are contained in Table 10.4.

The unit rates used for costing sewerage infrastructure assume a competitive tendering basis and reflect escalation that has occurred, particularly in South East Queensland, over the past two to three years. Note that unit rates for a given pipe diameter may vary based on the estimated depth of installation.

Table 10.4 Proposed staging of system augmentations and extensions

Item	Description	Qty.	Unit	Rate ($/unit)	Capital Cost ($)	Financial year	Notes	Staging 2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-15	2015-20	2020-30
CALLIOPE RIVER AND SOUTH TREES SCHEMES																
1	Flow monitoring and model calibration study (provisional amount)	1	Item	—	100,000	2005/06			100,000							
	SUBTOTAL				**100,000**											
CALLIOPE RIVER SCHEME																
Augmentations and extensions for southern catchments																
	Existing service areas															
2	Line CA augmentation - duplicate existing Ø450mm with Ø300mm	624	m	335	209,000	2016/17	**								209,000	
3	Line CE5 augmentation - duplicate existing Ø300mm with Ø300mm	673	m	458	308,000	2010/11	**							308,000		
4	Line CE5–1 augmentation - duplicate existing Ø225mm with Ø225mm	562	m	345	194,000	2010/11	**							194,000		
5	Ø300mm gravity transfer from Line S4-1 to Line A (incl. 2 creek crossings and 1 railway crossing)	693	m	—	384,000	2005/06			384,000							
6	SPS S4 and pressure main decommissioning	1	Item	—	20,000	2005/06			20,000							
7	Extension of Line CE5 - Ø300mm	666	m	458	305,000	2010/11	**							305,000		
8	Extension of Line CE5–1 - Ø225mm	846	m	422	357,000	2007/10	**					357,000				
9	Extension of Line CB - Ø150mm	725	m	290	210,000	2007/08	**				210,000					
10	Extension of Line S4–1 - Ø225mm	413	m	344	142,000	2005/06	**		142,000							
11	Extension of Line S4–2 - Ø225mm	430	m	422	182,000	2005/06	**		182,000							
12	SPS C3 upgrade	1	Item	—	23,000	2007/08					23,000					
13	Replace smaller pump at S1	1	Item	—	170,000	2004/05	****	170,000								
14	SPS S1 upgrade	1	Item	—	830,000	2008/09	****					830,000				
	New service areas															
15	SPS D2 pump station	1	Item	—	94,000	2016/17	**								94,000	
16	SPS D2 pressure main - Ø150mm	2,243	m	291	652,000	2016/17	**								652,000	
17	SPS D3 pump station	1	Item	—	51,000	2026/27	**									51,000
18	SPS D3 pressure main - Ø100mm	1,023	m	221	226,000	2026/27	**									226,000
19	Gravity connection of SPS D3 to SPS D2 - Ø225mm	360	m	228	82,000	2026/27	**									82,000
	SUBTOTAL				**4,439,000**											
Augmentations for northern catchments																
20	SPS A1 upgrade	1	Item	—	1,180,000	2006/07				1,180,000						
21	Line 1A augmentation – replace existing Ø375mm throttle at SPS A1 with Ø750mm	17	m	1,588	27,000	2006/07				27,000						
22	SPS A2 upgrade	1	Item	—	262,000	2006/07				262,000						
23	Line 6B minor works – seal manholes MH21/MH22	1	Item	—	3,000	2006/07				3,000						
24	Line 2A augmentation – duplicate existing Ø300mm with Ø375mm	91	m	473	43,000	2007/08					43,000					
25	SPS A6 upgrade	1	Item	—	247,000	2007/08					247,000					
26	Line 1A augmentation – duplicate existing Ø600mm, Ø525mm and Ø450mm with Ø375mm	1,382	m	648	895,000	2016/17									895,000	
27	Line 2A augmentation – duplicate existing Ø450mm with Ø300mm	847	m	506	429,000	2016/17									429,000	
28	SPS D1 upgrade	1	Item	—	114,000	2020/21	***									114,000
	SUBTOTAL				**3,200,000**											
SOUTH TREES SCHEME																
Augmentations and extensions																
	Pump station upgrades															
29	SPS T2	1	Item	—	276,000	2009/10	*						276,000			
30	SPS T5	1	Item	—	53,000	2006/07	*			53,000						
	Pressure main upgrades															
31	SPS T2 - duplication of existing Ø200mm	1,161	m	326	378,000	2009/10	*						378,000			
32	SPS T2 - extension with Ø300mm	322	m	519	167,000	2009/10	*						167,000			
	Future pump stations															
33	SPS ST1	1	Item	—	389,000	2010/11	*							389,000		
34	SPS ST3	1	Item	—	142,000	2011/12	*							142,000		
35	SPS ST4	1	Item	—	194,000	2026/27	*									194,000
36	SPS ST6	1	Item	—	22,000	2030/31	*									22,000
	Future pressure mains															
37	SPS ST3 - Ø150mm	1,331	m	277	369,000	2011/12	*							369,000		
38	SPS ST4 - Ø200mm	3,850	m	326	1,255,000	2026/27	*									1,255,000
39	SPS ST1 - Ø375mm	1,451	m	777	1,128,000	2010/11	*							1,128,000		
	Future trunk gravity main															
40	Line T2-30 Ø150mm duplication (D/S of T5 pressure main)		m	various	30,000	2006/07	*			30,000						
41	SPS ST1 subcatchment	1,263	m	various	686,000	2009/10	*						686,000			
42	SPS ST3 subcatchment - Ø150mm	1,957	m	289	565,000	2011/12	*							565,000		
43	Gravity main D/S of ST3 pressure main	1,470	m	258	378,000	2011/12	*							378,000		
44	SPS ST4 subcatchment	2,977	m	various	613,000	2026/27	*									613,000
	SUBTOTAL				**6,645,000**											
TREATMENT PLANT WORKS AND UPGRADES																
	Calliope River STP															
45	Biological filter plant refurbishment and flow metering	1	Item	—	545,000	2005/06			545,000							
46	Biological filter plant refurbishment and replacement of clarifiers	1	Item	—	1,180,000	2015/16									1,180,000	
47	New oxidation ditch	1	Item	—	7,450,000	2026/27										7,450,000
	South Trees STP															
48	Effluent reuse pipeline and pump station	1	Item	—	2,045,000	2008/09						2,045,000				
49	Treatment plant duplication	1	Item	—	3,700,000	2010/11								3,700,000		
50	Treatment plant augmentation	1	Item	—	3,700,000	2021/22										3,700,000
	SUBTOTAL				**18,620,000**											
TOTALS																
	Trunk sewerage systems				14,384,000			170,000	828,000	1,555,000	523,000	1,187,000	1,507,000	3,778,000	2,279,000	2,557,000
	Treatment plants				18,620,000			-	545,000	-	-	2,045,000	-	3,700,000	1,180,000	11,150,000
	ALL WASTEWATER INFRASTRUCTURE				**33,004,000**			**170,000**	**1,373,000**	**1,555,000**	**523,000**	**3,232,000**	**1,507,000**	**7,478,000**	**3,459,000**	**13,707,000**
	Calliope River Scheme				16,814,000			170,000	1,273,000	1,472,000	523,000	1,187,000	-	807,000	3,459,000	7,923,000
	South Trees Scheme				16,090,000			-	-	83,000	-	2,045,000	1,507,000	6,671,000	-	5,784,000

Notes
- * *Timing of works to be confirmed*
- ** *Timing of works is development driven*
- *** *Timing of works is dependent on operational feedback*
- **** *Staged upgrade - $250,000 in 2004/05 to replace smaller pump and balance in 2008/09*

10.6 POSSIBLE REDIRECTION OF MARINA SEWAGE PUMPING SYSTEM

A number of small SPS, namely A34 to A41 inclusive, are located at, or in close proximity to the Marina facility, in the northern sub-catchment. All sewage from these interconnected pump stations discharge from pump station A35 via a pressure main under Auckland Creek to the existing Calliope River sewerage scheme. Council wishes to minimise the risk of discharge into the creek by investigating the option of an alternative discharge point into the scheme.

The option of redirecting the flows from the existing Marina pumping system into a new pump station in Alf O'Rourke Drive, with a new pressure main directly to the Calliope River STP, has been investigated.

A new sewage pump station could be located in the road reserve in Alf O'Rourke Drive at its intersection with Bryan Jordan Drive. SPS A34, A35 and A36 would be decommissioned with a new 150 mm dia. sewer gravity main constructed from the A35 pump station site west-bound along Bryan Jordan Drive to the new pump station. The existing gravity sewers into SPS A34, A35 and A36 would be directed into this new gravity sewer via new/refurbished manholes.

Additionally, SPS A37 would be decommissioned with the flows from this catchment conveyed via gravity across Alf O'Rourke Drive directly into the new pump station. The pressure main from pump station A41 from the existing sub-catchment to the west of Alf O'Rourke Drive would also feed directly into the new pump station.

Should Council wish to pursue this alternative discharge point, the capital works outlined in Table 10.5 would be required.

Note that existing SPSs A38, A39 and A40 to the north-west and north-east of the Marina would remain as is.

It should be noted that the capital works detailed in Table 10.5 below have **not** been included in the augmentation schedule detailed in Table 10.4 previously.

It should be noted that whilst the redirection of the flows from the existing Marina pumping system would slightly ease the load on the existing and future A1 trunk system, it will not address the future theoretical shortfall at SPS A1 detailed previously in this report.

Table 10.5 Augmentations for Marina sewage pumping system

Item	Description	Qty.	Unit	Rate ($/unit)	Capital Cost ($)
	New Sewage Pump station:-				
1	Construct new sewage pump station (SPS) (depth approx. 11m)	1	Item	—	260,000
2	Construct new 100mm dia. pressure main direct to existing Calliope River STP	3250	m	210	682,500
	Existing SPS A37:-				
3	Decommission existing SPS A37 complete	1	Item	—	20,000
4	New 150mm dia. gravity main to new manhole across Alf O'Rourke Drive	30	m	375	11,250
	Existing SPS A36:-				
5	Construct 150mm dia. gravity main across Bryan Jordan Drive into new 150mm dia. gravity main west-bound to new SPS	30	m	196	5,900
6	Decommission existing SPS A36 complete	1	Item	—	20,000
	Existing SPS A35:-				
7	Convert existing SPS A35 into manhole for gravity sewer incl. decommissioning existing pump station and pressure main	1	Item	—	30,000
	Existing SPS A34:-				
8	Convert existing SPS A34 into manhole for gravity sewer incl. decommissioning pump station and pressure main	1	Item	—	30,000
9	Construct 150mm dia. gravity main from manhole at A35 location to new SPS	1000	m	375	375,000
	Sub-total				**1,434,700**

11 Sewage treatment plants

11.1 INTRODUCTION

This section of the report reviews the current planning reports for the Calliope River and South Trees STPs in light of the secondary effluent requirements for the two end users NRG and QAL.

NRG has an agreement with Council to take up to 2.0 ML/d of treated effluent for inclusion in their ash waste. It is understood that secondary treated effluent that meets the current discharge licence is acceptable to NRG.

QAL and Council have a 30-year agreement for Council to supply all the effluent to QAL less that previously contracted to NRG. It is understood that secondary treated effluent that meets the current discharge licence is acceptable to QAL. It is also understood that pathogens and nutrients are removed from the effluent during use within QAL.

In particular the following items have been reviewed:

- The capacity of the oxidation ditch and the biological filter sections of the plant and the total capacity of the plant. The total capacity of the plant is currently rated at 41,000 EP with the filter plant capacity being 11,000 EP and the oxidation ditch capacity 30,000 EP.
- The decision to phase out the filter plant due to its inability to remove nutrients.
- Future augmentation program.
- Recommendations for and preliminary design for the refurbishment of the biological filter.

11.2 CALLIOPE RIVER STP

The Calliope River STP has been rated in the previous planning reports as a 41,000 EP plant.

The Calliope River STP is a combination of two plants. The original plant is a biological filter plant, the first stage of which was constructed in 1961. This stage was duplicated in 1971. In previous planning reports this plant has been rated as an 11,000 EP capacity plant.

In 1991 a second process stream was constructed. This stream was augmented in 1995 by the construction of a secondary clarifier and the plant was converted from an intermittently aerated oxidation ditch to a continuously operated aeration ditch. The oxidation ditch is preceded by screening and grit removal facilities.

The secondary clarifier was sized to suit future operation of the plant as a biological nutrient removal plant.

A second secondary clarifier has now been constructed and the two clarifiers are operated in parallel.

Flow to the plant is pumped from a number of pump stations to a flow dividing chamber where the flow can be directed to the biological filter plant and/or the oxidation ditch plant.

No odour control facilities are provided or are considered necessary at the flow dividing chamber or at the screening/grit control units of both plants.

There are no flow metering facilities at the inlet to the STP. Flow rates and quantities are determined by addition of flow metering measurements from the contributing pump stations. It is recommended that flow meters be installed at the inlets to the two process trains of the treatment plant to allow operations personnel to more accurately divide the flows between the two process trains and thereby maintain a higher effluent quality.

11.2.1 Plant performance

The filter plant capacity has been checked using the National Research Council (NRC) formulae as recommended in the Water Resources Commission’s Sewerage Guidelines (1994). The capacity has been confirmed at 11,000 EP and 2.75 ML/d. This type of plant does not nitrify, denitrify or reduce phosphorous. Therefore the effluent has a high NH_3 and P content. This plant can meet the existing licence discharge conditions.

This plant is not considered suitable for conversion to a BNR process.

The aerated oxidation ditch plant is rated as a 30,000 EP plant. This plant produces a highly nitrified effluent. It is not a BNR plant. To convert this plant to a BNR plant would require:

- Provision of an anaerobic/anoxic zone of approximately 30 minutes hydraulic detention time between the grit removal tanks and the oxidation ditch.
- Provision of additional aeration in the oxidation ditch to allow for intermittent aeration so denitrification can occur in the ditch. The aeration capacity would have to be doubled. Floating aerators could be provided so the ditch would not have to be taken off line for long periods to install these aerators.
- Diversion of the RAS pipelines to the anaerobic/anoxic tank plus an increase in RAS pump sizing to allow for higher sludge return rates.
- Provision of chemical dosing plant for phosphorus removal to ensure future licence conditions can be met.

The capacity of the plant after these additions to enable the plant to operate as a BNR plant would remain at 30,000 EP.

The current practice of thickening the scum and sludge from the secondary clarifiers in one of the secondary digesters will have to be discontinued if the plant is converted to a BNR process as phosphorus which is contained in the sludge will be released back into the liquid phase once the sludge becomes anaerobic. Sludge thickening will have to be performed, and it is recommended that a gravity drainage deck be installed for this purpose when required by the increasing plant load.

The location of the plant is such that odour outside the plant boundaries is not a problem.

11.2.2 Effluent quality requirements

The current discharge licence long term 80 percentile release limits for BOD and total suspended solids are 20 and 30 mg/L respectively. Council must maintain the capacity to treat all effluent to the required discharge quality irrespective of the disposal point of the effluent.

The agreement with QAL is subject to six months termination notice. If QAL or Council terminate the agreement and no other large long-term user of the effluent is available, the effluent will have to be discharged to the Calliope River. With potential impact of increased nutrient loads to the river, the EPA could require any future effluent discharge to the Calliope River to meet much stricter discharge licence conditions with reduced BOD, Total N and Total P. Total P may be reduced to 1 or 2 mg/L. If this occurs the existing oxidation ditch plant will have to be augmented to provide BNR facilities, the biological filter plant taken out of service and further BNR facilities constructed when the load to the plant reaches 30,000 EP. Whilst six months is insufficient time for Council to convert the existing plant to or construct a new plant with BNR capabilities it will be sufficient time to prepare an environmental management plan (EMP) and provided Council adheres to this EMP, Council will have up to three years to construct BNR facilities at the plant.

Although it is considered unlikely that the QAL agreement will be cancelled and nutrient removal facilities will be required at the plant, any new process train constructed should be designed and constructed so that it can be readily converted to a BNR plant.

11.2.3 Projected population and flows

The current raw sewage flow on the Calliope River STP is 7.5 ML/d. This is equivalent to an EP of 29,450 at 255 L/EP/d.

Table 11.1 summarises the project population and flow growth up to 2030 for the Calliope River STP catchment. The equivalent population reaches 41,000 EP in 2026/ 2027. This is the rated capacity of the existing plants operating under the existing licence conditions. If the filter plant were to be abandoned within the next few years a new oxidation ditch type plant would be required by 2006.

Table 11.1 Calliope River STP catchment—summary of population projection

Year	2003	2006	2011	2016	2021	2030
Residential population	28,224	29,405	33,090	35,030	36,840	39,900
Industrial population equivalent	1,226	1,344	1,416	1,678	1,973	2,505
Total EP	29,450	30,749	34,506	36,708	38,813	42,405
Average dry weather flow @ 255 L/EP/d	7.51	7.84	8.80	9.36	9.90	10.81

The population growth predicted between 2021 and 2030 is less than 1% per year. Projection of this growth rate beyond 2030 indicates that 45,000 EP will be reached in 2040. A result of this low growth rate is that the augmentation of the Calliope River treatment plant could be more economically undertaken by the construction of a new plant of less than 30,000 EP.

11.2.4 Development options

The options available to Gladstone City Council for the development of the Calliope River STP assuming QAL continue are to take all the plant effluent and nitrogen and phosphorus reduction is not required:

Option 1 – Refurbishment of biological filter plant by 2006

Refurbish the existing trickling filter plant prior to 2006 and maintain the oxidation ditch plant at 30,000 EP. The total capacity of the plant will remain at 41,000 EP and no further augmentation will be required until 2026. By the year 2026 the original trickling filter plant will be nearly 70 years old and the plant will be at the end of its useful life.

The refurbishment of the trickling filter plant can be undertaken in two stages to match the population growth. The plant includes two primary clarifiers, two trickling filters and two secondary clarifiers. Until the contributing EP to the plant reaches 35,000 only one of each of these units needs to be operated. Therefore only one trickling filter needs to be refurbished initially and the second filter taken out of service until 2011-12 when the population predictions indicate the one filter will be fully loaded.

Construct another oxidation ditch plant adjacent to the existing oxidation ditch in 2026 and take the trickling filter plant out of service. A 15,000 EP plant would satisfy population growth to 2040.

Option 2 – Augmentation of the existing oxidation ditch plant

Construct a 15,000 EP plant by 2006 and abandon the trickling filter plant. The new oxidation ditch plant would be suitable for easy conversion to a BNR plant.

Option 3 – Conversion and augmentation of existing plant to BNR capabilities

Assuming a BNR plant is required:

- construct a 15,000 EP oxidation ditch designed for nutrient removal by 2006
- modification of existing oxidation ditch to provide for nutrient removal. The works required for this augmentation are
  - construction of anaerobic/anoxic tank with a hydraulic retention time of 120 minutes upstream of the oxidation tanks
  - installation of additional aerators in ditch of same total capacity as the existing 2 aerators. Floating aerators recommended to reduce off-line time of plant during the conversion
  - divert RAS return pipeline to the new anaerobic/anoxic tank
  - augment RAS pumping system

- provide a belt thickener upstream of the existing filter belt dewatering—timing dictated by load on plant.

The capacity of the treatment plant when the 30,000 EP oxidation ditch is taken off line for augmentation will be 26,000 EP. However, secondary clarifiers of the 30,000 EP plant can remain in service and a third clarifier will be constructed and made operational as part of the 15,000 EP augmentation. The use of the three secondary clarifiers and operation of the aerators to provide additional oxygen at average dry weather flows will enable the oxidation ditch plant to treat the short term dry weather overloads during conversion of the existing oxidation ditch plant to a BNR facility.

11.2.5 Comparison of options

In the following comparisons all estimates are in 2004 dollars.

Option 1—Refurbishment of biological filter plant by 2006

The projected population contributing to the flow to the Calliope River STP indicate that the population will reach 30,000 EP during 2006, and increase to 35,000 by 2016.

Therefore, it will be possible to refurbish the biological filter plant in two stages:

- *2005*
  - Refurbish 1 No. biological filter.
  - Miscellaneous minor repairs and upgrades.
  - Refurbish gear boxes on aerators in oxidation ditch
- *2015–2016*
  - Replace existing primary clarifier and secondary clarifier mechanisms.
  - Refurbish 1 No. biological filter.
- *2026*
  - Construct new 15,000 EP plant.
  - The estimated cost of this option is $9,130,000 made up as shown in Table 11.2.

Table 11.2 Development option 1 for Calliope River STP

Year	Item	Estimated cost ($)
2005	Refurbish 1 biological filter including rebuild walls and underdrains and replace distributor	260,000
	Repair and repaint primary digester roof	80,000
	Refurbish surface aerators' gearboxes	30,000
	Replace gas compressors	20,000
	Miscellaneous minor upgrades and repairs including replace guardrails	110,000
2015	Replace existing clarifier mechanisms (4 No.)	520,000

Year	Item	Estimated cost ($)
2016	Refurbish 1 biological filter including underdrains	260,000
	Refurbish heating and mixing equipment on primary digester	400,000
2026	Construct new 15,000 EP oxidation ditch	7,450,000
	Total upgrade cost	**9,130,000**

Option 2—Augmentation of the existing oxidation ditch plant

- *2005:* Construct new 15,000 EP oxidation ditch plant $7,450,000

  Refurbish surface aerators' gearboxes $30,000
- *2016:* Augment sludge drying facility with gravity drainage deck $400,000

Total upgrade cost **$7,880,000**

Option 3—Conversion and augmentation of existing plant to BNR capabilities

- *2005:* Construct 15,000 EP BNR treatment train $9,700,000
- *2006:* Modify existing oxidation ditch plant to provide nutrient removal capabilities:
  - anaerobic–anoxic tank $500,000
  - additional aerators (2 x 65 kW) $150,000
  - diversion of RAS line to anaerobic–anoxic tank $55,000
  - augment RAS pump station $60,000
  - Refurbish existing aerators' gearboxes $30,000
- *2016:* Augment sludge drying facility with gravity drainage deck $400,000

Total upgrade cost **$10,895,000**

NPV analyses based on the above construction programs and Year 2004 costs, and including additional power and maintenance costs were performed to rank the options on a financial basis. At 6% discount rate, the NPVs of the three options were:

- Option 1—$5.1 million
- Option 2—$9.6 million
- Option 3—$12.8 million.

The above analysis does not take into account the payment of any Government subsidies.

A 40% (maximum) subsidy may be applicable to that portion of the expenditure applicable to the provision of BNR capabilities in the plants. NPV analyses were also undertaken allowing for the 40% subsidy on the applicable portion of the expenditure in Option 3. At a 6% discount rate the NPVs of the three options were:

- Option 1—$5.1 million

- Option 2—$9.6 million
- Option 3—$11.8 million.

Option 1 is clearly the most advantageous option for the Gladstone City Council to adopt on an NPV basis.

Adoption of this option would also result in major capital expenditure of $7,450,000 being delayed by 20 years.

11.3 SOUTH TREES STP

South Trees STP is an intermittently operated oxidation ditch. Rated capacity is 5,000 EP. This plant produces a nitrified and partly denitrified effluent. No significant phosphorus removal is achieved. This plant was constructed in 1988.

11.3.1 Plant performance

This plant in its current form is capable of meeting the discharge licence.

The plant can be converted to BNR capabilities by the:

- provision of an anaerobic/anoxic zone of 30 minutes hydraulic detention time between the grit removal links and the oxidation ditch
- provision of additional aeration capacity and change of operation to allow equal aerated and non-aerated periods to increase nitrification and denitrification.

11.3.2 Population

The current load on the South Trees STP is estimated at 1,875 EP.

Table 11.3 summarises the growth in flow and equivalent population up to 2030 for the South Trees catchment. The areas contributing to the catchment of the South Trees STP are Glen Eden, O'Connell, South Trees and 50% of Kirkwood.

Table 11.3 South Trees STP catchment—summary of population projections

	Year					
	2003	2006	2011	2016	2021	2030
Residential population	1,075	2,011	4,585	6,638	8,826	11,398
Industrial population equivalent	800	825	850	875	900	925
Total EP	**1,875**	**2,836**	**5,435**	**7,813**	**9,726**	**12,323**
Average dry weather flow @ 255 L/EP/d	0.42	0.64	1.22	1.76	2.19	2.77

Table 11.3 indicates that, provided BNR is not required to meet changed discharge licence conditions, the existing treatment plant at South Trees is adequate to the year 2010. A second treatment train will be required to be constructed in 2009. If this second treatment train has a treatment capacity of 5,000 EP and is the same size as the existing plant, a further augmentation of the plant will be required in 2021.

11.3.3 Effluent quality requirements

It is understood that QAL will accept the effluent from South Trees STP, as well as the Calliope River STP. If the effluent is sent to QAL, BNR capability will not be required.

With potential impact of increased nutrient loads discharged through the outfall the EPA could require any future effluent discharge via the outfall to meet much stricter licence conditions with reduced BOD, Total N and Total P. Total P may be reduced to 1 mg/L or 2 mg/L. If this occurs, the existing plant will have to be converted to BNR capability, as described in Section 11.2. Council will then need to prepare an environmental management plan and install the new facilities at the treatment plant over a period of three years. It is considered that the earliest date by which BNR capabilities would be required at South Trees STP is 2008.

Sludge lagoon

The sludge lagoon liner is in poor condition. Irrespective of which option for the development of the plant is proceeded with, the sludge lagoons should be abandoned and replaced by mechanical sludge dewatering.

11.3.4 Development options

The options available to Gladstone City Council for the development of the South Trees STP are:

Option 1–Discharge of effluent to QAL via a 5.5 km pipeline and associated pump station

- This option applies if all plant effluent is discharged to QAL for reuse, and nitrogen and phosphorus reduction is not required.
- Construct a 5.5 km pipeline from South Trees STP to QAL, and effluent pumping station at South Trees STP.
- Duplicate existing plant by 2010 to increase capacity to 10,000 EP.
- Further augment plant in 2021 to 15,000 EP capacity.

Option 2–Conversion and augmentation of existing plant to BNR capabilities

- Convert the existing plant to BNR capability by 2008.
- Construct new 5,000 EP BNR plant by 2010.
- Further augment plant in 2021 (as BNR facility) to 15,000 EP capacity.

11.3.5 Comparison of options

For the purposes of this report, the comparison of options has been based on commencing the capital works of each option in the same year.

Option 1 - Discharge of effluent to QAL

The estimated total cost of this option is $9,445,000 made up as shown in Table 11.4.

Table 11.4 Development option 1 for South Trees STP

Year	Item	Estimated cost ($)
2008	Construct 5.5 km DN225 pipe @ $290/m	1,595,000
	Construct effluent PS	450,000
2010	Construct new 5,000 EP capacity intermittently aerated oxidation ditch treatment plant	3,700,000
2021	Construct new 5,000 EP capacity intermittently aerated oxidation ditch treatment plant	3,700,000
	Total estimated cost	**9,445,000**

Option 2— Convert existing plant to BNR capabilities

The total cost of this option is $10,050,000 made up as shown in Table 11.5.

Table 11.5 Development option 2 for South Trees STP

Year	Item	Estimated cost ($)
2008	New anaerobic–anoxic link	210,000
	New secondary clarifier	400,000
	Pipework	90,000
	RAS pump station	200,000
	Chemical dosing facility	150,000
	Sub-total	**1,050,000**
2010	Construct new BNR plant—capacity 5,000 EP	4,500,000
2021	Construct new BNR plant—capacity 5,000 EP	4,500,000
	Total estimated cost	**10,050,000**

NPV analyses based on the above construction programs and costs, including the cost of power to pump the effluent to QAL, and the additional maintenance and operation costs of a BNR plant were undertaken to rank the options on a financial basis but excluding any government subsidies which may be payable.

At the three discount rates used, 4%, 6% and 8%, the options rated the same on this basis, e.g. at 6% the Option 1 NPV is $7,030,600 and the Option 2 NPV is $7,055,400. The difference is less than 0.3% and less than the order of accuracy of the estimates.

The above analyses did not take into account any government subsidies which may be payable for constructing facilities for reuse of effluent or providing BNR facilities. The maximum subsidies which may be payable for these facilities are 40% of capital costs for reuse facilities and 50% if the reuse is considered beneficial reuse and 40% for the additional costs incurred by including or adding BNR facilities to a treatment plant. The subsidy for reuse is restricted to works outside the boundary of the treatment plant. Reuse of effluent that reduces the use of potable water is an example of beneficial reuse.

If a subsidy of 40% is applied to the estimated cost of the pipeline to QAL in Option 1 but not to the pump station and a subsidy of 40% is applied to the additional cost of

BNR facilities at the treatment plant for Options 2, the financial analyses indicate that at a 6% discount rate the NPVs of the two options are:

- Option 1—$6.5 million
- Option 2—$6.3 million

There is a difference of only 3% in these NPVs. This difference is lower than the accuracy of the estimates and both schemes may be considered of equal cost to the Council on a NPV basis.

It is considered that with the proposed EPA wastewater treatment policy it will only become more difficult to discharge effluent to waterways and especially to waterways which discharge to marine environments in the future. The transporting of the effluent to QAL is therefore considered the most appropriate option for Council to adopt.

11.4 GOVERNMENT SUBSIDIES

The application of Government subsidies to capital expenditure on the works at both treatment plants was discussed Mr Rob Drury of NRM. The advice received was;

- that the maximum subsidies which may be payable for these facilities are 40% of capital costs for reuse facilities and 50% if the reuse is considered beneficial reuse and 40% for the additional costs incurred by including or adding BNR facilities to a treatment plant. The subsidy for reuse is restricted to works outside the boundary of the treatment plant. Reuse of effluent that reduces the use of potable water is an example of beneficial reuse. The subsidies are subject to negotiation with NRM and Council cannot assume that the maximum or any subsidy will be paid without negotiation.

11.5 FLOW METERING

The installation of flow meters on the inlets to the two process trains at Calliope STP is recommended. The estimated cost of the flow meters and associated pits is $45,000. This cost is an additional cost to the estimates used in the NPV analyses.

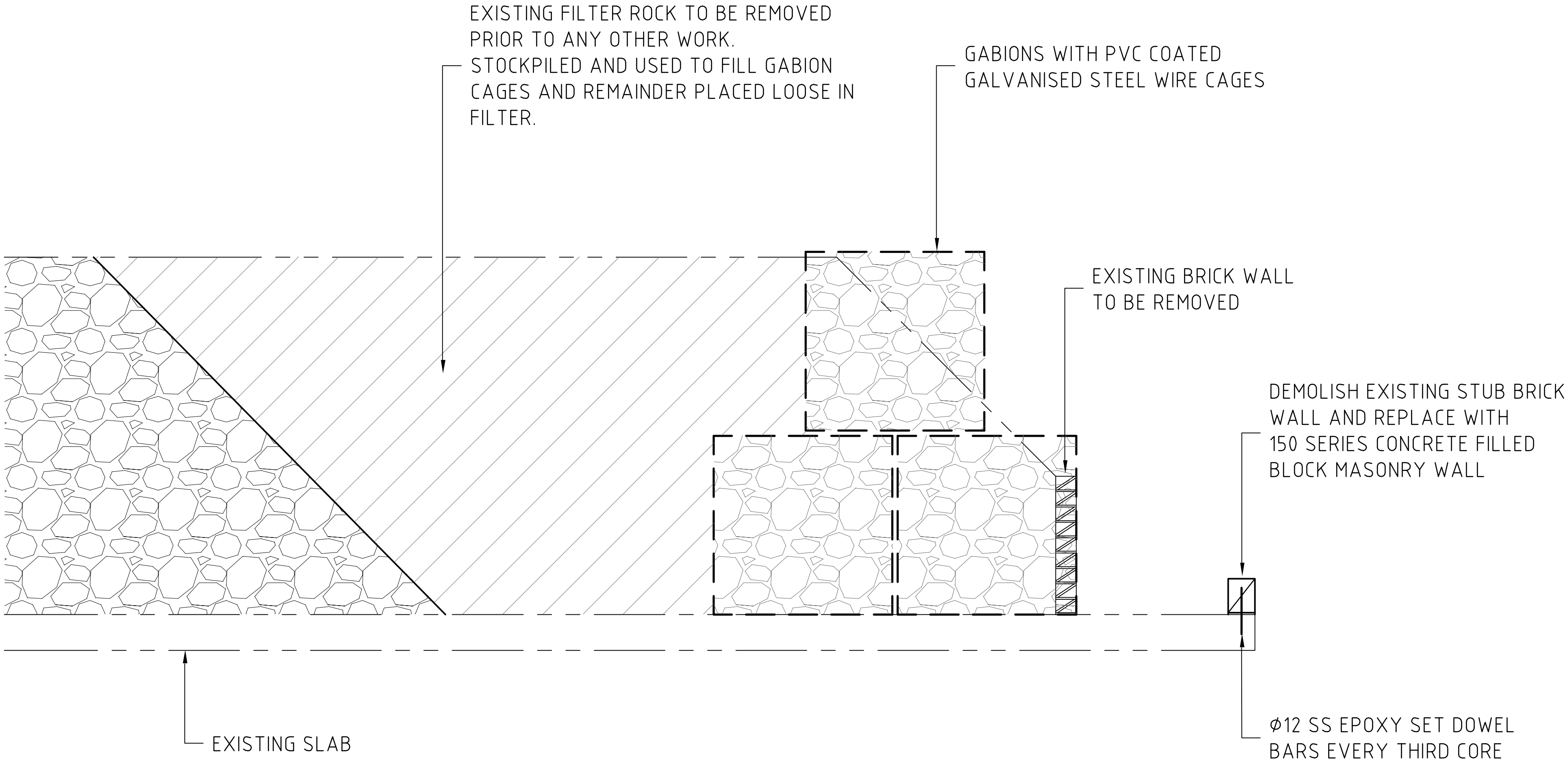
11.6 RECOMMENDATIONS

It is recommended that Gladstone City Council adopt this section of the report, and:

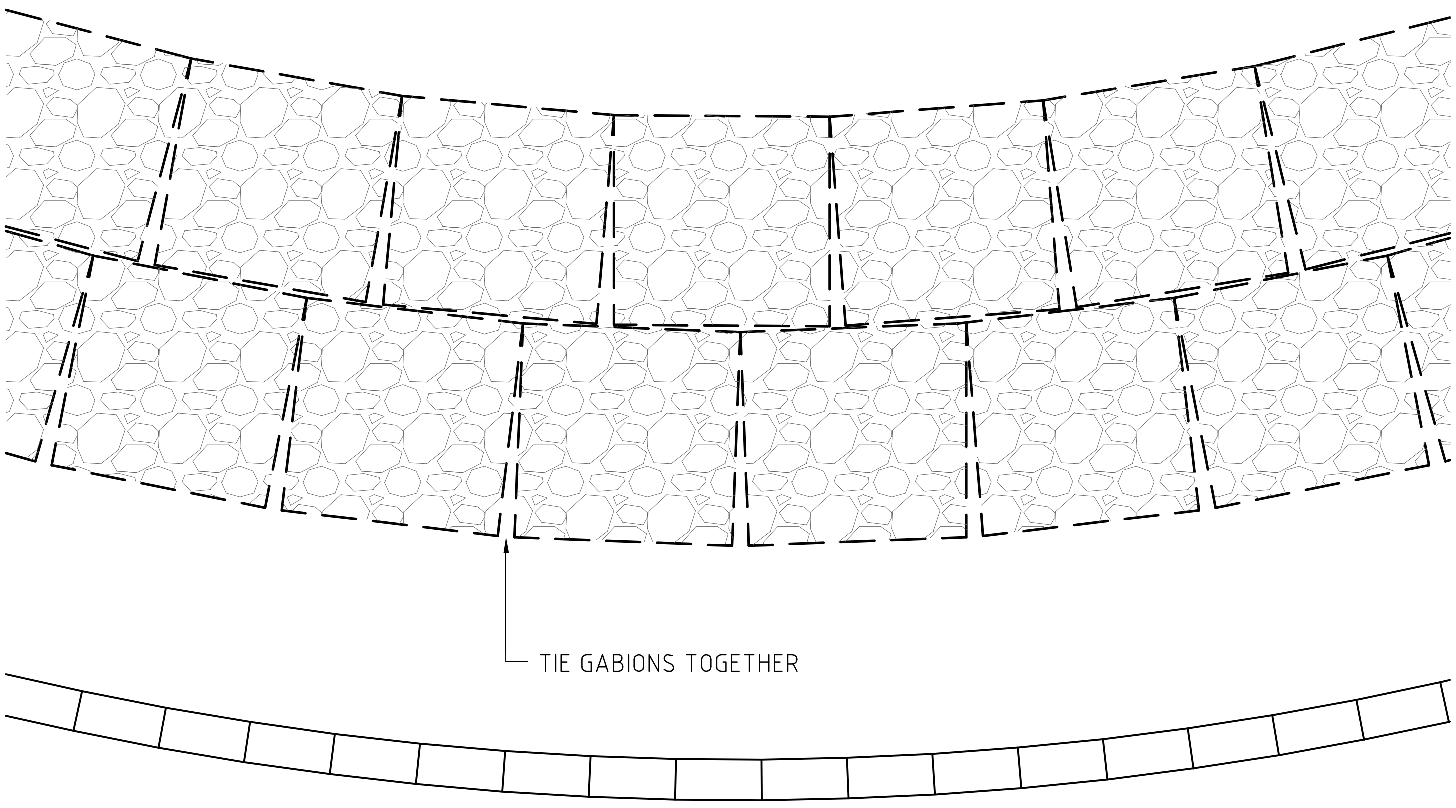
- For Calliope River STP, proceed with Option 1 with the refurbishment of the biological filter plant with an approximate expenditure of $500,000 which includes the flow meters in 2005 and $1,180,000 in 2015–2016.

  A preliminary design sketch of the proposed refurbishment of the biological filters is shown in Figure 11.1.

- For South Trees STP, proceed with Option1 - the transport of treated effluent to QAL with an approximate initial expenditure in 2008 - 2010 of $5,750,000 and a further expenditure of $3,700,000 in 2021.



TYPICAL SECTION



PART PLAN

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Figure 11.1
CALLIOPE RIVER STP
BIOLOGICAL FILTER REFURBISHMENT

12 Inflow/infiltration

12.1 BACKGROUND

Inflow/infiltration into an existing sewerage scheme occurs a number of ways, generally as follows:

- infiltration via groundwater where the sewers are laid below the groundwater table
- infiltration via rainwater entering defective pipes and joints from the surrounding soil
- infiltration via stormwater discharge into sewers from unauthorised roof water connections and/or stormwater connections or through poorly sealed/unsealed manhole covers

Inflow/infiltration is thus of most significance during periods of high rainfall where these flows combine with average dry weather flows (ADWF) to produce peak wet weather flows (PWWF).

12.2 ENVIRONMENTAL PROTECTION (WATER) POLICY 1997

Section 40(1) of the Environmental Protection (Water) Policy 1997 states:-

A local government that operates a sewerage system must develop and implement an environmental plan about sewage management that minimises unnecessary flows entering the system.

Additionally, Section (3) (part only) of the Policy states:

The local government must consider including the following measures in its plan:

(a) ways of reducing infiltration to sewers;

(b) ways of avoiding unintended stormwater inflow to sewers.

The local government can address this requirement through the preparation of an Inflow/Infiltration Management Plan as a sub-plan of the Total Management Plan (TMP) documentation.

Gladstone City Council has an Inflow/Infiltration Management Plan as part of its TMP documentation.

12.3 ASSESSMENT OF EXISTING INFLOW/INFILTRATION

Based on the raw data received from Council, an assessment of the current level of inflow/infiltration at existing sewage pump stations in the Gladstone City Council catchment area has been undertaken for two periods, namely, August 2003 and January 2004. Rainfall records have been obtained and compared to the pump station flows as follows:-

Table 12.1 Assessment of pump stations—inflow/infiltration (I/I)

Date	Pump Stn	ADWF (ML/d)	PWWF (ML/d)	Catchment area (ha)	Pipe length (m)	Res (ET)	Non-res (ET)	Total ET	PWWF/ ADWF	Rainfall (mm)
Jan 04	A5	0.6	2.1	226	19,054	328	998	1,326	3.50	80.5
Aug 03			1.5						2.50	81.0
Jan 04	A2	1.45	5.4	455	48,930	1,658	2,966	4,624	3.72	80.5
Aug 03			4.1						2.83	81.0
Jan 04	A10	0.8	3.8	216	26,794	1,208	130	1,338	4.75*	80.5
Aug 03			3						3.75	81.0
Jan 04	A1	4.2	19.7	1,069	116,086	4,277	6,354	10,631	4.69*	80.5
Aug 03			11.7						2.79	81.0
Jan 04	S1	3.75	12.4	1,241	160,257	5,803	936	6,739	3.31	80.5
Aug 03			10						2.67	81.0

* *High I/I in A10 sub-catchment—flows onto A1.*

It should be noted that rainfall data used in the assessment has been obtained from records at the existing water treatment plant site only for the total 18-month period i.e. one site for the total study area. A uniform rainfall pattern has thus been assumed in the assessment.

Records have also been available for the existing Calliope River Sewerage Scheme for 2004 (January–July) only. Variability between rainfall records at these two sites for the 2004 period (January–July only) has been noted.

From the data in the table above, it is noted that the ratio PWWF/ADWF is highest in the sewer catchments for pump stations A10 and A1, i.e. it would appear that the inflow/infiltration component of the sewage flow is highest in these two catchments. It is further noted that catchment A1 is directly downstream of catchment A10.

This would thus be considered the starting point for a condition assessment program of existing sewerage assets within Gladstone City.

13 Trade waste

13.1 ENVIRONMENTAL PROTECTION (WATER) POLICY 1997

Trade waste has not been a significant issue in Gladstone City to date and, as such, Council does not currently have a Trade Waste Policy.

Section 41(1) and (2) of the Environmental Protection (Water) Policy 1997 states:

(1) A local government that operates a sewerage system must develop and implement an environmental plan about trade waste management that controls trade wastes entering the system.

(2) The local government must consider including in its plan:

(a) requirements for waste prevention, recycling and treatment measures before the release of trade waste to sewer may be authorised; and

(b) provisions about the effect of trade waste on-

(i) the recycling of waste water and sludge; and

(ii) the materials used to construct the sewerage system; and

(iii) the health and safety of people working on the sewerage system; and

(iv) the treatment capabilities of sewage treatment plants.

It is recommended that Council prepare and implement an environmental plan about trade waste management in accordance with the Environmental Protection (Water) Policy 1997.

13.2 TRANSPORT OPERATIONS (MARINE POLLUTION) ACT 1995

The *Transport Operations (Marine Pollution) Act 1995* stipulated the introduction of ship sourced sewage requirements. As such, it is anticipated that the Gladstone Port Authority will introduce holding tank/pump-out facilities at the Marina.

Clause 3(1) of the Act states:

> The overall purpose of this Act is to protect Queensland's marine and coastal environment by minimising deliberate and negligent discharges of ship-sourced pollutants into coastal waters.

Clause 3(3)(b) states that the purpose of the Act (among others) is also to be achieved by making provision about the discharge of sewage from ships.

The future provision of holding tank/pump-out facilities at the Marina will make provision for sewage discharge from ships entering/berthing at the Marina facility.

The facilities would generally consist of the following:

- Pump out equipment, e.g. diaphragm type pump units, vacuum type units, centrifugal pumps or peristaltic pumps, each designed to suit the particular site.
- Single hose attachment fitting for connection to standard vessel fitting (vessel fitting in accordance with AS 3542–1996—Pleasure Boat—Toilet Waste Collection).
- Electrical switch with timer.
- Flashing light alarm indicating malfunction.
- Water supply connection for (a) flushing of the pump out suction line and (b) basin for washing of hands.
- Signage detailing instructions for use.

The location of pump out units within the marina facility for the collection of the ship-sourced sewage can generally be located at a fuel outlet particularly as this facilitates its operation by personnel. It may however be beneficial to consider locating the facility on a separate wharf if this would more effectively service the marina vessels. The facility's location in close proximity to connection point(s) into the existing Council sewerage scheme is also a major consideration.

Disposing of sewage from the proposed pump-out facility could be directly to the existing Council sewerage scheme, to a holding tank, or to a sewage treatment plant. Based on the location of existing sewage reticulation mains and a number of SPSs along both the southern, north-western and north-eastern shores of the marina, sewage disposal would be most cost-effective by conveying sewage directly into the existing Council sewerage scheme. This would minimise the need to pre-treat any sewage prior to its entering the Council system.

A preliminary assessment of the inlet levels into the existing SPSs (particularly stations A34, A37 and A38) indicates that this approach would be feasible via a gravity main from the pontoon/wharf directly into an SPS.

Figure 13.1 shows the location of these existing reticulation mains and SPSs.

Based on a previous study into five existing Crown boat harbours in Queensland undertaken in 1998 (Kinhill), it was concluded that there was substantial evidence to suggest that the use of pump-out facilities for disposal of ship-sourced sewage will remain low for a number of years. This conclusion supports the preference to dispose of this sewage directly into the Council sewerage scheme as quickly as possible to avoid the build-up of odours/septicity in a holding tank facility.

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December 2004

Figure 13.1
MARINA DEVELOPMENT
EXISTING SEWERAGE DISPOSAL OPTIONS

14 Grey water reuse

14.1 BACKGROUND

Grey water refers to all water discharged from a residential dwelling with the exception of water from toilets. Grey water includes water from hand basins, baths/showers, washing machines and laundry sinks, dishwashers and kitchen sinks.

Reuse of grey water from residential dwellings provides benefits to both rate payers and the service authority, e.g. Council, alike. Residents can re-direct the grey water onto lawns and gardens thus generally reducing the resident's demand for treated water, and consequently the associated cost. This reduction in demand is of obvious benefit to Council in reducing the stress placed on the water supply infrastructure, particularly during drought/low rainfall periods. Reduced short and long demands on the infrastructure also assists Council in offsetting future water supply capital works programs.

This lower demand also reduces the stress on the Council sewerage scheme due to a reduction in incoming sewerage flows resulting form a percentage of the flow being diverted to garden/lawn use. Again, this assists Council in offsetting future sewerage capital works programs.

This reduction in sewerage flows was most notable within Gladstone City during the recent drought conditions in the area, conditions which prompted Council to implement water restrictions during that time. Council reported that sewerage flows into the scheme were reduced by approximately 20% during this period before returning to near normal flows following the lifting of the restrictions. Council were accepting of the fact that a high level of grey water reuse was being undertaken during this period.

14.2 LEGISLATION

The Queensland State Government, in a media statement dated June 2004, has advised that legislation will be introduced in early 2005 to allow householders to reuse domestic grey water for irrigating gardens and lawns.

The government has endorsed the move following satisfactory outcomes from extensive investigations and testing into whether the untreated grey water would pose a health hazard to residents and/or the general public alike.

14.3 FUTURE TRENDS

Following the proposed enactment of the legislation detailed in Section 14.2 above, it is anticipated that ratepayers will embrace the move towards grey water reuse on gardens and lawns. The relatively low upfront installation cost of the reuse system (particularly on residential allotments) would be recovered through the ratepayer anticipated reduced water and sewerage rate charges associated with the lower treated water usage.

Grey water reuse would appear to be a future significant demand management tool available to Councils state-wide and, through proper ratepayer awareness programs and advertising, would provide benefits to both ratepayers and Council alike. The ratepayer awareness programs would need to highlight the quantitative benefit through reduced water and sewerage charges to provide a significant incentive to the ratepayer to embrace the program.

Individual approvals from the Council would be required by the ratepayer prior to installation of the associated pipework for the reuse system. Installation would need to be performed by a licenced plumber.

15 QAL reuse

In Council's third party agreement with QAL, up to 5% of the effluent reused by both QAL and NRG has been allowed to be used by Council for irrigation of sporting fields. The quality of the effluent is such that it is anticipated that small package treatment plants may be required to be installed at the Council off-take points.

It is considered that the quality of the secondary treated effluent (including chlorination) is of Class C standard in accordance with Table 5.1 of the Queensland Guidelines for the Safe Use of Recycled Water (draft - 2004). Disposal of Class C effluent, in accordance with Table 8.1 of the guidelines, in public open space such as sporting fields, parks and gardens, and the like, is recommended only in areas where public access is controlled (e.g. man-proof fencing and lockable gates).

Conversely if public access cannot or will not be controlled, further treatment including filtration will need to be provided to produce a Class A quality effluent which is suitable for disposal via irrigation under uncontrolled public access conditions.

The provision of package treatment plants incorporating filtration and further disinfection (to also reduce the high phosphorus load in the treated effluent) at various sites at, or in close proximity to the sporting fields, would produce a Class A effluent suitable for disposal via irrigation. It is also likely that the package plant will need to incorporate a booster pump station for treated effluent flow through the filters.

Council, in consultation with the relevant sporting bodies, would need to assess the alternative options of Class A and Class C effluent quality and the associated cost and non-cost implications of both.

As is required in the draft guidelines, a Recycled Water Safety Plan will need to be developed and implemented prior to use of the treated effluent in this manner. A Recycled Water Use Agreement between the Council and the sporting bodies may also need to be negotiated to provide terms and conditions of use.

16 Conclusions

The conclusions that have been reached with regard to the Calliope River wastewater transport and treatment systems are as follows:

- Under current loading conditions, existing trunk gravity mains have sufficient capacity to transport dry and wet weather flows. A high proportion of gravity main is predicted to run at less than 0.6 m/s in ADWF, however siltation is not considered to be a significant issue based on a lack of historical problems.
- Existing pump stations A2, A6, C3, D1 and S4 have insufficient station capacity to meet current design loading conditions.
- Existing pump stations A1, A2, A6, C3, D1 and S1 will need to be upgraded provide sufficient station capacity up to the year 2030. Two additional pump stations D2 and D3 will be required to accommodate future industrial development within Callemondah.
- Augmentations will be required for existing gravity trunk lines CE5, CE5-1, CA, 1A, 2A and 6B. Extensions will be required for existing gravity trunk lines CE5, CE5-1, CB, S4-1 and S4-2 to service future residential development in New Auckland and Kirkwood.
- A gravity diversion to transfer flow from Line S4-1 to Line A, in conjunction with the decommissioning of SPS S4, is recommended in preference to upgrading SPS S4 and augmenting Line CB.
- For Calliope River STP, refurbishment of the existing biological filter plant is the most advantageous development option on an NPV basis.

The conclusions that have been reached with regard to the South Trees wastewater transport and treatment systems are as follows:

- Existing pump station T5 has insufficient station capacity to meet current design loading conditions.
- Existing pump stations T2 and T5 will need to be upgraded to accommodate future growth within Glen Eden and O'Connell, and support connection of additional pump stations.
- Additional pump stations ST1, ST3, ST4 and ST6 will be required to expand the existing South Trees scheme in order to service new residential areas in Glen Eden and O'Connell, and smaller parts of Kirkwood, New Auckland and Telina.
- For South Trees STP, transport of treated effluent to QAL is the most appropriate development option based on environmental considerations. NPV analysis is unable to discern between options at the current level of assessment.

The capital cost requirements for wastewater infrastructure within the Calliope River and South Trees schemes are summarised below.

Table 16.1 Summary of capital costs for wastewater infrastructure

Program year	Financial year	Capital cost* Calliope River	Capital cost* South Trees	Capital cost* Total
1	2004/05	170,000	—	170,000
2	2005/06	1,273,000	—	1,273,000
3	2006/07	1,472,000	83,000	1,555,000
4	2007/08	523,000	—	523,000
5	2008/09	1,187,000	2,045,000	3,232,000
6	2009/10	—	1,507,000	1,507,000
7-12	2010–2015	807,000	6,671,000	7,478,000
13-17	2015–2020	3,459,000	—	3,459,000
18-27	2020–2030	7,923,000	5,784,000	13,707,000
Totals		**16,814,000**	**16,090,000**	**32,904,000**

** Note: Does not include provisional amount of $100,000 for flow monitoring and model calibration study.*

17 Recommendations

It is recommended that Gladstone City Council:

1. Adopt this report and the capital works program for both the Calliope River and South Trees sewerage schemes with approximate capital expenditure of **$32,900,000**.

2. Use this report as the basis for the development of the Priority Infrastructure Plans.

3. Use the outcomes of a catchment-wide flow monitoring program to revisit the adopted sewer loading model and assess the likely impact on system planning.

4. Undertake a detailed review of information retained on existing wastewater system assets and develop an asset register with comprehensive details of existing sewage pump stations and system overflow points.

5. Prepare and implement an environmental plan about trade waste management in accordance with the Environmental Protection (Water) Policy 1997.

6. Continues to actively apply and encourage demand management initiatives, including grey water reuse.

7. Forward this report to NRM&E for approval as a planning report.

8. Consult with the relevant sporting bodies to assess the alternative options of Class A and Class C effluent quality for disposal of treated effluent on sporting fields.

18 References

Environmental Protection Agency 2004, Approving the amended draft Environmental Management Program—Prevention of Raw Sewage Overflow to Waters.

Environmental Protection Agency 2004, Queensland Guidelines for the Safe Use of Recycled Water (draft).

Gladstone City Council 1991, Planning Scheme for the City of Gladstone.

Gladstone City Council 2004, Draft Planning Scheme for the City of Gladstone.

Queensland Government State Development 2002, The Gladstone Growth Management initiative—Residential Land Study, Sinclair Knight Merz.

Gladstone City Council 2002, The likely Impacts of the GGMI Predicted Growth on the Operations of Gladstone City Council.

Gladstone City Council 2003, Strategic Asset Management Plan for Water Supply and Sewerage Services.

Gladstone City Council 2004, Kirkwood Road South Structure Plan.

Gladstone City Council 2004, CBD Study.

Gladstone City Council 1997, Gladstone Water Supply—1997 Planning Report.

Gladstone City Council 2003, Water Supply Infrastructure Policy.

Gladstone City Council 1997, Sewerage Planning Report 1997.

Gladstone City Council 2003, Effluent Reuse to Queensland Alumina Ltd Feasibility Report.

Gladstone City Council 2002, Heads of Agreement for Supply of Treated Effluent to QAL.

Gladstone City Council 1996, Strategy Report for Stage 3 Augmentation (including South Trees).

Gladstone City Council 2000, Calliope River Water Pollution Control Works Augmentation.

Gladstone City Council 2000, Environmental Management Plans—Sewerage Treatment and Pumping Stations.

KBR, 2004a, Water and Wastewater Planning Studies—2030, Water Supply Report, Kellogg Brown & Root Pty Ltd.

KBR 2004b, Water and Wastewater Planning Studies—2030, Environmental Audit Report, Kellogg Brown & Root Pty Ltd.

MacIntyre & Associates 1997, Gladstone Sewerage Scheme Planning Report.

Water Resources Commission 1994, Guidelines for the Planning and Design of Sewerage Schemes.

Appendix A

SEWERAGE SYSTEM INFRASTRUCTURE LAYOUTS

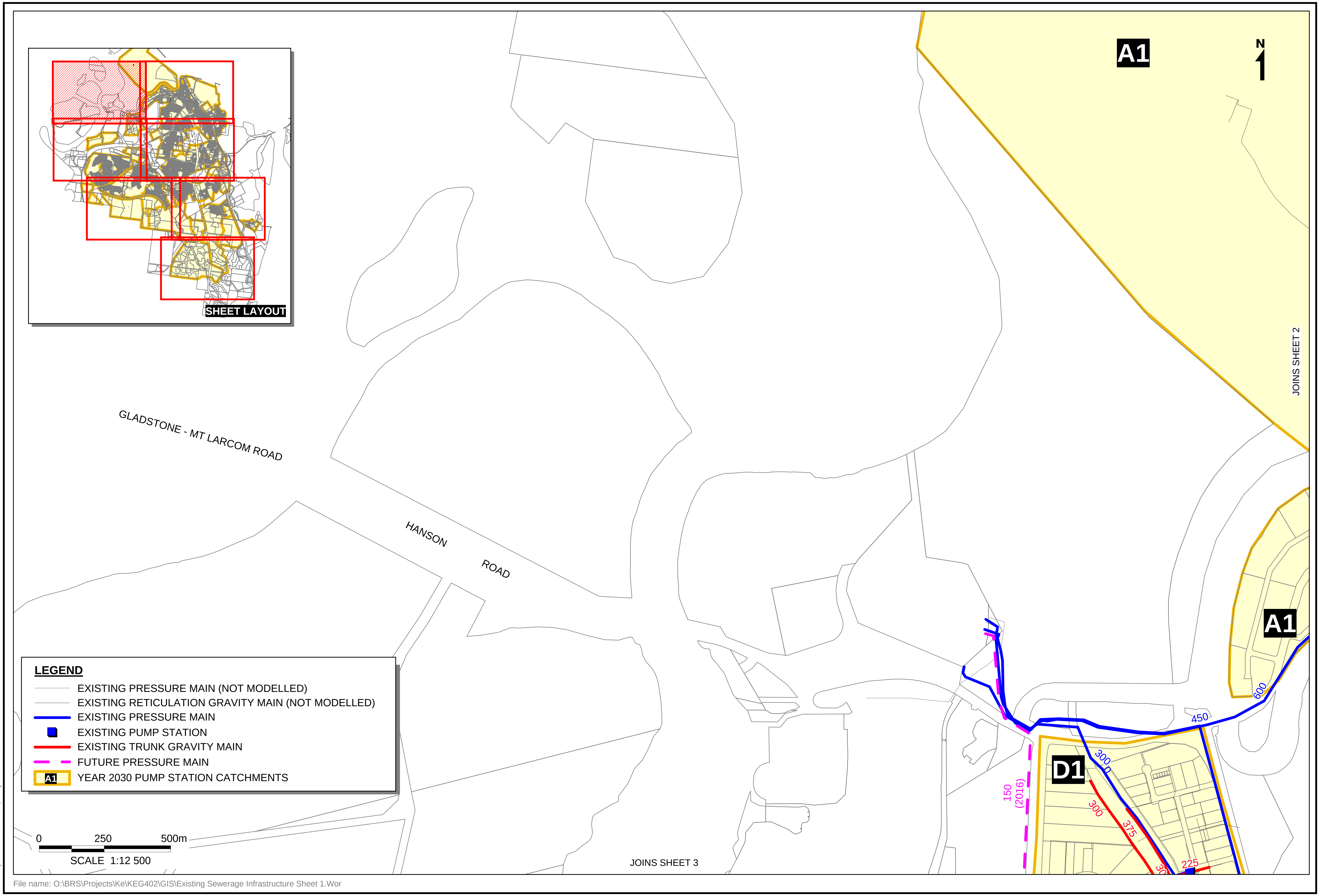

Figure A.1
EXISTING SEWERAGE INFRASTRUCTURE AND PROPOSED AUGMENTATIONS
SHEET 1 OF 7

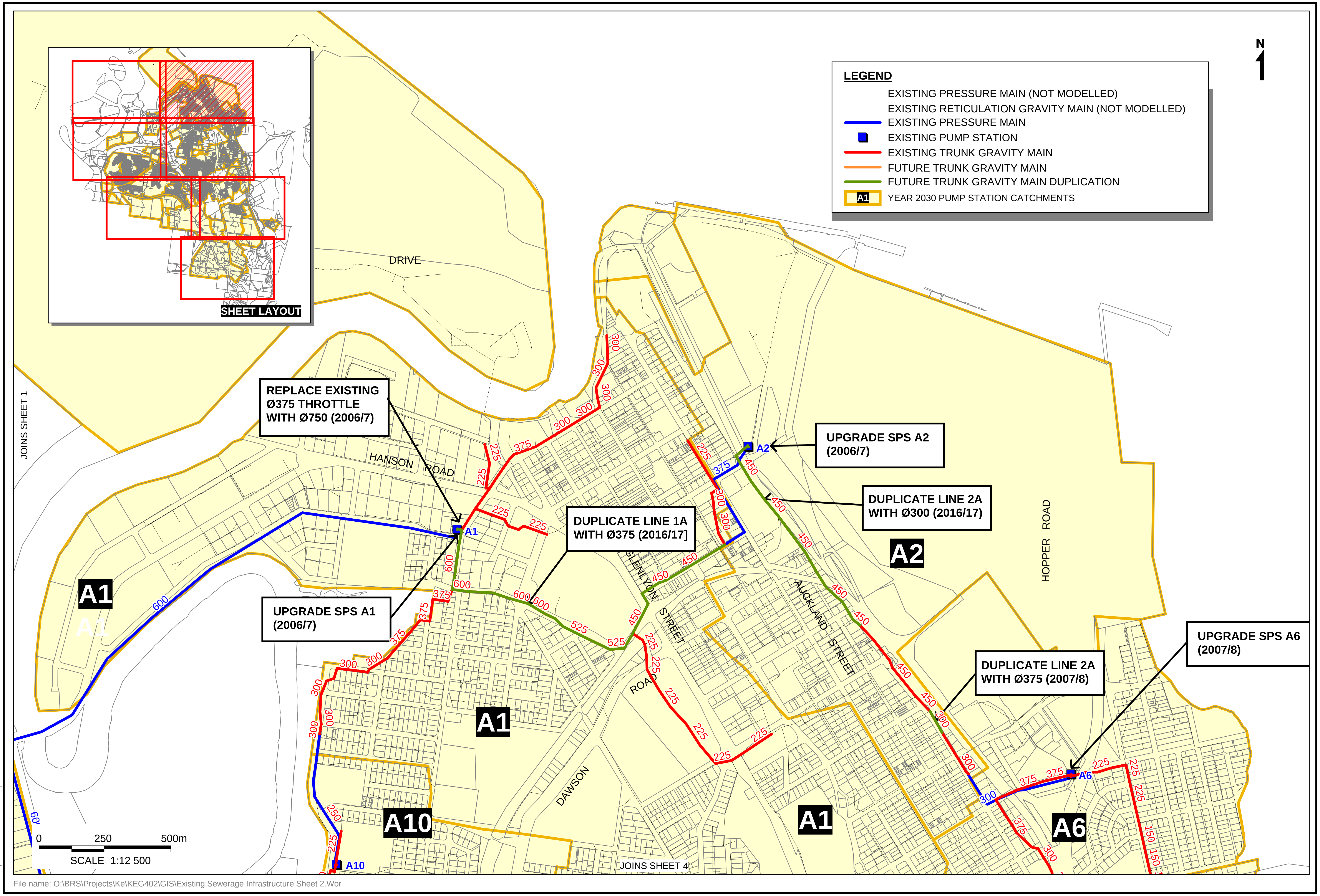

Figure A.2
EXISTING SEWERAGE INFRASTRUCTURE AND PROPOSED AUGMENTATIONS
SHEET 2 OF 7

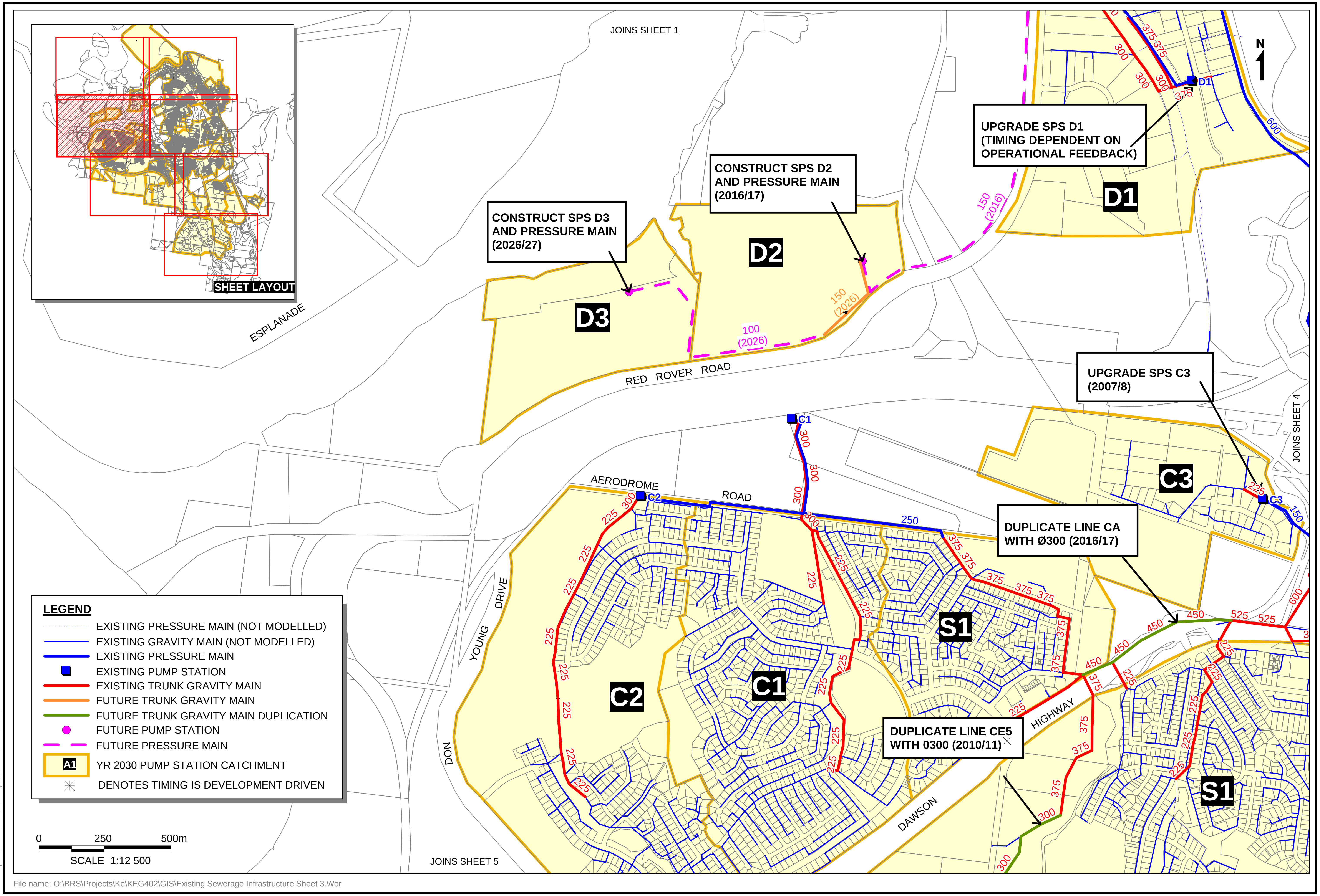

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Figure A.3
EXISTING SEWERAGE INFRASTRUCTURE AND PROPOSED AUGMENTATIONS
SHEET 3 OF 7

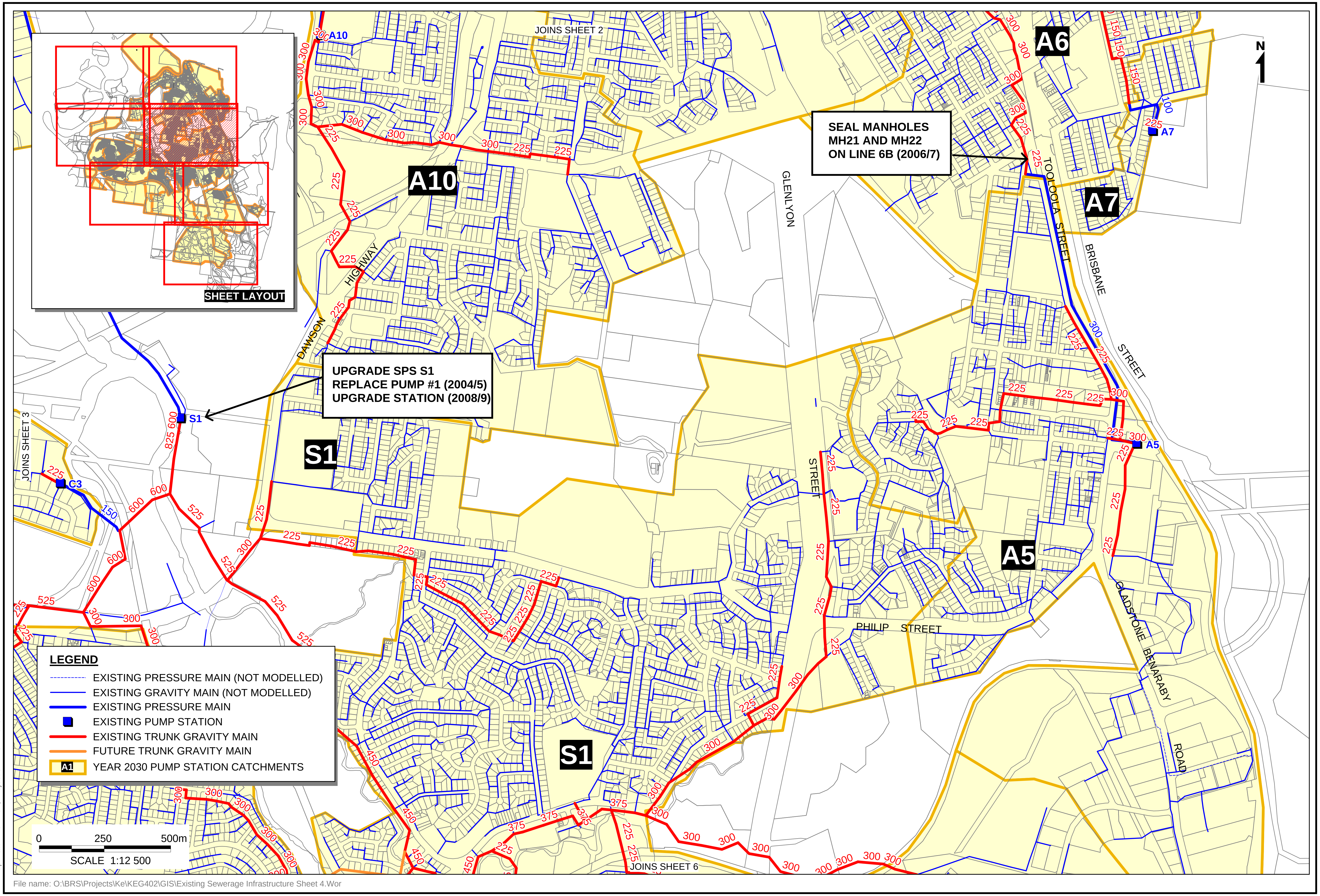

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Figure A.4
EXISTING SEWERAGE INFRASTRUCTURE AND PROPOSED AUGMENTATIONS
SHEET 4 OF 7

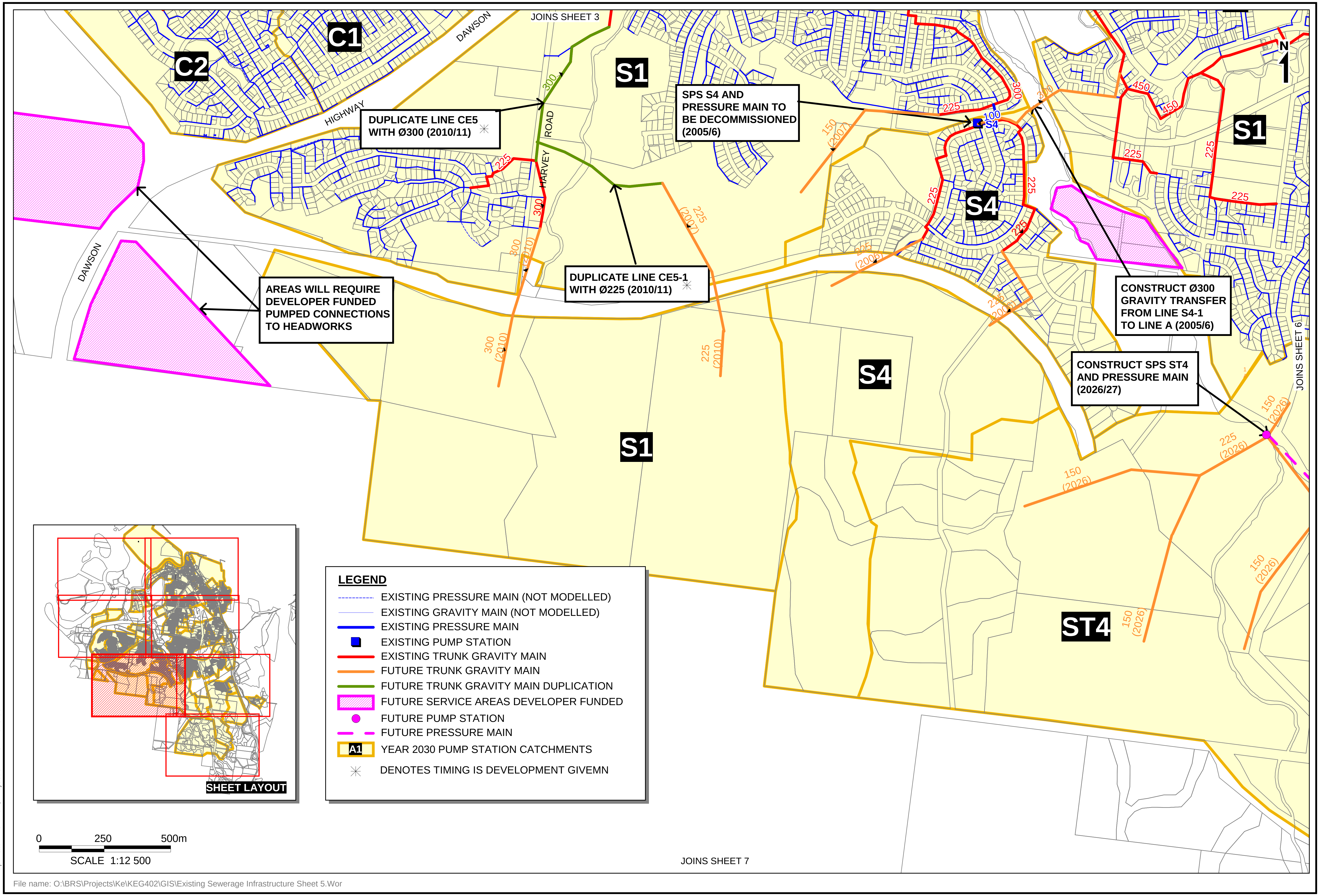


Figure A.5
EXISTING SEWERAGE INFRASTRUCTURE AND PROPOSED AUGMENTATIONS
SHEET 5 OF 7

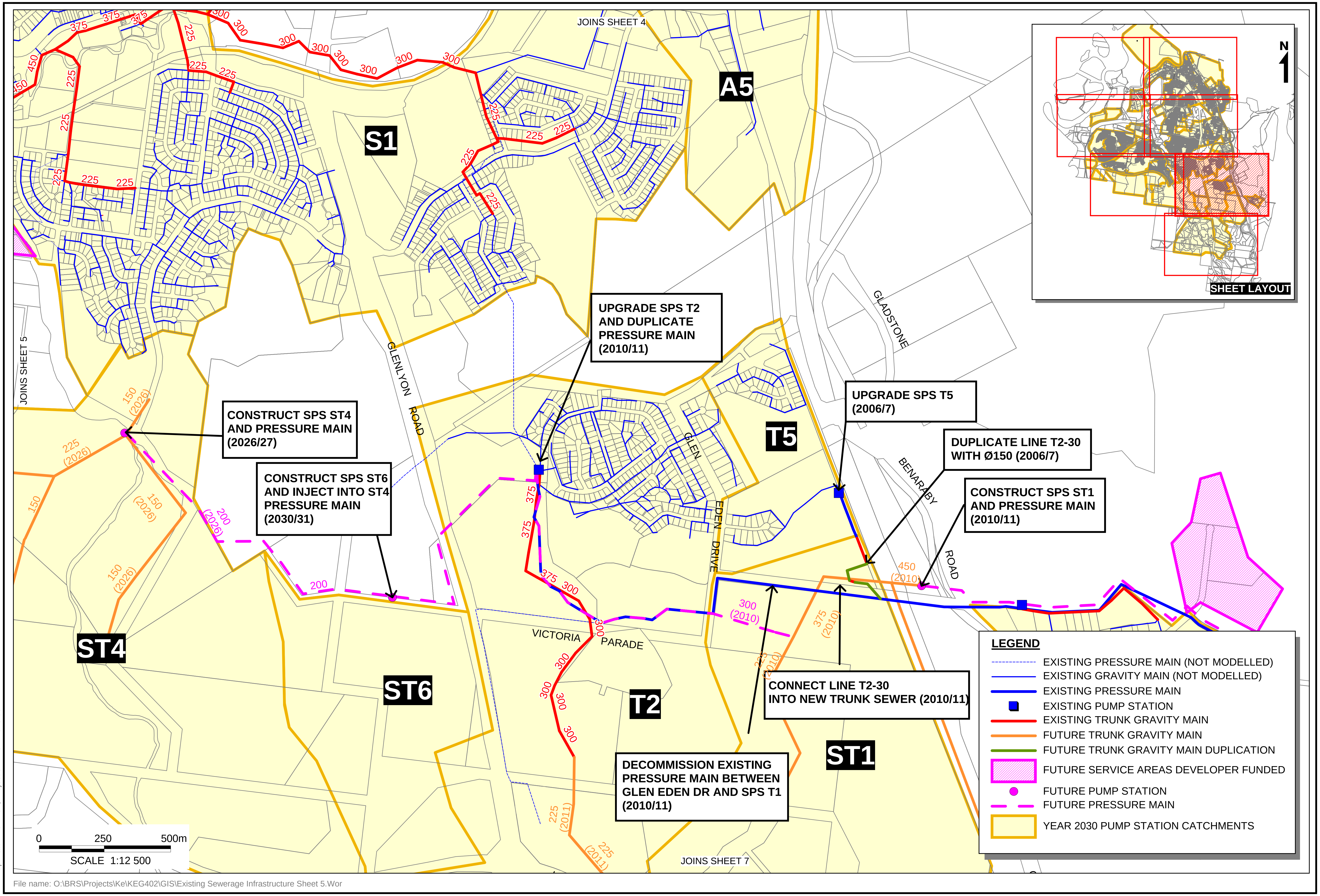


Figure A.6
EXISTING SEWERAGE INFRASTRUCTURE AND PROPOSED AUGMENTATIONS
SHEET 6 OF 7

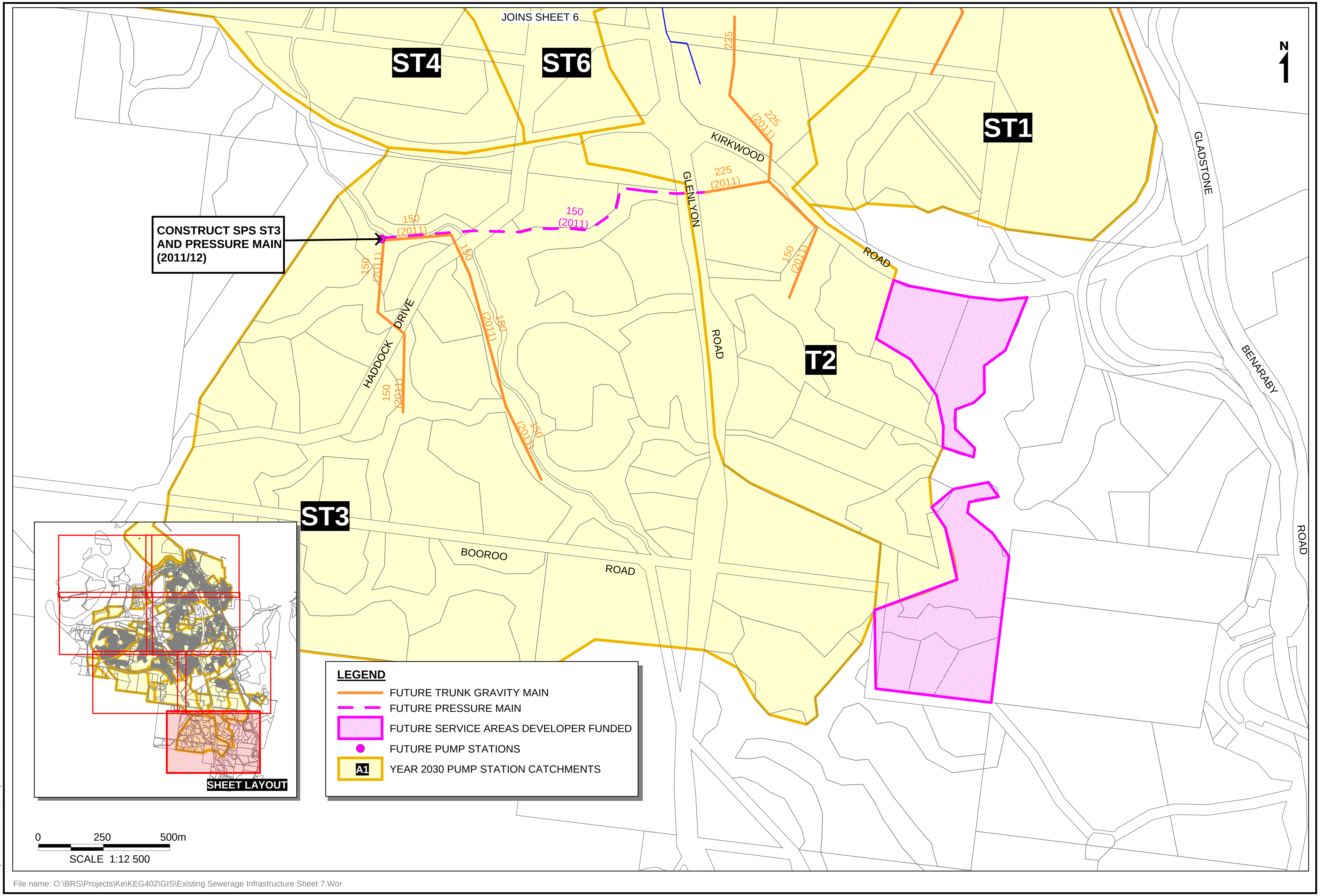


Figure A.7
EXISTING SEWERAGE INFRASTRUCTURE AND PROPOSED AUGMENTATIONS
SHEET 7 OF 7

Appendix B

MODEL BUILD SUMMARY

Appendix B
Model Build Summary

1 INTRODUCTION

Network analysis models for the Calliope River and South Trees sewerage schemes were developed using MOUSE v2003 (Danish Hydraulic Institute).

MapInfo Professional v6.5 was the primary model build tool used to manipulate, clean and transfer data between Gladstone City Council's (GCC) asset database and MOUSE. MapInfo was also used for subcatchment mapping, development of the sewer loading model and processing/presentation of modelled results.

The MOUSE models provide a detailed representation of the trunk sewerage system within each scheme, and also include minor parts of the reticulation system where appropriate for connectivity, to include major sewage pumping stations and to achieve sufficient model definition, subcatchment discretisation and inflow distribution.

2 MODEL DATA DESCRIPTION

2.1 Sewerage system data

A separate model was established for each of the Calliope River and South Trees sewerage schemes.

The initial dataset from GCC's asset database contained 41,083 m of sewer links (designated 'trunk' mains), 250,910 m of sewer links (designated "reticulation' mains) and 5,934 nodes representing manholes, vents and other junctions.

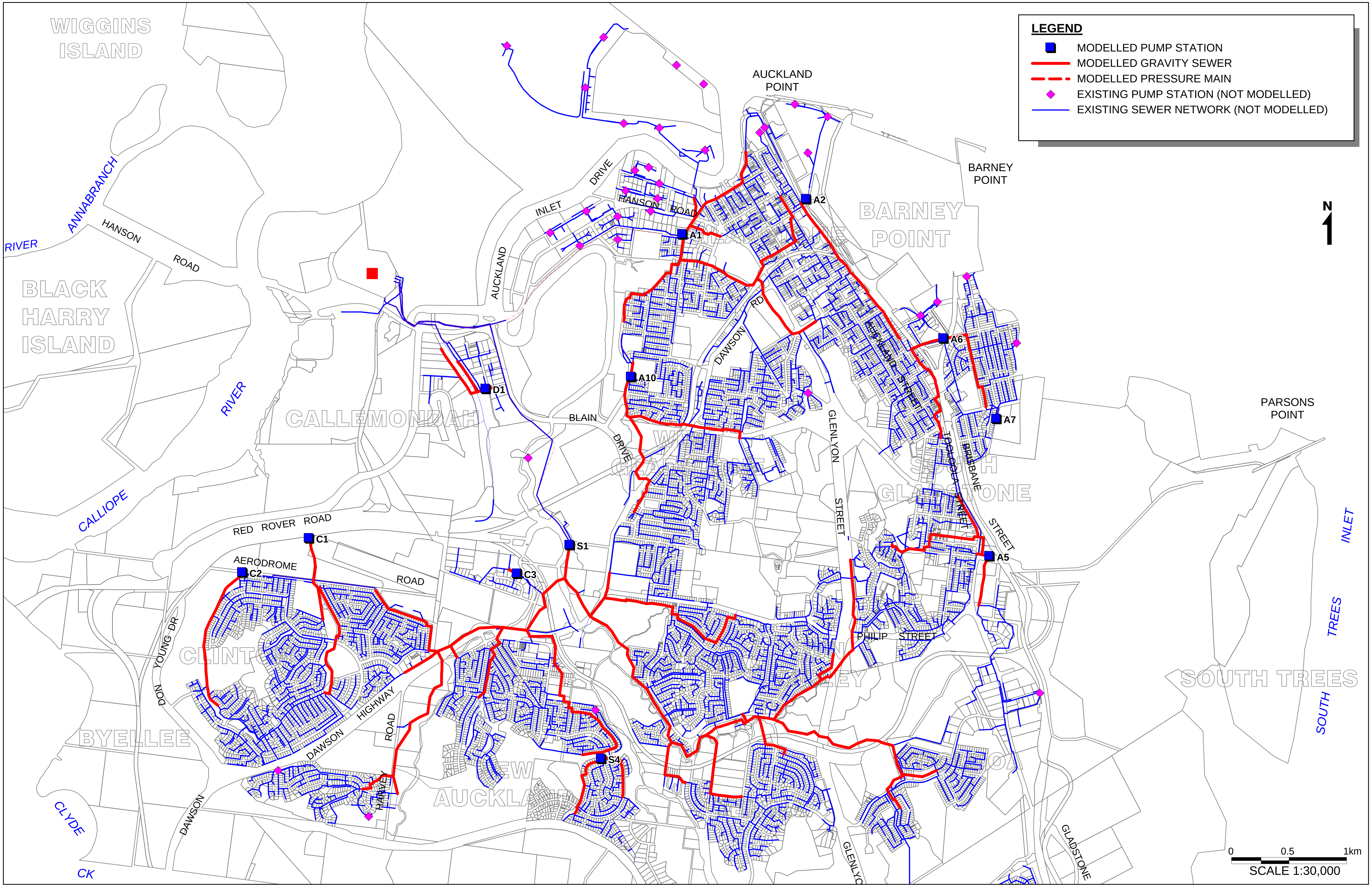
In general, the following was used as a basis for including or excluding sewer from the modelled network:

- links designated as 'trunk' main in the asset database were included;
- all sewer at least 300 mm diameter was included;
- all major pump stations (refer to Section 2.3) were included, with the model extended at least one link upstream of the pump station wet well; and
- connectivity with future expansion/growth areas.

A significant proportion of 225 mm diameter sewer, as well as some 150 mm diameter sewer, was incorporated into the models to ensure connectivity and to obtain appropriate definition and distribution of inflows. To illustrate the level of detail retained in the modelled dataset for the Calliope River scheme, 43% (or 11,415 m) of the total length of modelled sewer is 225 mm or less in diameter.

The inclusion of known overflows did not form a significant consideration since GCC advice was that such structures only exist within pump stations.

Figures B.1 and B.2 provide an overview of the existing Calliope River and South Trees schemes, and illustrate the extent of modelled sewer in each system.



Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\T01\GIS\FIGURES FOR REP-003\Figure B.1 Extent of modelled sewer - Calliope River.wor

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Figure B.1
EXTENT OF MODELLED SEWER
CALLIOPE RIVER

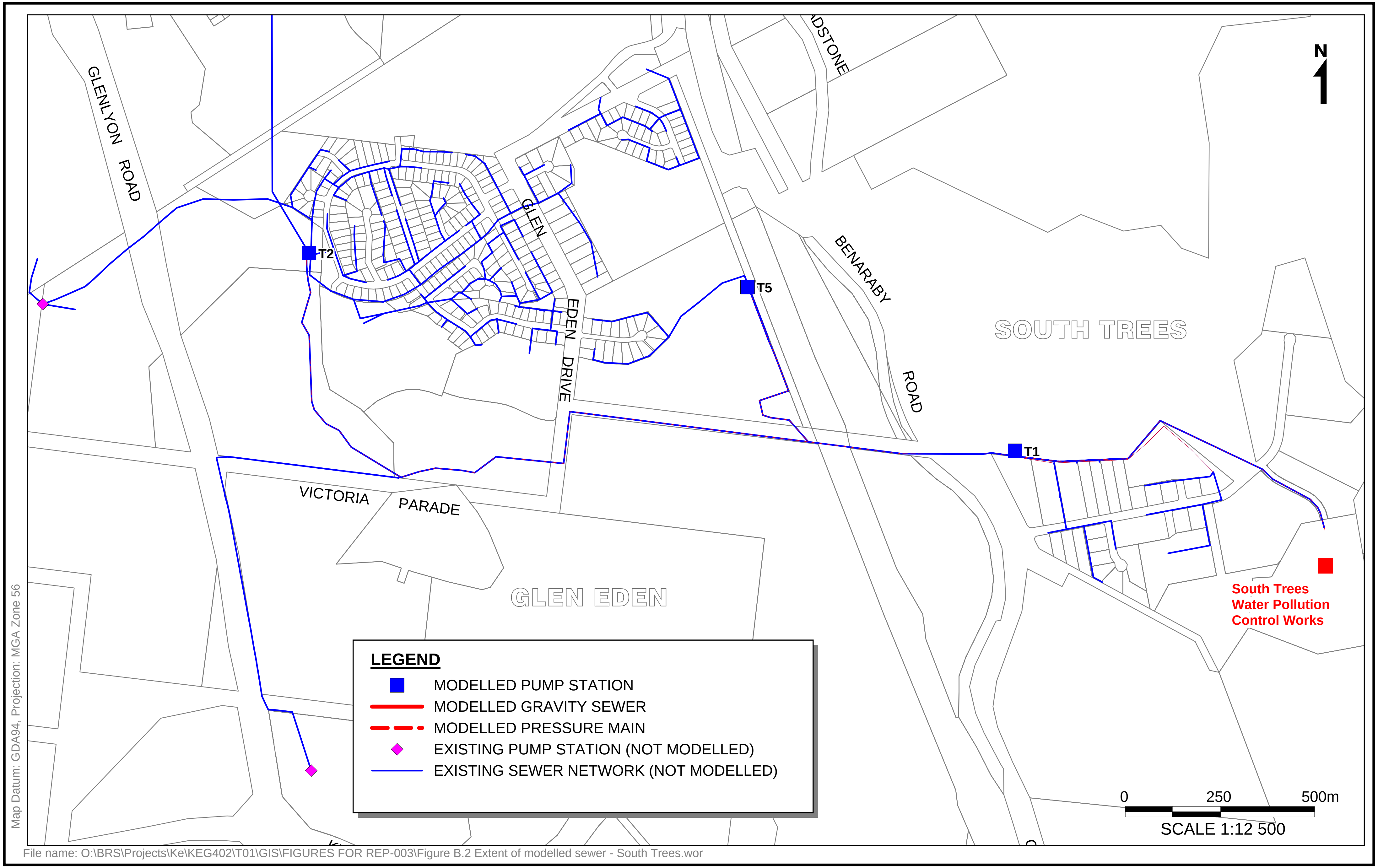

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Figure B.2
EXTENT OF MODELLED SEWER
SOUTH TREES

2.2 Connectivity and naming conventions

Network connectivity was established by manipulating the line references and manhole numbers contained within the asset database to form unique identifiers for each manhole, and then applying a series of database queries to populate the sewer pipe data with the correct upstream and downstream manhole identifiers prior to the MOUSE import.

Identifiers for each manhole (the MOUSE Node ID) were created by combining the line reference and manhole number contained in the asset database (eg. manhole number 2 on line S4-1-3 is identified by S4_1_3_MH2).

The "Business_ID" field (in a format similar to S-TM-CL-57) was adopted as the identifier for each link, although this is only an optional label in addition to the upstream and downstream Node IDs that define the link connectivity in MOUSE.

To enable geographic representation of the model in MOUSE, which assists in model set-up and understanding and also allows for automatic calculation of pipe lengths, manhole co-ordinates were extracted within the GIS based on GDA94 datum and MGA Zone 56 projection. Sewer links are then effectively georeferenced through their connectivity to manholes.

2.3 Infill of missing data

In general, the sewer record data from GCC's asset database showed a good level of integrity for links designated as 'trunk' main. Although the data included a number of missing or incorrect invert levels and pipe diameters, most of these could be accurately estimated or inferred through connectivity to adjacent parts of the system, maintaining nominal drops through manholes, grading between known levels or adopting minimum design grades. Changes made to this data are flagged within a separate MapInfo database generated by KBR during the model build process (refer to Table 1 for flag references that identify data sources for link invert levels and for manhole cover levels). While the integrity of data for 'reticulation' mains was poor, this did not impact significantly on the model build since only a small proportion of this data was required.

Table 1 Link and node level data sources

Flag	Source of level data	
	Link invert level	Manhole cover level
A	Based on level contained in asset database	Based on "Depth" field
B	Based on level reported in previous planning study	Based on contour data
C	Based on minimum drop through manhole	Based on level for adjacent node
D	Based on minimum grade or connectivity	-
E	Correction to obviously erroneous data	-
F	Set equal to pump stop or well invert level	-
G	Best guess – no other data available	-
H	Based on survey data	-
I	Based on design drawings	-

Following infill of missing link invert data, manhole invert levels were globally updated by adopting a level 10 mm below the upstream invert level of the outlet link.

Manhole cover levels were globally updated by adopting a level equal to the manhole invert level plus 10 mm plus the value recorded in the "Depth" field in the asset database. Where the "Depth" field was blank, manhole cover levels were estimated from an elevation grid established from 1m contour data.

Manhole diameters were determined from the "Type" field in the asset database, with Type 1, 2 or 3 manholes assigned a diameter of 1.1 m, and Type 4 or 5 manholes assigned a diameter of 1.5 m (as per GCC Standard Drawings for sewerage infrastructure).

2.4 Ancillary data

2.4.1 Sewage pumping stations

There are 46 sewage pumping stations (SPSs) currently operating within the Calliope River sewerage system, 12 of which were incorporated into the Calliope River trunk system model.

There are five SPS currently operating within the South trees system, three of which were incorporated into the South Trees trunk system model.

Details for each modelled SPS, based on current data provided by GCC, are provided in Table 2.

Table 2 Modelled SPS data

SPS	Station duty (L/s)	Well diameter [3] (m)	Well invert (m)	Ground level (m)	Pump stop (m)	Pump start (m)	Source [1]	Receiving node
Calliope River								
A1	300	3.8	-3.90	4.25	-3.80	-2.30	A	STP
A2	102	6.0	-3.15	3.95	-3.05	-1.75	A	1A_MH24
A5	58.3	5.2	-1.47	3.89	-1.37	-0.07	A	6B_MH23
A6	68	6.0	-2.83	4.17	-2.70	-1.50	A	2A_MH23
A7	19.7	2.0	-1.88	3.92	-1.78	-1.18	B	6A_8_MH2
A10	50.5	5.2	-2.55	3.95	-2.45	-1.25	A	1B_MH17
C1	45	4.0	5.60	11.25	5.70	6.65	B	CA_MH34
C2	42	4.0	10.87	16.17	10.97	11.57	B	CA_MH34
C3	8	1.8	0.95	5.62	1.04	1.50	B	CA_MH3
D1	16	3.0	-2.75	5.75	-2.65	-2.00	B	STP
S1	265	5.5	-1.38	6.02	-1.28	0.22	A	STP
S4	10	2.0	7.81	13.16	7.91	8.36	B	CB_MH30A
South Trees								
T1	23.5	2.0	-2.47	4.63	-2.27	-1.67	B	STP
T2	31 [2]	2.2	23.01	28.01	23.21	23.86	B	STP
T5	3.8	2.0	7.06	10.26	7.26	7.71	B	T2_30_MH8

Notes:

1. Source of SPS operating levels (A = 2004 telemetry data, B = MacIntyre, 1997).

2. Data advised by GCC.

3. Well diameter or equivalent modelled diameter.

Pump well configurations (including size, invert and ground levels) for all modelled pump stations were taken from data previously documented by MacIntyre & Associates (1997), or as otherwise indicated by GCC during the course of the study. All wells were modelled as circular, with equivalent well diameters determined for stations with a half-well (WW/DW) configuration.

Rising main data was taken primarily from GCC's asset database, supplemented by MacIntyre & Associates (1997) where required as directed by GCC.

2.4.2 Overflows

Based on information provided by GCC, a directed overflow point was incorporated into the model at each SPS. No other underground overflow structures are known to exist within either the Calliope River or South Trees systems.

Each overflow point was modelled as a 225 mm diameter pipe connecting directly to the pump well.

Overflow crest levels were determined from the telemetry data available for 6 SPSs within the Calliope River system, which related the overflow level to the known well invert level. Modelled overflow levels for the remaining 6 SPSs within the Calliope River system, and for the 3 SPSs within the South Trees system are estimates only (generally taken as the obvert level at the upstream end of the pipe upstream of the wet well since property connection levels were not known).

Modelled overflow levels are provided in Table 3.

Table 3 Modelled overflow levels

Overflow ID	Overflow level (m)	Data source
Calliope River		
OF_PS_A1	1.40	2004 telemetry data
OF_PS_A2	1.95	2004 telemetry data
OF_PS_A5	2.64	2004 telemetry data
OF_PS_A6	1.10	2004 telemetry data
OF_PS_A7	1.92	Estimate
OF_PS_A10	1.25	2004 telemetry data
OF_PS_C1	9.40	Estimate
OF_PS_C2	14.67	Estimate
OF_PS_C3	4.75	Estimate
OF_PS_D1	1.05	Estimate
OF_PS_S1	4.72	2004 telemetry data
OF_PS_S4	11.61	Estimate
South Trees		
OF_PS_T1	-0.72	Estimate
OF_PS_T2	24.30	Estimate
OF_PS_T5	8.42	Estimate

2.4.3 Other ancillaries

There are no other ancillary structures incorporated into either system model.

2.5 Subcatchment definition

Sewerage system subcatchment discretisation and mapping was undertaken within MapInfo and was initially based on the sewer reticulation layout and cadastre. Subcatchments were then refined to ensure all water supply demand nodes (exported from an H_2ONet water supply demand model) were geographically incorporated within the modelled sewerage system service areas.

This approach was consistent with the adopted use of a peaking factor to specify wet weather flow as a function of dry weather flow, rather than linking wet weather flow to catchment areas.

2.6 Hydraulic parameters

2.6.1 Pipe roughness

Pipe roughnesses were assigned within MOUSE based on the pipe material recorded in the GCC asset database. Default friction loss coefficients were applied due to the lack of any better information. or gauged sewer flows/depths that could otherwise be used for calibration. Table 4 shows the relationship between the pipe type recorded in the asset database, the adopted MOUSE pipe material and default Mannings M (and n) values.

Table 4 Pipe roughness parameters

GIS pipe type	MOUSE pipe material	Mannings M (n) value
AC	Normal concrete	75 (0.0133)
CONC	Normal concrete	75 (0.0133)
PVC	Plastic	80 (0.0125)
uPVC	Plastic	80 (0.0125)
VC	Ceramics	70 (0.0143)

2.6.2 Headloss parameters

All manhole outlet shapes were specified Round Edged Outlet within MOUSE. The default headloss coefficient of 0.25 for this outlet shape was applied in the absence of any better information.

3 MODEL INFLOW DEVELOPMENT

3.1 Sewerage loading model

The water supply demand model developed as part of the concurrent Water Supply study formed the basis for the dry weather component of the sewerage loading model.

The process for converting water supply demand to sewer loads is outlined below:

- Sewerage system subcatchments were discretised and mapped in MapInfo, geographically capturing sewerage system service areas as well as the demand nodes from the H_2ONet water supply demand model.
- Subcatchment data was populated with ET demand input for various land uses from the demand node attribute data through a series of GIS-based queries.
- Subcatchment data was imported into MOUSE and assigned to appropriate loading points.
- Dry weather and wet weather inflows were specified on the basis of subcatchment ET loads, average water consumption rates and estimated sewer return factors for each subcatchment.

3.2 Conversion factors

Table 5 presents a summary of the global conversion factors that were adopted to translate water supply demand ET to sewer loads.

Table 5 Conversion factors

	Residential	Non-residential
Estimated overall proportion of water users returning water to sewer	100%	70%
Estimated average return factor for typical water user	0.60	0.70
Unaccounted For Water	15%	15%
Adopted return factor	100% x 0.60 x (100-15)% = 0.51	70% x 0.70 x (100-15)% = 0.42

Additional conversion factors were applied to account for water demand distribution and specific non-residential water usage patterns.

The water supply demand distribution adopted for water supply modeling purposes ranged between 1,200 and 1,400 L/ET/day. Each sewerage subcatchment was assigned a corresponding water supply zone for this purpose based on geographical location.

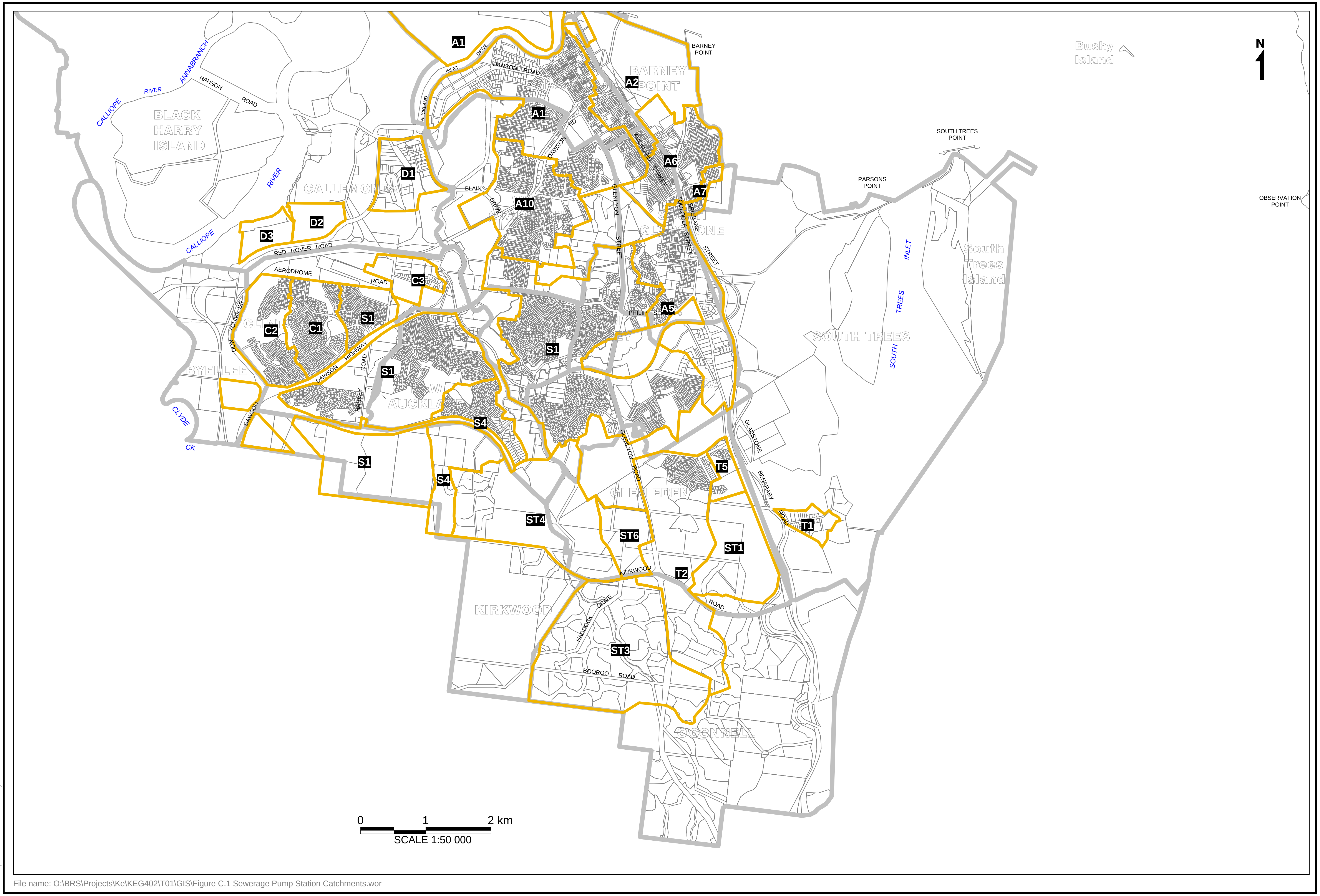
A number of large water users were considered to return effectively zero water to the sewer and their demand contributions were accordingly removed. These comprised NRG, QAL, Barney Point Coal, Clinton Coal, Gladstone Port Area and the Tondoon Botanical Gardens. Two further non-standard water users were also individually accounted for—the Gladstone Marina Area was estimated to return 10% of water to the sewer and an allowance of 120 kL/d (direct to sewer) was added to account for wasted backwash water (sourced from raw water supply) at the Gladstone Water Treatment Plant.

Base flows were not explicitly accounted for in the modeling, and are effectively assumed to be included in the sewer loading derived for residential and non-residential water users.

Wet weather flows were derived through direct peaking of dry weather flows. A conversion factor of five was adopted for the purposes of the study (ie. peak wet weather flow assumed to be five times average dry weather flow).

Appendix C

PUMP STATION SUBCATCHMENTS



File name: O:\BRS\Projects\Ke\KEG402\T01\GIS\Figure C.1 Sewerage Pump Station Catchments.wor

Figure C.1
SEWERAGE PUMP STATION CATCHMENTS