WATER AND WASTEWATER PLANNING STUDIES - 2030

WATER SUPPLY 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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INTRODUCTION

The purpose of this consultancy is to review and update the previous planning for the Gladstone water supply scheme, preparing an up-to-date network analysis model and 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.

WATER SUPPLY SCHEME

Gladstone City is supplied via infrastructure that is owned by the Gladstone Area Water Board (GAWB) including the Gladstone Water Treatment Plant (WTP), High Lift and Low Lift treatment plant pumps and several distribution mains.

The existing GAWB WTP has a capacity of 53 ML/day however as a result of increased backwashing to treat blue green algae is likely to be reduced to 50 ML/day.

The Gladstone City water supply system is split up into four different zones as explained below.

- Zone A

Zone A is supplied via Radar Hill Reservoir and Ferris Hill Reservoir which are both supplied via the Low Lift pump station at the treatment plant.

- Zone BC

Zone BC is supplied via Paterson Street Reservoir and Fisher Street Reservoir. Paterson Street Reservoir is gravity fed from Round Hill Reservoir and Fisher Street Reservoir is supplied via the Low Lift Pump Station at the treatment plant.

- Zone D

Zone D is the largest zone and is served via the GAWB owned South Gladstone Reservoir and the Gladstone City Council owned Round Hill Reservoir. Both of these zones are supplied via the High Lift pump stations at the treatment plant.

Gravity flow from Round Hill reservoir supplies Clinton Park Reservoir, Paterson Street Reservoir and the Clinton Industrial Estate. Supply to the Clinton Park Reservoir is boosted at higher demand times by the Auckland Street Pump Station.

The South Gladstone Reservoir, supplied via the High Lift Pump Station via GAWB trunk mains, supplies the south east region of the Gladstone City supply network and also supplies Calliope Shire and Boyne Islands/Tannum Sands.

- Zone F

Zone F is primarily an industrial zone with the main demand consisting of the Power Station. It is supplied via the Clinton Industrial Estate reservoir which is gravity fed from the Round Hill reservoir.

- Zone X

Calliope Shire Council has been represented as Zone X carried over from the previous planning report.

STUDY AREAS AND OBJECTIVES

The study areas for this investigation are the existing and planned reticulated water supply areas of the Gladstone City water supply system. Gladstone City Council has four existing supply zones and also supplies parts of Calliope. This study will incorporate significant growth in the suburbs of Kirkwood, Glen Eden and O'Connell.

The objectives of this report are to update the previous studies for the water supply scheme by addressing, in particular, the following:

- Effectively plan 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 water supply systems necessary to service future development;
- Form part of Council's Strategic and Total management Plans;

- Be used as the basis for infrastructure charging pursuant to the Integrated Planning Act 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.

PLANNING PERIOD AND POPULATION GROWTH ASSESSMENT

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

The existing equivalent populations for the water system were derived from the Watsys demand model and verified. 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

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/day (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 (Yr 1990—Yr 2004) and the daily flows from the Gladstone Water Treatment Plant.

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/day
- Zone BC—1300 L/ET/day
- Other (including Zone D)—1400 L/ET/day

These demands including unaccounted for water. The following residential peaking factors have been adopted.

- MDMM/AD—1.5
- MD/AD—2.0

DESIRED STANDARDS OF SERVICE

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

The system performance design criteria have been based on the Water Resources Water supply Guidelines 1989 which requires the performance of a water supply distribution system be evaluated in terms of supply the design flow rates while simultaneously satisfying the system performance criteria.

NETWORK ANALYSES AND MODEL VALIDATION

The Gladstone City Council water supply scheme has been analysed using the dynamic network analysis package H2Onet for the following cases.

- Existing (2004) reticulation and trunk main system using actual peak period flows
- The existing (2004) reticulation and trunk main system using adopted consumptions figures
- The existing reticulation and trunk main system with Yr 2006 growth in the Gladstone CBD and Barney Point
- The proposed water supply network for the year 2016 and 2030 using projected figures for consumption

WATER SUPPLY SCHEME SYSTEM PERFORMANCE

This revised planning has resulted in the following recommendations for the Gladstone water supply scheme.

- Zone A and Zone BC will be rezoned to allow Paterson Street Reservoir to supply Zone BC and Fisher Street Reservoir, Radar Hill Reservoir and Ferris Hill Reservoir to supply Zone A.
- Clinton Park Zone will be rezoned to prevent high pressures in New Auckland downstream of the Auckland Creek Booster Pump Station.
- A second reservoir at South Gladstone will be required to service this region
- A high level zone will be created to service the suburb O'Connell located south of Glen Eden

FIRE FLOW ASSESSMENT

Fire fighting capacity of the Gladstone City system was assessed at a macro level. In particular, the investigation focused on fire fighting flows in excess of Council's standards to meet industry or major user requirements.

Areas of deficiencies were encountered in developments supplied via 100mm diameter pipework. However the non-residential large water users all achieved satisfactory results.

RECOMMENDATIONS

It is recommended that Gladstone City Council:

1. Adopts this report and the capital works program with approximate capital expenditure of **$ 12,012,000**.
2. Undertake a detailed investigation into the most appropriate site for the second South Gladstone Reservoir including preliminary geotechnical investigation and preliminary survey.
3. Use this report as the basis for the development of the Priority Infrastructure Plans.
4. Continues to actively apply and encourage demand management initiatives.
5. Forwards this report to the Gladstone Area Water Board
6. Forwards this report to the NRM&E for approval as a planning report.

1 Introduction

1.1 COMMISSIONING

Kellogg Brown & Root Pty Ltd (KBR) was commissioned by Gladstone City Council to prepare a Planning Report for water supply infrastructure which includes:

- Assessment of infrastructure needs to meeting existing and future demands to year 2030;
- preparation of logical calculations 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.

1.2 INTRODUCTION

The purpose of this consultancy is to review and update the previous planning for the Gladstone water supply scheme, preparing an up-to-date network analysis model and 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 WATER SUPPLY SCHEME

2.1.1 Infrastructure

GAWB Infrastructure

Gladstone City is supplied via significant infrastructure that is owned by the Gladstone Area Water Board (GAWB). This includes the Gladstone Water Treatment Plant, the Low Lift and High Lift pump stations (see below) and trunk mains (Appendix A).

Bulk Supply

Gladstone City is supplied from the Gladstone Treatment Plant which is owned by GAWB but is operated and maintained by the Gladstone City. The existing GAWB WTP has a capacity of 53 ML/day however as a result of increased backwashing to treat blue alga is likely to be reduced to 50 ML/day. The future planning of this facility was not part of this study and a further study will be required on the augmentation of bulk infrastructure of the treated water system.

Raw water is obtained from Awoonga Dam and pumped to a 50 ML raw water storage at South Gladstone and then treated at the Gladstone Treatment Plant and stored in clear water storages.

Water from the treatment plant is supplied to a number of 'points of supply' as follows:-

- At the junction of the Boards 375mm diameter low lift rising main from the water treatment plant with the existing 300 mm diameter CI pipeline;
- At the junction of the 600 mm diameter high lift rising main with Gladstone City council's 600 mm diameter pipeline to the Round Hill Reservoir;
- At the outlet of the 9.1 ML South Gladstone (Toolooa Estate) Reservoir;
- A stop valve controlled connection at the junction of the Board's 300 mm diameter high lift rising main and the Gladstone City Council's 375mm diameter pipeline along Philip Street. This connection is retained for emergency operation only;
- At a point to be determined in the future on the Boyne Island/Tannum Sands pipeline between the 9 ML South Gladstone Reservoir and the City/Shire boundary;
- At a point to be determined in the future on the Calliope Township pipeline between the 9 ML South Gladstone Reservoir and The City/Shire boundary.

Pump Stations

The water is distributed from the Gladstone Treatment Plant via two pump stations, the High Lift Pump Station and the Low Lift Pump Station. The future planning of these facilities was not a part of this study however their existing and required capacities has been identified.

The High Lift Pump Station, with a rated capacity of 389 L/s vs 56.4 m, supplies Round Hill reservoir and the South Gladstone Reservoir. The high lift pump station consists of three pumps with one duty pump. The duty pump is telemetry controlled by Round Hill Reservoir and South Gladstone Reservoir. The second pump is manually operated only and is turned on by the treatment plant operator under high demand conditions. It is understood that this has only occurred once in the last 12 months for four hours in November 2003.

The Low Lift Pump Station, with a rated capacity of 170 L/s vs 59 m, supplies the Zone A reservoirs.

The Auckland Creek Street Pump Station provides flow to the Clinton Park reservoir and has a rated capacity of 90 L/s vs 40 m.

The Fisher Street Pump Station, with a duty of 60 L/s vs 22.5 m, is a direct supply to reticulation. It was installed to enable Fisher Street Reservoir to turn over. Fisher Street and Paterson Street reservoirs both supply similar areas however Paterson Street Reservoir has a higher TWL and therefore will generally be utilised in preference, over the Fisher Street Reservoir. To allow Fisher Street Reservoir to turn over, the booster pump station turns on for 4 hours from 3pm to 7pm.

The following table summarises the pump station information.

Table 2.1 Gladstone City Council pump stations

Pump station	Nominal duty	Controlling node	Pump start level (m AHD)	Pump stop level (m AHD)
Low lift PS	170 L/s vs 59m	Radar Hill Reservoir	59.62	60.74
		Fisher Street Reservoir	59.9	61.02
		Ferris Hill Reservoir	59.62	61.13
High lift PS	389 L/s vs 56.4 m	South Gladstone Reservoir	89.63	91.28
		Round Hill	89.28	90.07
Auckland Creek Street PS	90 L/s vs 40 m	Clinton Park Reservoir	90.19	91.28
Fisher Street booster PS	60 L/s vs 22.5 m	Time controlled 3pm—7pm	—	—

Reservoirs

Gladstone City Council has a total of seven reservoirs. The Council also has access to 7.5 ML of the GAWB owned 9.1 ML South Gladstone reservoir. Table 2.2 describes the reservoirs which form part of the existing Gladstone City water supply system.

Table 2.2 Gladstone City Council reservoirs

Reservoir no.	Location	Capacity (ML)	Useable capacity (ML)	TWL (m AHD)	BWL (m AHD)	Diameter (m)
4	Radar Hill	2.3	2.3	61.3	55.7	36.3
5	Fisher St	2.3	2.3	61.3	55.7	36.3
6	Paterson St	4.6	4.6	79.3	74.22	36.4
8	Ferris Hill	9.1	9.1	61.3	52.88	35.6
9	South Gladstone* (Toolooa)	9.1	7.5	91.4	85.5	44.9
10	Round Hill	13.64	10.6	91.44	85.35	38.9
11	Clinton Industrial Estate	13.6	10.9	51.8	42.9	33.7
12	Clinton Park	13.6	13.6	91.4	85.4	39.2

* Only 83% of South Gladstone capacity is available for GCC use

It should also be noted that as a result of ring beam failure in Round Hill Reservoir and Clinton Industrial Estate Reservoir they can only fill to 78% and 80% respectively. It will be assumed in this report that their available capacity is limited to these values.

Pipes

Asset data for the existing pipe network as determined from the GIS data provided to KBR is presented in Table 2.3. Pipe diameter information is presented for both the reticulation and distribution mains and does not include pipes owned by the Gladstone Area Water Board. The table indicates that the majority of pipe components in the system are 100 mm nominal diameter.

It should be noted that although the nominal diameters are referred to here, the internal diameter of the pipe, based on the pipe material, was used for modelling purposes.

Table 2.3 Gladstone City water supply pipe diameter profile

Nominal diameter (mm)	Total retic length (m)	% of reticulation	Total distribution main length (m)	% of distribution mains
≤50	6,275	2.9	—	—
80	1,076	0.5	—	—
100	131,173	60.8	—	—
150	54,498	25.3	—	—
200	22,773	10.6	—	—
225	—	—	197	0.5
250	—	—	9, 909	21.1
300	—	—	14,124	30.1
375	—	—	10,496	22.4
450	—	—	8,030	17.1
525	—	—	411	0.9
600	—	—	3,680	7.8
650	—	—	81	0.2
Total	**215,795**	**100**	**46,928**	**100**

Detailed GIS based drawings of the existing water supply infrastructure are provided later in this report in Appendix A.

2.1.2 System zoning

The Gladstone City water supply system is split up into four different zones as explained below and shown in Figure 2.1.

- *Zone A*

Zone A is supplied via Radar Hill Reservoir and Ferris Hill Reservoir which are both supplied via the Low Lift pump station at the treatment plant.

- *Zone BC*

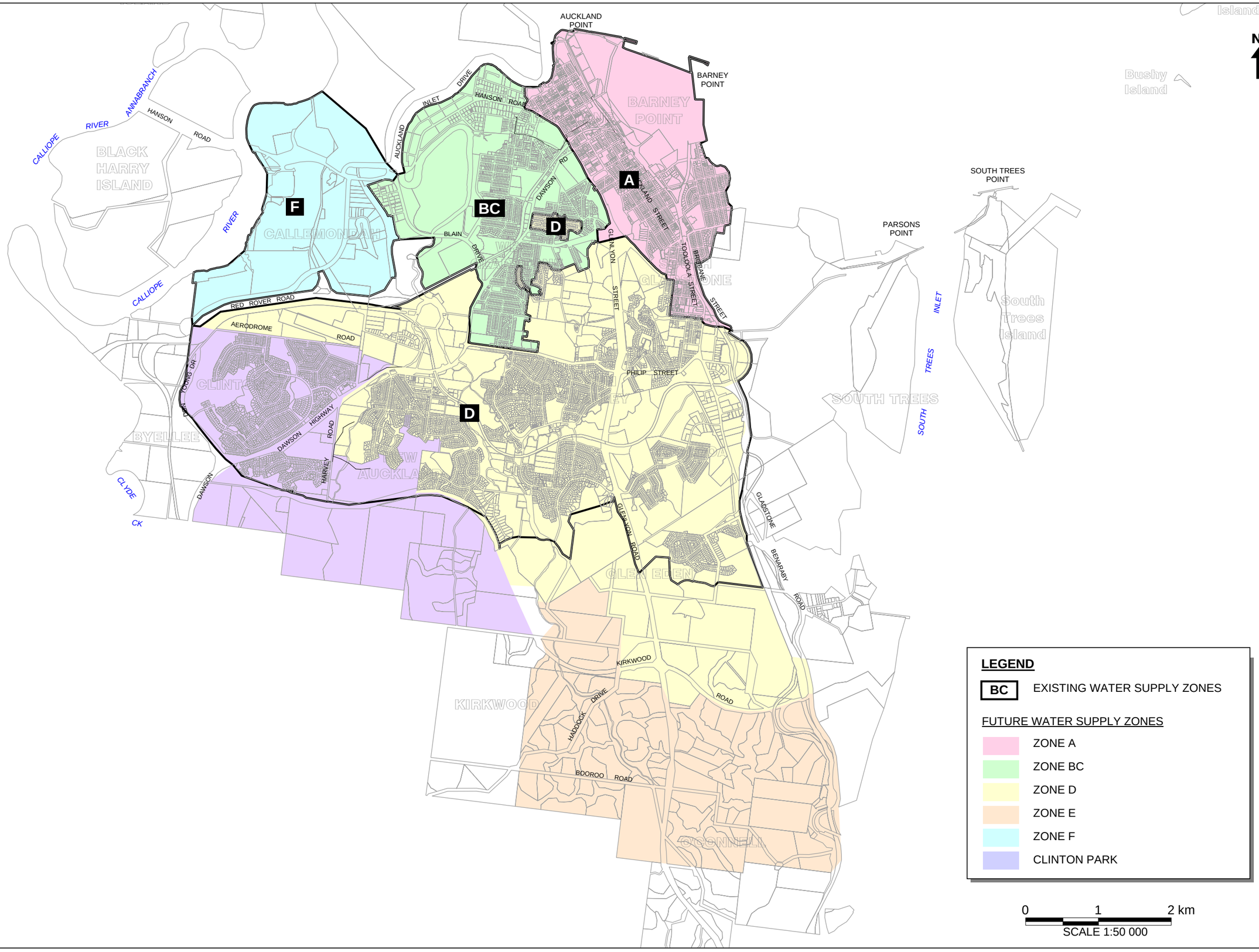
Zone BC is supplied via Paterson Street Reservoir and Fisher Street Reservoir. Paterson Street Reservoir is gravity fed from Round Hill Reservoir and Fisher Street Reservoir is supplied via the Low Lift Pump Station at the treatment plant.

- *Zone D*

Zone D is the largest zone and is served via the GAWB owned South Gladstone Reservoir and the Gladstone City Council owned Round Hill Reservoir. Both of these zones are supplied via the High Lift pump stations at the treatment plant.

Gravity flow from Round Hill reservoir supplies Clinton Park Reservoir, Paterson Street Reservoir and the Clinton Industrial Estate. Supply to the Clinton Park Reservoir is boosted at higher demand times by the Auckland Street Pump Station.

South Gladstone Reservoir supplies the south east section of the Gladstone City supply network and also supplies Calliope Shire and Boyne Islands/Tannum Sands.



Map Datum: GDA94, Projection: MGA Zone 56

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Figure 2.1
EXISTING AND FUTURE WATER SUPPLY ZONES

- *Zone F*

Zone F is primarily an industrial zone with the main demand consisting of the Power Station. It is supplied via the Clinton Industrial Estate reservoir which is gravity fed from the Round Hill reservoir.

- *Zone X*

Calliope Shire Council has been represented as Zone X carried over from the previous planning report.

2.2 PREVIOUS PLANNING

Two relevant planning reports have been previously prepared for the Gladstone City water supply schemes. They are:

- *Gladstone Area Water Board: Review of Treated Water System*, GHD, May 2000.
- *Gladstone City Council: Gladstone Water Supply,* McIntyre & Associates, November 1997.

The GHD report deals with the major water supply infrastructure components owned by the Gladstone Area Water Board and operated and maintained by the Gladstone City Council.

The McIntyre & Associates report included investigations based on network models and forecasts of population increase and development to the year 2026. It included consideration of the storage and reticulation components of the system with the objective of providing an estimate of the capital works required to augment the water supply system over that period.

3 Study areas and objectives

3.1 STUDY AREAS

The study areas for this investigation are the existing and planned reticulated water supply areas of the Gladstone City water supply system. An overview of the water supply for Gladstone City Council showing the service areas are supplied in Appendices A and B respectively.

Gladstone City Council has four existing supply zones, A, BC, D and F as shown in Figure 2.1.

Also included in this study are several suburbs and large industry in Calliope Shire as follows:

- Tannum Sands/Boyne Island
- Calliope Township.

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 OBJECTIVES

The objectives of this report are to update the previous studies for the water supply scheme by addressing, in particular, the following:

- Effectively plan 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 water supply systems necessary to service future development;
- Form part of Council's Strategic and Total management Plans;
- Be used as the basis for infrastructure charging pursuant to the Integrated Planning Act 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.

3.4 SCOPE OF WORK

The scope of work undertaken by KBR includes:

- model construction;
- demand establishment and assignment for water supply;
- model validation (2003–2004);
- analyses for Maximum Day (MD), Mean Day Maximum Month (MDMM) and Average Day (AD) for Year 2006 for Gladstone CBD and Barney Point only;
- scenario analyses for Maximum Day (MD), Mean Day Maximum Month (MDMM) and Average Day (AD) for 2004, 2016 and 2030;
- determine augmentation requirements, costs and staging for the water networks;
- macro fire fighting assessment;
- preparation of draft planning report and workshop presentation incorporating all aspects of the study;
- preparation of final planning reports.

4 Planning period and population growth assessment

4.1 PLANNING PERIOD

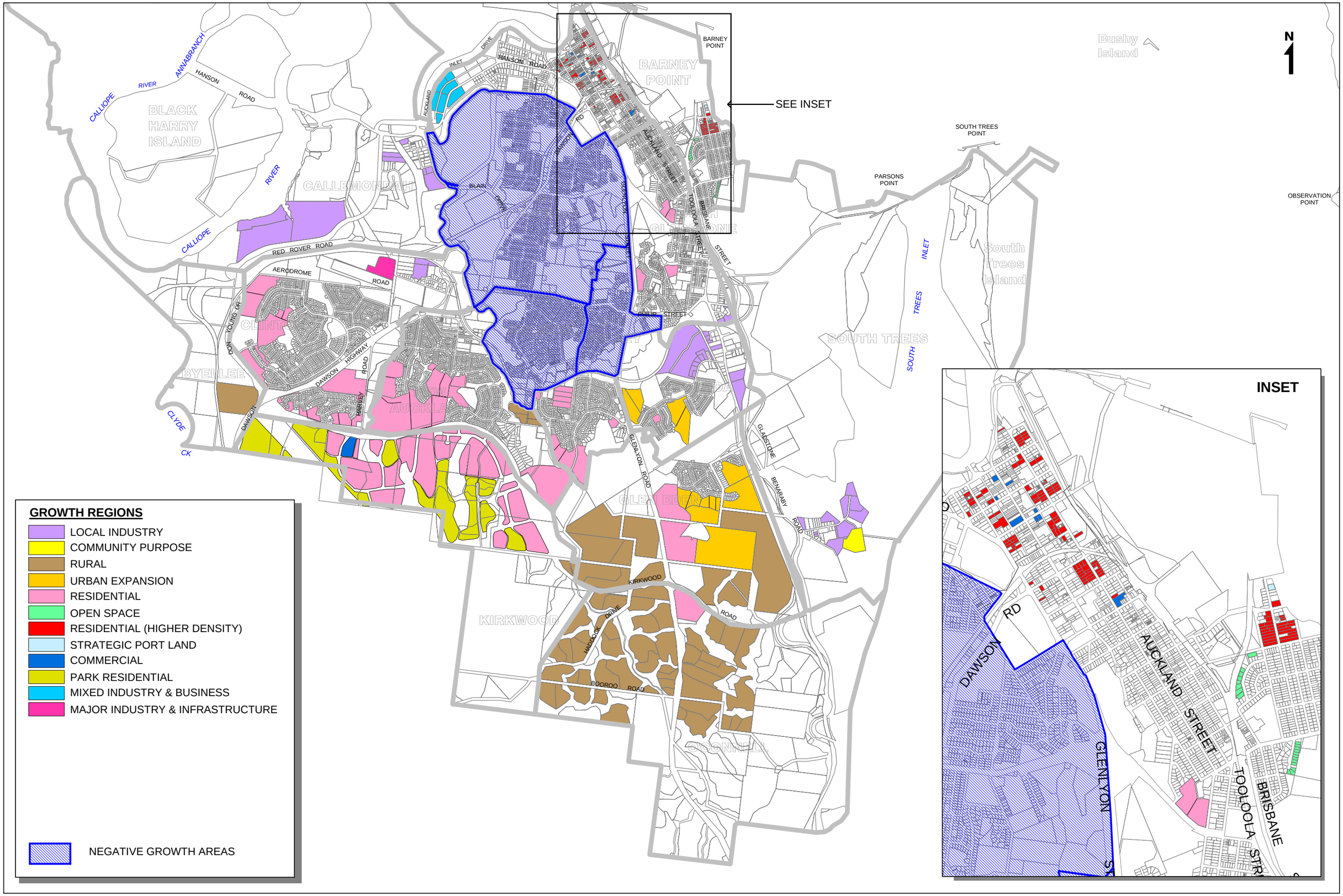
This study was undertaken to analyse Gladstone City's water supply infrastructure under existing and future foreseeable demands to 2030.

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 conservative on the high side. Updated population forecasts from the Department of Local Government (DLGP)'s Planning Information and Forecast Unit (PIFU) were allocated to areas suitable for greenfield growth and redevelopment within Gladstone City Council. The PIFU model will be utilised in conjunction with the CBD study, 2004, to ensure that demand is appropriately allocated to the system including an allowance for the redevelopment of the CBD area. The areas to which population have 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. Projected growth projections from the PIFU model were obtained and then added to these for each planning period and shown in Figure 4.1. A summary of the population projections is shown in Table 4.1.

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



GROWTH REGIONS

- LOCAL INDUSTRY
- COMMUNITY PURPOSE
- RURAL
- URBAN EXPANSION
- RESIDENTIAL
- OPEN SPACE
- RESIDENTIAL (HIGHER DENSITY)
- STRATEGIC PORT LAND
- COMMERCIAL
- PARK RESIDENTIAL
- MIXED INDUSTRY & BUSINESS
- MAJOR INDUSTRY & INFRASTRUCTURE

NEGATIVE GROWTH AREAS

Map Datum: GDA94, Projection: MGA Zone 56

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Figure 4.1
GROWTH AREAS

Table 4.1 Residential population projects for Gladstone City

	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, 2002 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, five primary areas will be adopted for future industrial growth;

- Along Hanson Road
- Industrial area surrounding Blain Drive and Red Rover
- 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/annum and a minimum growth rate of 45 EP/annum. Given the variation in growth over the past four years a conservative growth rate should be

adopted. Following discussions with Council, 120 EP/annum has been adopted. The calculated figures for industrial growth are presented in Table 4.2.

Table 4.2 Industrial growth figures

	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	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
Total		**240**	**599**	**605**	**602**	**1,086**	**3,132**	**1,119**

5 Demand and loading models

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/day (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 (Yr 1990—Yr 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 year 2003. Consumptions less than 50 kL/annum were removed, and then an average consumption per dwelling (L/ET/day) was calculated.

The Watsys model was developed as a L/s model. However the H2Onet model will be developed as an ET model therefore the Watsys demand input has been converted ET demand input. This is undertaken using the average consumption developed from the rates database. The L/s applied on each node in the Watsys model is divided by the average consumption to obtain the ET as shown in Table 5.1.

Table 5.1 Demand distribution

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

Demand pattern curves for each demand node in the system varied its daily demand with time throughout a 24-hour period. The daily demand patterns are stored as ordinates for each half-hourly interval starting at 12 midnight, and finishing at 11:30 p.m. The value of an ordinate is the factor by which the initial value of area demand for each node is multiplied for that particular time. For times falling between the ordinates, the factor is linearly interpolated. A demand pattern curve for both residential and industrial (non-residential) ET was input to the model.

For the future model, the growth areas provided by PIFU were added as a digital layer to the existing DCDB, and using 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_20Net.

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;
- 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 1994/95 was a dry year with very high demand occurring in January.

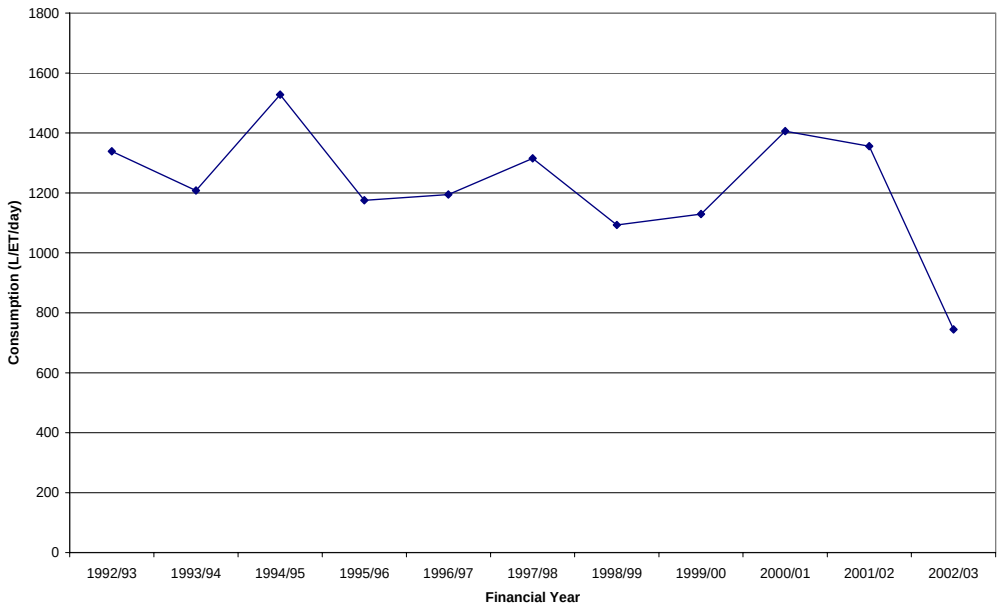


Figure 6.1
AVERAGE RESIDENTIAL CONSUMPTION

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 7.2.

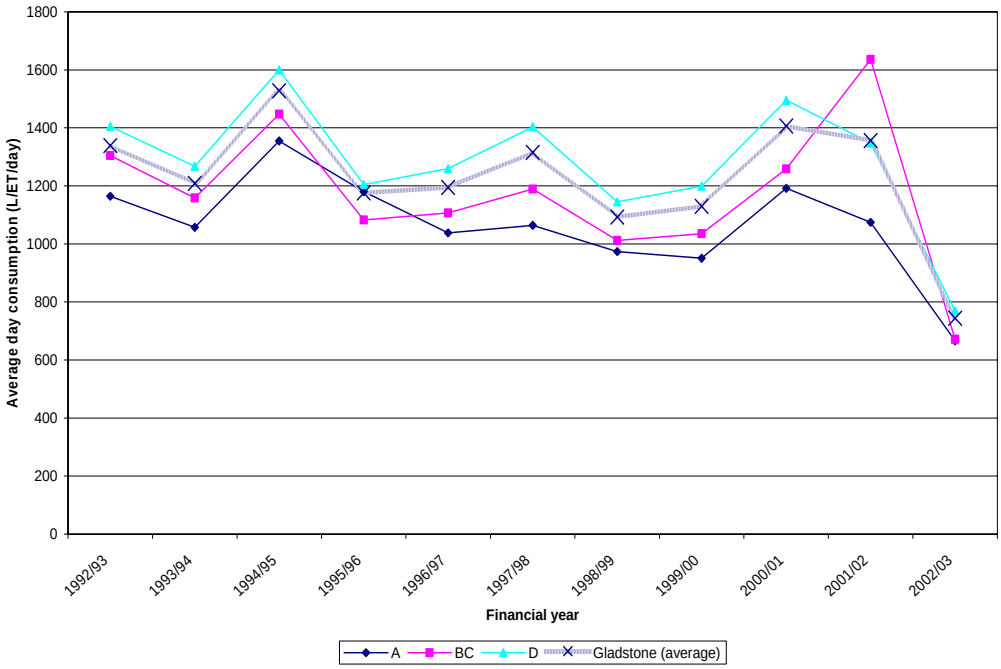


Figure 6.2
AVERAGE RESIDENTIAL CONSUMPTION

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

- Zone A—1200 L/ET/day
- Zone BC—1300 L/ET/day
- Zone D—1400 L/ET/day

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 2003/04 is a theoretical figure only. It was obtained by interpolating the 2003/04 connections from the meter data and then converted to ML/day. This is as a result of the 2003/04 metering data not differentiating between residential and industrial/commercial meters. It must also be noted that for the years 1978/79 to year 1993/94, the average day, mean day maximum month and maximum day information was obtained from the McIntyre & Associates, 1997 report.

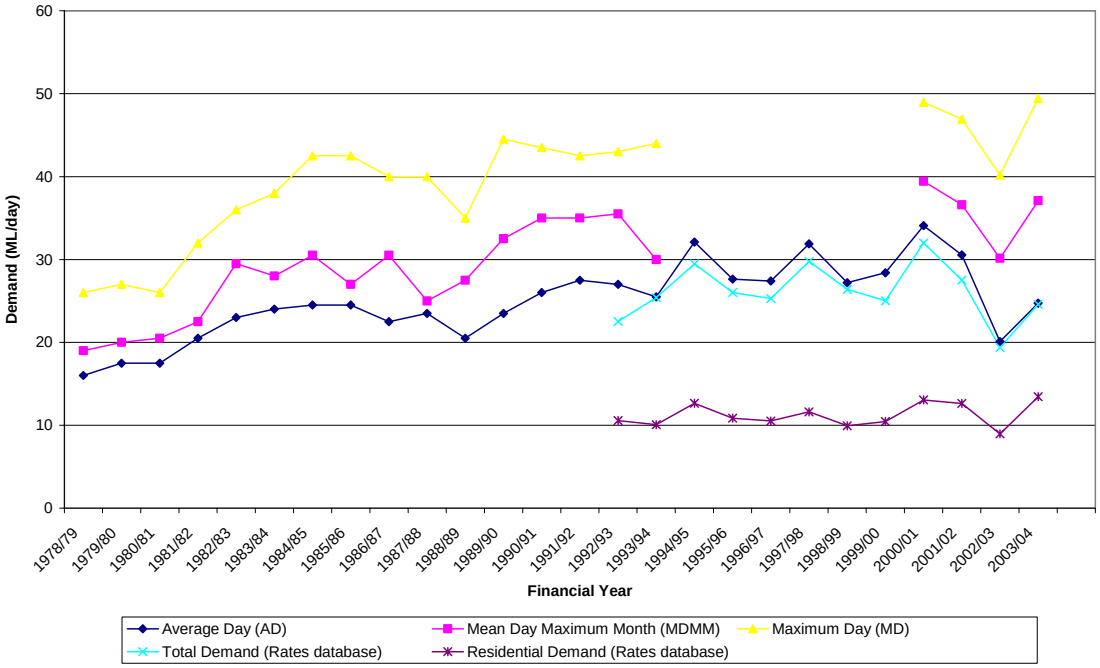


Figure 6.3
GLADSTONE WATER TREATMENT FLOWS AND WATER METER INFORMATION (INC CALLIOPE FLOWS)

Figure 6.3 indicates that the amount of Unaccounted For Water (UFW) is approximately 15%. Unaccounted for water 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 Unaccounted For Water. Therefore the difference between the treatment plant out and the sum of water usage in the rates database is the UFW.

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 Unaccounted for Water 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 2002/03 would also impact on the water consumption of the following years and this is supported in the trend analysis. The trend analysis has shown that the average day demand is 34 ML/day.

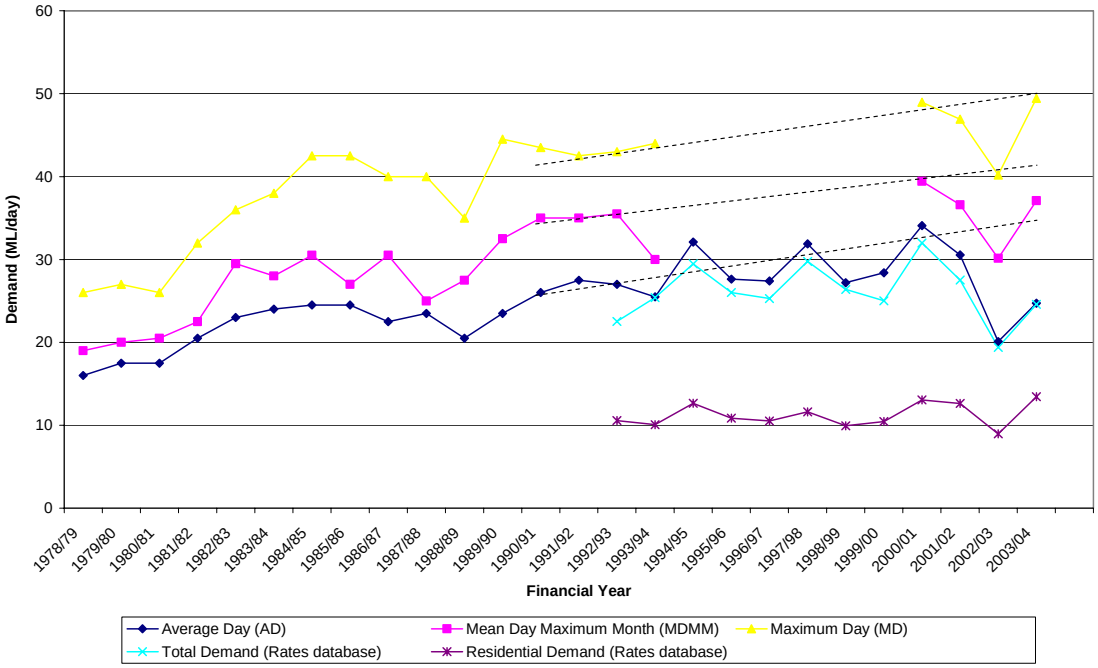


Figure 6.4
TREND ANALYSIS OF WATER TREATMENT FLOWS AND METER DATA (INCLUDING CALLIOPE FLOWS)

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 (including Calliope demand)

	AD (ML/day)	Actual 2003/04 Consumption Data (inc. UFW) (ML/day)
Residential	18.5	15.5*
Industrial/Commercial	18.5	18
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 H2Onet model, as is shown in Table 6.2.

Table 6.2 Adopted H2Onet demand —existing demand (including Calliope demand)

	AD (ML/day)
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 Treatment Plant for the years 2000/01 to the year 2003/04 and therefore the analysis was undertaken utilising trend analysis (Figure 6.4).

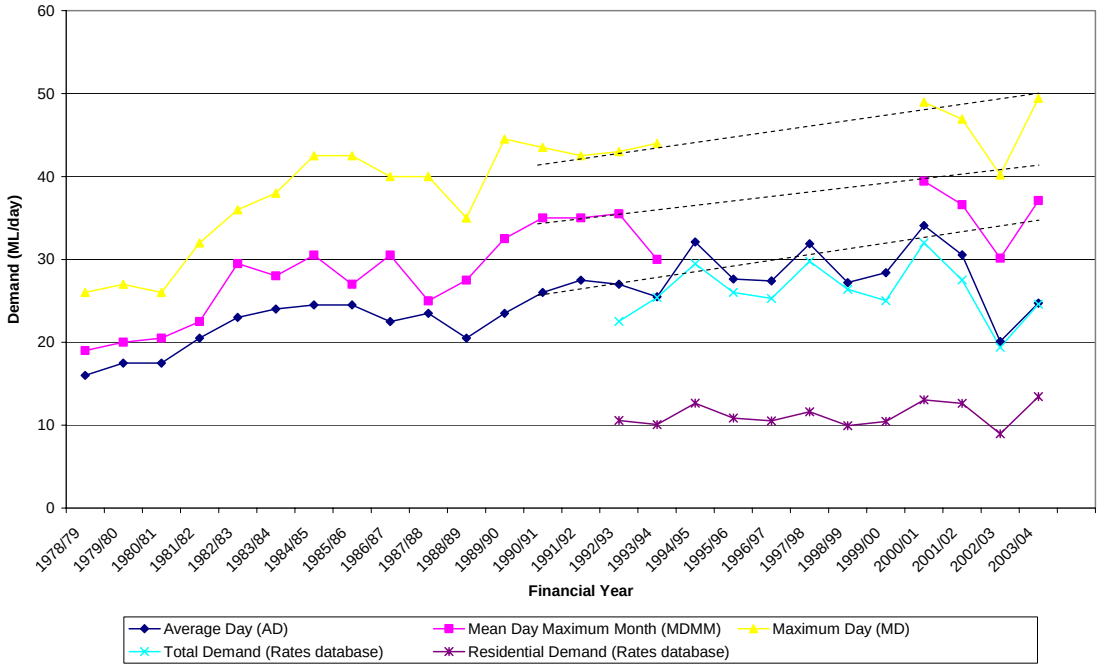


Figure 6.5
TREND ANALYSIS OF GLADSTONE WATER TREATMENT FLOWS AND WATER METER INFORMATION (INCLUDING CALLIOPE FLOWS)

As mentioned previously the trend analysis shows the continual increase in water consumption. The water restrictions that were applied in the year 2002/03 would also impact on the water consumption of the following year and this is supported in the trend analysis. It has shown that the average day demand is 34 ML/day, the MDMM demand is 41 ML/day and the maximum day (MD) demand of 50 ML/day.

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 16ML/day (Average Day), 24ML/day (MDMM) and 32ML/day (Maximum Day).

As a result the following residential peaking factors have been adopted.

- MDMM/AD = 1.5
- MD/AD = 2

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 the years 2004, 2016 and 2030 has been summarised below.

Table 6.3 Adopted consumption for year 2004

Zone	AD (ML/day)	MDMM (ML/day)	MD (ML/day)
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**	**50**

The adopted consumption for the Gladstone City Council has been included in Appendix E.

7 Desired standards of service

7.1 CUSTOMER SERVICE PROVISION

Desired Standards of Service have been developed for the water network which specifically form the basis for planning of the respective systems for the purposes of the ICP. These Desired Standards of Service have been outlined under the headings of Customer Service Provision and Design Criteria.

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 for Water.

Table 7.1 Desired Standards of Service

Ref No.	Performance Indicators	Target
Day to day continuity (water supply only)		
1	Number of rateable properties experiencing an unplanned interruption per 1000 rateable properties per year	100
2	Restoration of services due to unplanned	95% restored within 5 hrs
3	Number of rateable properties experiencing more than: 1 interruption per year 2 interruptions per year 3 interruptions per year 4 interruptions per year 5 interruptions per year	To be reported by 01/10/2007
4	Relative incidence of planned and unplanned interruption incidents	Ratio 10:1
5	Average duration of all interruptions (planned and unplanned)	To be reported by 01/10/2007
6	Response time to all events	4 hours

Table 7.1 (Continued)

Adequacy and quality of normal supply (water supply only)		
7	Minimum flow expectation at boundary	24 L/min
8	Minimum water pressure expectation at boundary	22m
9	Percentage of rateable properties experiencing low pressure and/or flow at any one time	To be reported by 01/10/2007
10	Compliance with NHMRC Guidelines for water supplied from Gladstone Water Treatment Plant	
	- microbiological	95%
	- pH 6.5—8.5	95%
	- Iron 0.3mg/L	95%
	- colour 5 HU	95%
	- turbidity 1 NTU	95%
	- Manganese 0.1mg/L	95%
	- Aluminium 0.2mg/L	95%
11	Number of drinking water quality complaints per 1000 rateable properties per year	5
12	Number of drinking water quality incidents per year	5
Continuity in the long term water supply		
13	Number of water main breaks and leaks per 100km of main per year	30
14	Rate of system water loss per rateable property per day	140 litres

7.2 DESIGN CRITERIA

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

Table 7.2 Design criteria—water supply network

Design criteria	Value
WATER DEMAND	
Average day demand	For distribution system: Zone A—1200 L/ET/day* Zone BC—1300 L/ET/day* Zone D (and beyond)—1400 L/ET/day* Zone F—1400 L/ET/day
Peaking factors	MDMM = 1.5 x AD MD = 2.0 x AD
PERIODS FOR SYSTEM PLANNING	
Bulk and zonal distribution	3 x MD network analysis Continuous MDMM network analysis (4 x MDMM was modelled)
SYSTEM PRESSURE	
Minimum residual pressure	22 m static at the connection stopcock, at maximum hour in the system. In small isolated and/or highly elevated areas, a minimum residual head of 16 m could be considered acceptable. This minimum allowable pressure should be maintained at the lowest operating level of the reservoir.
Maximum residual pressure	80 m in the reticulation system, where practical.

Table 7.2 (Continued)

FIRE FIGHTING REQUIREMENTS	
Commercial areas	Target of supplying 30 L/s with the residual pressure in the system not falling below 12 m at 2/3 maximum hour.
Residential areas	Target of supplying 15 L/s with the residual pressure in the system not falling below 12 m at 2/3 maximum hour.
RESERVOIR STORAGE	
Ground level storage capacity	Sized with a minimum storage of 3 x (MD - MDMM)
Elevated storage capacity	6 x (MH - 1/12 MDMM) + fire fighting reserve of 0.15 ML
PUMPING CAPACITY	
Duty pump serving ground level reservoir	Designed to supply MDMM demand in 20 hours
Duty pump serving elevated reservoir	(6 x MH - Operating volume)/(6 x 3,600) where volumes are in litres
Standby pump	To match duty, except where more than one duty pump
PIPELINE DESIGN	
Trunk main capacity	Sized to carry MDMM flows in 20 hours for pumped supplies, and 24 hours for gravity supplies.
Reticulation capacity	Sized for maximum hour and/or fire flow, whichever is greater.
Friction losses	Head losses in water mains are based on the Hazen-Williams formula: $V = 0.3543 \times C \times S^{0.54} \times D^{0.63}$ where V = pipe velocity (m/s) C = Hazen-Williams roughness coefficient S = pipe grade (m/km) D = pipe diameter (m)
Roughness coefficients†	100 to 150 mm diameter, C = 100 200 to 300 mm diameter, C = 110 > 300 mm diameter, C = 120.
Maximum velocity	2.5 m/s

* *These figures are inclusive of Unaccounted for Water (UFW)*

8 Network analyses and model validation

8.1 WATER SUPPLY SYSTEM NETWORK ANALYSIS

The Gladstone City Council water supply scheme has been analysed using the dynamic network analysis package H_2ONet for the following cases:

- The existing (2004) reticulation and trunk main system using actual peak period flows and reservoir levels for validation.
- The existing (2004) reticulation and trunk main system using adopted consumption figures
- The proposed water supply network for year 2016.
- The proposed water supply network for year 2030 using projected figures for consumption.

The model has been simulated for three consecutive days for each design case. From the simulation, the following data is presented in Appendices D and E:

- plots of reservoir levels and outflows
- plots of pump flows

The drawings of the water supply system have also been included in this report.

8.2 VALIDATION OF WATER SUPPLY SYSTEM MODELS

The validation analysis was assessed under 80% of the design MD flow. This was determined by comparing the maximum recorded day in November/December 2003 with the calculated design MD value.

Validation of the water supply network model for the Gladstone City water supply system was undertaken using the data available.

As a result of no flow meter information being available the pump stations were validated utilising a current operating duty and hours of operation and information regarding their high water usage days in December 2003.

The first high lift pump was operating at a maximum of 389 L/s for a duration of 19 hours. The second high lift pump was operating at a maximum of 389 L/s for a duration of 3 hours. This is consistent with current performance and the information available for December 2003 in that the second pump was required for a period of four hours.

The low lift pump station was operating at a peak of 176 L/s for a duration of 21.5 hours over the two day period.

The Auckland Creek Booster Pump Station was operating at an average of 130 L/s but peaking at approximately 153L/s for a duration of 16.5 hours. This is higher than the duty of 90 L/s however the pump units do pump at an efficient point on the curve. The reason for the higher pump output is that the pumps directly supply reticulation in Clinton and New Auckland.

9 Existing system performance

9.1 RATIONALISATION OF ZONES

9.1.1 Zone A and Zone BC

The validation of the water supply network identified an anomaly in the set up in that Round Hill Reservoir, Paterson Street Reservoir and Fisher Street Reservoir all were feeding the Zone BC. As a result Round Hill Reservoir was being emptied because it was supplying Zone BC and Zone D. Therefore the valve at the intersection of Breslin Street and Boles Street was closed (Figure A.5).

The brief identified the issue of Paterson Street Reservoir and Fisher Street Reservoir with a HGL difference of 10m feeding the same area. It was resulting in Paterson Street (TWL 71.4mAHD) supplying the area and Fisher Street not being utilised at all. Therefore a pump station was installed at Fisher Street to be turned on at 3pm—7pm to enable the Fisher Street Reservoir to turn over.

Figure 2.1 shows a more efficient zoning of Zone BC and Zone A (see Appendix A for details). It is proposed in this zone rationalisation to separate the service areas of the Paterson Street and Fisher Street Reservoirs.

The rezoning of Zone BC was initially undertaken based on the premise that Fisher Street Reservoir can not service areas above 25 mAHD without the booster pump station. As a result, it is appropriate that Fisher Street Reservoir supplement the supply to Zone A. This would be achieved by decommissioning the pump station, closing the pipe that supplies the reticulation and interconnecting the 450mm diameter trunk main downstream of the Fisher Street Booster Pump Station and the 300mm diameter trunk main to Radar Hill Reservoir and the Ferris Hill reservoir. The three Zone A reservoirs would then operate together. Several other pipes would need to be closed as shown Appendix A. Zone A would also be extended to service the industrial zone surrounding Hanson Road.

9.1.2 Clinton Park Zone

The caravan park in New Auckland is the first connection from the Auckland Creek Booster Station on the 375/450 mm diameter water main that feeds the Clinton Park Reservoir. As a result receives pressures up to 95 mAHD which exceeds the maximum allowable pressure of 80 m. The caravan park has consequently installed a PRV on their connection however Council does not consider this a satisfactory long term solution.

It is proposed this area be rezoned and incorporated into the South Gladstone zone. In order to achieve this, a connection from the suction side of Auckland Creek Pump

Station to the 200 mm diameter in Beak Street would be required in addition to a connection from the 200 mm diameter in Dickinson Street to the 200 mm diameter in Witney Street to provide the two supplies. The two existing connections from the 375/450 feed to Clinton Park Reservoir would also need to be closed.

This rezoning can be undertaken after the infrastructure has been constructed in Kirkwood Road which will allow all areas within New Auckland to achieve satisfactory pressures.

This rezoning has been incorporated into the capital works program in the financial year 2006/07.

9.2 EXISTING DESIGN SYSTEM PERFORMANCE

The existing system achieves satisfactory performance in most areas of its infrastructure.

There were several areas of deficiency as highlighted below:

- Downstream of Paterson Street Reservoir, West Gladstone (Figure A.4)—These lots are supplied by Paterson Street however are at elevations 70 mAHD. These lots have been identified as too high too service, (with the desired standards of service).
- Along Goondoon Street, South Gladstone (downstream of Radar Hill Reservoir)—These lots are supplied from the 61.4 mAHD pressure and are considered too high to service (A.2), (with the desired standards of service).
- Lots in Bembooka Close, Glen Eden—These lots, with an elevation of 62m, are supplied by South Gladstone Reservoir with a TWL of 91.4. It is noted that 22m residual pressure cannot be supplied to these allotments. However, the minimum pressure that is obtained at this location is 17 m which is above the required 16m for isolated and elevated locations (Figure A.6).

9.2.1 Reservoir performance

Table 9.1 summarises the calculated performance of the supply reservoirs using the existing and future demand figures stated

Table 9.1 Gladstone City system reservoir capacity

	Existing capacity (ML)	2004 requirement (ML)	2030 requirement (ML)	Comment
Zone A (revised zoning)	13.7	13.6	15.4	×
Zone BC (revised zoning)	4.55	4.5	4.6	✓
Zone F (revised zoning)	13.6	10.1	11.1	✓
Zone D	34.7	20.5	40.5	×
South Gladstone zone	*21.1*	*14.9*	*30.5*	×
Clinton Park Zone	*13.6*	*5.6*	*10*	✓
Zone E	—	—	2.27	×
Total	**66.55**	**48.7**	**73.9**	×

For the purposes of this existing design scenario, Round Hill has been assumed to be at 100% capacity. Round Hill is the storage that supplies three other reservoirs and is therefore pivotal to the system. Therefore to aid in continuity of supply it is recommended the repairs be undertaken to restore the 100% capacity. In this analysis, Round Hill does fall to a level (20%) which triggers the operation of the second high lift pump. Once this pump is operational, the reservoir level recovers quickly.

The three storages that supply zone D are able to adequately service this zone. South Gladstone falls to 40% and Clinton Park Reservoir is adequately served via the Auckland Creek pump station and does not fall to below 80%. In the future scenario the area south of Kirkwood Road will be supplied via the Clinton Park Reservoir. This region is to be one of the biggest growth areas in Gladstone City.

The revised zone BC is adequately served via Paterson Street Reservoir which is near capacity under this scenario. It falls to only 65%. Zone BC will have very little growth and therefore Paterson Street Reservoir has sufficient capacity to the year 2030.

It is noted that the inlet to Paterson Street is hydraulically advantaged as a result of its proximity to the Round Hill Reservoir. Therefore during maximum hour when the level in Paterson Street Reservoir is dropping, Round Hill Reservoir immediately tops it up, effectively supplying maximum hour to the Paterson Street Reservoir zone. The installation of a flow control valve on the inlet to the Paterson Street Reservoir which allows only MDMM flow would prevent Round Hill supplying maximum hour to the zone. This would also more effectively utilise the storage of Paterson Street Reservoir and allow the level to fluctuate.

9.2.2 Pump station performance

There are four pump stations in the Gladstone City system, three of which pump to reservoirs. The Fisher Street Booster pump station is provided to turn over the Fisher Street reservoir and it is proposed that this pump station will be decommissioned as previously identified.

The design guidelines adopted for duty pumps serving ground level reservoirs and elevated reservoirs is:

- ground level reservoirs = supply MDMM in 20 hours
- elevated reservoirs = (6 x MH - Operating volume)/(6 x 3,600).

The assessment of the performance of the three pumps according to these criteria is contained in Table 9.2.

Table 9.2 Gladstone City system pump station capacity

	Existing capacity (L/s)	2004 requirement (L/s)	2030 requirement * (L/s)	Comment
Low Lift PS	170	183	214	×
High Lift PS	750	479	780	×
Auckland Creek PS	100	107.8	160	×
O'Connell HLZ	—	—	26	—

* *Note-Incorporates rezoning to Clinton Park zone*

This table shows that the Low Lift pump station is under capacity however the augmentation of the trunk main to Radar Hill reservoir allows the pump to pump at an increased flow. This is as a result of the decrease in friction losses through the pump. It operates for approximately 12.5 hours.

This table also shows that the High Lift Pumps at the treatment plant are performing satisfactorily for the existing scenario. The first high lift pump operates for approximately 19.5 hours and second high lift pump operates for approximately 7.5 hours at a flow of 389 L/s.

Auckland Creek Pump Station has adequate capacity to service the existing areas prior to the rezoning of the region.

9.2.3 Trunk main performance

The 300 mm diameter trunk main supply to Ferris Hill Reservoir and Radar Hill Reservoir has been identified as being under capacity with a head loss of 30 m/km. This trunk main has been highlighted by Council as requiring replacement. This trunk main will require a 450mm diameter augmentation to provide a minimum flow of 200L/s. This augmentation has been included in this existing model performance.

As a part of the rezoning of Zone BC, the trunk main downstream of Paterson Street Reservoir will require augmentation.

10 Future system requirements

10.1 OVERVIEW

The majority of growth in Gladstone City Council is to occur in the three suburbs Kirkwood, Glen Eden and O'Connell. These suburbs are largely undeveloped and therefore significant infrastructure will be required to service these areas.

Two additional reservoirs will be required in Gladstone, the first to supplement the existing South Gladstone Reservoir in 2018 and the second reservoir to service the O'Connell zone in 2025. A booster pump station will be required to service this reservoir that will supply the higher elevated area in the O'Connell zone.

The existing trunk system in Gladstone performs satisfactorily with velocities not exceeding 2.5 m/s and few existing trunk mains requiring augmentations. This is as a result of little growth in the north areas of Gladstone and significant capacity in the GAWB mains that supply the South Gladstone Reservoir.

10.2 RESERVOIR CAPACITY ASSESSMENT

Using the design criteria adopted in Table 7.2, ground level reservoirs are required to store three times the difference between MD and MDMM demands for each area. On this basis, the theoretical requirement for the Gladstone City system is 1.5 times AD demand.

Table 9.1 shows that there is sufficient storage to meet 2004 design demand. The existing model results show all reservoirs performing satisfactorily.

Zone A

The three storages supplying the revised Zone A do not fall to below 67%. Under future demand conditions the three reservoirs theoretically do not meet the design requirements. However the low lift pumps have sufficient capacity to ensure that the three storages do not empty. As the deficiency is only minor, it is considered acceptable for the reservoirs to not achieve the required design criteria.

Zone BC

There is little growth in Zone BC and therefore Paterson Street Reservoir has sufficient capacity till the year 2030.

Zone D

Additional storage will need to be constructed to service this growth area. Two preliminary sites have been selected both with advantages and disadvantages. It will

have the same TWL as the South Gladstone Reservoir of 91.4 mAHD. The sites identified are at the existing South Gladstone Reservoir site and in the Tondoon Botanical Gardens.

South Gladstone Reservoir Site

The South Gladstone Reservoir is the preferred location because it would not require any additional mains beyond local interconnecting pipework. The two reservoirs would be connected with the inlet in the first reservoir and the outlet on the second to ensure effective mixing. Although the existing reservoir site is not large enough to locate the reservoir the surrounding land is Council owned and therefore there would be no acquisition costs. However the reservoir site has several large diameter GAWB mains that go through the site and would require relocation. In addition significant earthworks would be required to ensure that both have the same flow level and TWL. This is essential to allow neither reservoir to be hydraulically advantaged.

Tondoon Botanical Gardens Site

This is the only other site in the area that would allow construction of a second reservoir at the same TWL. The advantage with this site is that no relocation of GAWB mains would be required and there would be less earthworks required. However it is in the Botanical Gardens and would not be simple to acquire the land. Additional pipework would also be required.

Both of these sites have the advantage of not requiring an additional pump station to service because can be supplied from the High Lift Pump Station. Alternative sites were located in Glen Eden and O'Connell.

Zone D (Clinton Park Sub-Zone)

There is significant growth within this zone however the rezoning was undertaken so additional storage would not be required at Clinton Park.

Additional investigation works will be necessary to determine if there will be a need for re-chlorination at Clinton Park reservoir. Sampling will be required to ensure that there is a free chlorine residual of at least 2mg/L after the required contact time where the contact is not less than 20 minutes to the first consumer. In no case should the dose rate be less than 5 mg/L. A minimum free chlorine residual of 0.2 mg/L should be maintained at all points in the system.

Zone E (future)

The southern area of Gladstone i.e. the suburbs of Glen Eden and O'Connell will also be one of the biggest growth areas of Gladstone.

It is proposed that the suburb of O'Connell will be a small high level zone serviced by a 2.27 ML reservoir with a TWL to 140 mAHD. It is also noted that a site has already been acquired for the siting of this reservoir in O'Connell.

Zone F

The Clinton Industrial Reservoir has sufficient capacity to service Zone F under existing and future design scenarios as is shown in Table 9.2.

Graphs of the reservoir levels and outflows for each reservoir under the existing demand scenario is included in Appendix C, and under future demands in Appendix D.

10.3 PUMP STATION CAPACITY ASSESSMENT

Zone D

Under the year 2030 demand scenario the high lift pumps require a duty of 780 L/s. At the treatment plant there are three high lift pumps and can be operated in a duty/follow/standby arrangement. The high lift pumps do not possess sufficient capacity to the year 2030 and will require augmentation. However the future planning of this facility was not a part of this study and a further study on the Augmentation of the Treated Water System will be necessary.

Clinton Park Zone

Table 10.2 shows that Auckland Creek pump station is under capacity for 2004 however the pump curve is such that the pump can pump at higher flows and therefore is able to service the existing zone. If Clinton Park Zone is rezoned to exclude the suburb of Auckland Creek (area bounded by Dawson Highway, Harvey Road, Kirkwood Road and the railway) it has adequate capacity and may only require a slight upgrade to be achieved with an increase in impeller diameter if possible. Under the future demand scenario Auckland Creek Pump Station will require a duty of approximately 160 L/s vs 35m.

O'Connell HLZ

The proposed O'Connell HLZ is generally at an elevation too high to be serviced by the South Gladstone Reservoir at TWL 91.4 mAHD. The O'Connell HLZ will therefore initially be serviced via a variable speed drive (VSD) pump station that will directly supply maximum hour to the region. Upon the O'Connell HLZ exceeding a population that can be serviced by the VSD pump station the reservoir and trunk system can be constructed to serve the high level zone. The pump station will then supply MDMM flow to the reservoir.

10.4 TRUNK SYSTEM CAPACITY ASSESSMENT

The augmentation and staging of trunk mains and reticulation mains to meet future demands are detailed below;

Zone A supply

The supply to Radar Hill and Ferris Hill has already been identified as requiring augmentation because it is over seventy years old and is under capacity. However it is considered feasible to delay this augmentation to 2007/08 by running the low lift pump station for longer hours. However should it become evident that the low lift pumps are not capable of maintaining the level in the three reservoirs, then its construction may need to be brought forward.

An additional augmentation of the trunk downstream of the Low Lift pumps is scheduled for the year 2030 scenario.

Zone BC supply

The rezoning of the Paterson Street Reservoir zone has resulted in the trunk main downstream operating at an average head loss of 10m/km but peaking at 30m/km. As a result therefore the supply trunk main downstream of Paterson Street Reservoir has been augmented with 250mm diameter pipework. In addition to this augmentation, a valve in Charles Street (identified in Figure A.4) will be opened.

Zone D (Clinton Park Sub-zone)

The 375mm diameter trunk main that bypasses Auckland Creek booster pump station is under utilised because it acts as a pump station bypass and as a result flows only pass through when the pump station is not operating. It is proposed the interconnection between the 300mm diameter and the 375mm diameter bypass upstream of the pump station has been opened.

Clinton Park Zone will be adequately serviced by the existing trunk network for the existing areas because the zone has been dramatically reduced. However, a 450 mm diameter main west from the Clinton Park Reservoir will be required to join an existing 375mm diameter main in Kirkwood Road.

The future demand scenario will require extension of the trunk main along Kirkwood Road to service the new development area.

Zone D (South Gladstone Sub-zone)

Significant infrastructure will be required to service these new development areas including a trunk main to the new O'Connell HLZ.

10.5 GLADSTONE AND BARNEY POINT INTERIM ANALYSIS

Council has advised that a number of high rise buildings are planned for the inner CBD predominantly for both motel and apartment accommodation.

Council has subsequently provided a list of current approved development applications for, predominantly, the inner city suburb of Gladstone. These applications which are planned for the purposes of accommodation are as detailed in Table 10.1 following:-

Table 10.1 Current approved development applications

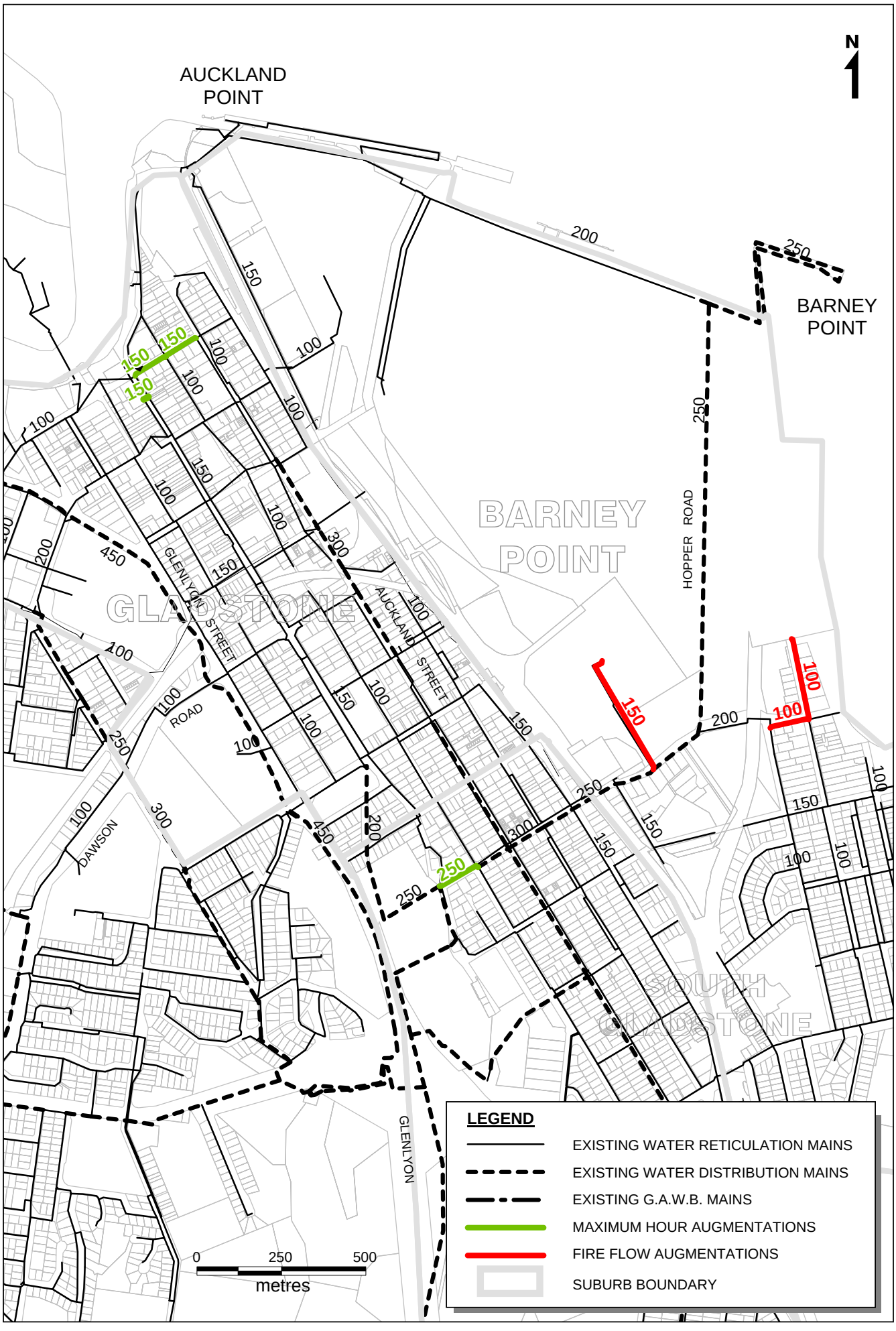
No.	Location	Approved Development Application	Unit	Demand (EP)	Demand (ET)
1	Grand Hotel 79 Goondoon Street	120 room motel	1.6 EP/accommodation room	192	69
2	30 Goondoon Street	70 serviced apartments	2 EP/room	140	50
3	17-79 Roseberry Street	24 units	1.6 EP/unit	38	14
4	19-23 Flinders Parade	31 units and restaurant	1.6 EP/unit	50	18
5	30-32 Yarroon Street	18 units and gym	1.6 EP/unit 9 EP/lot (gym)	38	13
6	RSL Development 7 Goondoon Street	113 units	1 EP/unit	113	40
7	20 Roseberry Street	16 units	2.3 EP/unit	37	13
8	22 Barney Street	36 units (under construction)	25—1 EP/unit 11—1.6 EP/unit	42	15
9	58 Glenlyon road	10 units (completed)	2.3 EP/unit	23	8
10	39-43 Bramston Street	40 units	2.3 EP/unit	92	33

These developments were input into the model and an interim model (2006) was undertaken for Gladstone City and Barney Point only to determine the effect of these developments on the surrounding system.

One area was identified to be deficient under maximum hour conditions along Yarroon Street. Several augmentations in Yarroon Street and pipework closer to the Radar Hill Reservoirs in Short Street are required to rectify these deficiencies as highlighted in Figure 10.1.

Under the year 2030 demand scenario, the Gladstone CBD and Barney Point perform satisfactory with these augmentations and others proposed for the system.

A fire fighting analysis highlighted that the reticulation in Barney Point is not adequate to provide satisfactory pressure.



Map Datum: GDA94, Projection: MGA Zone 56

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Figure 10.1
AUGMENTATIONS FOR GLADSTONE CBD AND BARNEY POINT

10.6 AUGMENTATION SCHEDULES

Schedules of the proposed works for the Gladstone City Council water supply scheme are contained in Table 10.2—10.7.

The unit rates used for costing the trunk main and reticulation infrastructure were discussed and agreed upon by Council. The unit rates do not allow for fluctuations in the price of pipe and assume the use of Council workforce for installation. It is recognised that North Queensland may not have been subject to the escalation of prices that has occurred in South East Queensland.

Table 10.2 Priority for augmentation—required for rezoning of Zone BC and A

Item	Description	Qty	Unit	Rate** ($/Unit)	Capital cost ($)	Financial year
1	Opening valves	1	No.	2,000	2,000	2005/06
2	Closing valves	6	No.	2,000	12,000	2005/06
3	Decommission Fisher Street pump station	1	Item		10,000	2005/06
4	Ø450mm interconnection between Fisher Street, Radar Hill and Ferris Hill Reservoirs	70	m	620	43,400	2005/06
5	Ø300mm flow control valve upstream of Paterson Street	1	Item		5,100	2005/06
6	Ø250mm pipework downstream of Paterson Street Reservoir —from reservoir to Paterson Street —from Rigby Crescent to Breslin Street	924	m	248	229,000	2005/06
	Sub-–total				**301,500**	

***Note: - Unit rates as agreed through discussions with Council. Assumes Council day labour*

Table 10.3 Priority for augmentation—required for rezoning of South Gladstone zone

Item	Description	Qty	Unit	Rate** ($/Unit)	Capital cost ($)	Financial year
1	Connect New Auckland (suburb) upstream of Auckland Creek pump station (Ø375mm)	27	m	500	13,500	2007/08
2	Connect New Auckland and Telina along Dickinson Road (Ø200mm)	1,642	m	203	334,000	2007/08
3	Closing valves	2	No.	2,000	4,000	2007/08
4	Ø200mm connection to Callemondah Industrial zone	297	m	203	60,000	2007/08
	Sub–total				**411,500**	

***Note: - Unit rates as agreed through discussions with Council. Assumes Council day labour*

Table 10.4 Priority for augmentation— New development area in Clinton Park Zone

Item	Description	Qty	Unit	Rate*** ($/Unit)	Capital cost ($)	Financial year
1	Ø200mm (extension of main in Skyline Drive to connect proposed FKP development)	251	m	203	51,000	2005/06
Pipework along Kirkwood Road						
2	Ø375mm (East from Harvey Road)	1,000	m	250**	250,000	2005/06
3	Ø300mm (to Skyline Drive)	488	m	308	150,000	2005/06
4	Ø300mm (Harvey Road to Kirkwood Road)	324	m	308	100,000	2005/06
5	Ø300mm (east of Skyline Drive)	441	m	308	136,000	2005/06
6	Ø300mm (west of Harvey Road)	142	m	308	44,000	2008/09*
7	Ø375mm (West of Harvey Road)	777	m	500	389,000	2008/09*
8	Ø250mm (east of Skyline Drive)	931	m	248	231,000	2020/21
9	Ø200mm	523	m	203	107,700	2025/26
10	Ø150mm	164	m	173	29,000	2030/31
	Sub–total				**1,487,000**	

** Note:- Dependent on development*

***Note:-Pipe has already been obtained. Unit rate is for installation only.*

****Note: - Unit rates as agreed through discussions with Council. Assumes Council day labour*

Table 10.5 Priority for augmentation— Developer funded infrastructure

Item	Description	Qty	Unit	Rate** ($/Unit)	Capital cost ($)
Pipework south of Kirkwood Road					
1	Ø150mm	748	m	173	130,000
2	Ø200mm	2,325	m	203	472,000
3	Ø375mm	248	m	500	124,000
4	Ø150mm	121	m	173	21,000
5	Ø200mm	112	m	203	23,000
6	Ø150mm	373	m	173	65,000
7	Ø200mm	117	m	203	24,000
8	Ø150mm	1,098	m	173	190,000
9	Ø200mm	613	m	203	125,000
10	Ø150mm	1,674	m	173	290,000
Pipework north of Kirkwood Road					
11	Ø150mm (second connection to the north after Harvey Road)	354	m	173	62,000
12	Ø200mm (first connection to the north after Harvey Road)	850	m	203	173,000
13	Ø150mm (first connection to the north after Harvey)	1,094	m	173	190,000
	Sub-total				**1,889,000**

***Note: - Unit rates as agreed through discussions with Council. Assumes Council day labour*

Table 10.6 Priority for augmentation—New development areas in South Gladstone Zone

Item	Description	Qty	Unit	Rate** ($/Unit)	Capital cost ($)	Financial year
Glen Eden region						
Glen Eden pipework						
1	Ø200mm along Victoria Parade	838	m	203	170,000	2015/16
2	Ø200mm along Glen Eden Drive	178	m	203	36,000	2015/16
3	Ø200mm other	3,154	m	203	640,000	2015/16
O'Connell High Level Zone (HLZ)						
4	O'Connell Booster Pump Station—VSD 26 L/s vs 85m	1	Item		127,800	2010/11
5	O'Connell HLZ Reservoir—2.27ML ground level storage	1	Item		683,000	2023/24
O'Connell HLZ Pipework						
6	Ø150mm (along Haddock Drive and Booroo Road)	2,809	m	173	486,000	2011/12
7	Ø200mm (Along Glenlyon Road and Booroo Road)	1,924	m	203	391,000	2011/12
8	Ø375mm (along Glenlyon Road from Victoria Parade)	643	m	500	322,000	2011/12
9	Ø150mm (east of Glenlyon Road along extension of Kirkwood Road)	1,287	m	173	223,000	2016/17
10	Ø250mm (along Glenlyon Road from Kirkwood Road to Booroo Road)	1,691	m	248	420,000	2016/17
11	Ø300mm (from Booroo Road to O'Connell HLZ Reservoir)	1,388	m	308	428,000	2016/17
12	Ø200mm (connection from HLZ booster pump station to reservoir)	3,779	m	203	767,000	2023/24
13	Ø300mm (reservoir outlet pipework to Ø300mm in Booroo Road)	1,178	m	308	363,000	2023/24
14	Ø150mm (north-western area of HLZ)	3,111	m	173	538,000	2030/31
	Sub–total				**5,595,000**	

***Note: - Unit rates as agreed through discussions with Council. Assumes Council day labour*

Table 10.7 Priority for augmentation—general

Item	Description	Qty	Unit	Rate** ($/Unit)	Capital cost ($)	Financial year
Reservoirs						
	Round Hill Reservoir repair— Ring beam failure repair					
1	Investigation	1	Item		20,000	2006/07
2	Repair works	1	Item		300,000	2006/07
3	Second South Gladstone Reservoir—9.1 ML ground level storage	1	Item		1,970,000	2017/18
Trunk mains and reticulation						
	Maximum hour augmentations to Gladstone and Barney Point— Due to development in CBD/Barney Point only					
4	Ø150mm	217	m	173	38,000	2005/06
5	Ø250mm	136	m	248	34,000	2005/06
6	Ø450mm out of Clinton Park Reservoir	250	m	620	155,000	2005/06*
	Augmentation of trunk main to supply Radar Hill Reservoir					
7	Ø450mm (along Glenlyon Road from Clayton valve to Ferris Hill Reservoir offtake, include connection to Fisher St Reservoir offtake)	1,040	m	620	645,000	2006/07
8	Ø375mm (along Glenlyon Road, from offtake to Ferris Hill Reservoir to Radar Hill Reservoir)	543	m	500	272,000	2007/08
	Pipework out of South Gladstone Reservoir along Dixon Drive					
9	Ø300mm (from South Gladstone Reservoir to Dalrymple Drive)	230	m	308	71,000	2006/07
10	Ø250mm (from Dalrymple Drive to Glenlyon Road)	188	m	248	47,000	2006/07
11	Ø150mm reticulation to boost pressure along Allunga Drive	590	m	173	102,000	2007/08
12	Ø250mm (from Glenlyon Road to Uniting Place)	229	m	248	57,000	2008/09
13	Ø250mm (from Uniting Place to Venus Street)	131	m	248	33,000	2011/12
14	Ø250mm (from Venus Street to Mercury Street)	269	m	248	67,000	2020/21
15	Ø375mm pipework downstream of Low Lift Pump Station	812	m	500	406,000	2030/31
	Sub–total				**4,217,000**	

** Note:- Dependent on development*

***Note: - Unit rates as agreed through discussions with Council. Assumes Council day labour*

11 Demand management

Demand management is now an important part of the management of a water supply system with the decrease of water availability. A water demand management strategy can be broadly split beneath two headings: water demand reduction strategy and supply rationalisation strategy.

A water demand reduction strategy could involve volumetric charging, education campaigns, water restrictions, installation/retrofitting of water efficient equipment, best practice irrigation water management.

A supply rationalisation strategy could involve accurate metering, pressure reduction, water loss reduction, leakage detection and repair, reducing seepage and evaporation losses in dam storage and irrigation systems, effluent reuse, off-stream storage and irrigation tailwater reuse.

Gladstone City Council has already implemented several demand management techniques.

11.1 TARIFF STRUCTURE

A 3-tiered tariff structure was introduced in July 2002 with the price of water as below:

- 55 cents per kL for the first 400 kL
- 80 cents per kL for volumes between 401 kL to 1,000 kL
- $1.10 for each kL over 1,000 kL

11.2 WATERWISE PROGRAM

As a component of the Waterwise program Gladstone City Council formulate a program with the EPA on an annual basis.

11.3 GREY WATER REUSE

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.

Following the proposed enactment of the legislation, 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 licensed plumber.

11.4 PRESSURE REDUCTION/LEAK DETECTION

As part of new legislation, in 2005 Gladstone City Council will implement a pressure reduction/leak detection strategy.

12 Fire flow assessment

12.1 FIRE FLOW ASSESSMENT

Fire fighting capacity of the Gladstone City Council systems was assessed. Fire fighting flows were simulated at residential and non-residential nodes.

Fires were modelled according to the adopted design criteria for fire fighting requirements contained in Table 7.2. This was equivalent to a flow of 30 L/s for commercial/industrial fires, and 15 L/s for residential fires while maintaining a residual pressure in the system of 12 m at two thirds maximum hour.

It is noted that an update to the Queensland Water Supply Guidelines, issued in 1997, suggests that fire flows should be analysed in conjunction with maximum hour demand. However, the Gladstone City Council system design has been based on the 1989 requirements of two-thirds maximum hour background demand.

No analysis for special fire hazards, where desired flow rates may exceed 30 L/s, has been undertaken as it is beyond the scope of this investigation.

12.2 EXISTING SYSTEM

The nodes that did not achieve the required design criteria are shown below in Table 12.1.

Table 12.1 Fire flow failure points

Node #	Location	Supply zone/area	Res/non-res fire	Supply pipe	Fire flow demand (L/s)	Residual pressure (m)	Available flow (L/s)	Available flow pressure (m)
799	Dead end street at intersection of Derby Street and Ann Street, South Gladstone	Zone D	Non-residential	150 mm	30	-67.8	10.1	12
792	Intersection of Derby Street and Adelaide Street, South Gladstone	Zone D	Residential	100 mm	15	-45.0	7.9	12
6117	End of Pine Avenue, West Gladstone	Zone D	Residential	100 mm	15	-40.1	6.2	12
785/6	Intersection of Adelaide Street and Roberts Street, South Gladstone	Zone D	Residential	100 mm	15	-29.4	7.5	12
704	Dead end at end of Maye Court, Sun Valley	Zone D	Residential	100 mm	15	-18.1	6.3	12
703/5	Dead end retic at end of Cairncross Street, Sun Valley	Zone D	Residential	100 mm	15			12
788	Ousten Place, South Gladstone	Zone D	Residential	100 mm	15	-16.5	7.5	12
816/7/8	Dead end at end of Koppabella Close, South Gladstone	Zone D	Residential	100 mm	15	-13.5	9.6	12
4037/8	Dead end retic at end of Lyons Street, South Gladstone	Zone D	Residential	100 mm	15	-11.2	9.8	12
819/20/1	Dead end retic at end of Forest Place, South Gladstone	Zone D	Residential	100 mm	15	-10.1	10.4	12
375	Dead end retic in Gladstone Benaraby Road at intersection with Dalrymple Drive, Toolooa	Zone D	Residential	100 mm	15	-7.2	11.2	12
1573	Dead end retic in Carthurbie Court, New Auckland	Zone D	Residential	100 mm	15	-6.8	12.5	12
1614	Dead end retic in Saxonvale Court, New Auckland	Zone D	Residential	100 mm	15	-5.7	13.3	12
732/3/4	Dead end retic in Windward Passage, South Gladstone	Zone D	Residential	100 mm	15	-5.1	8.7	12
1047	Dead end retic in Rosslyn Close, Clinton	Zone D	Residential	100 mm	15	-3.7	10.7	12
6133	Dead end retic in Laver Street, West Gladstone	Zone D	Residential	100 mm	15	-3.2	11.3	12

Node #	Location	Supply zone/area	Res/non-res fire	Supply pipe	Fire flow demand (L/s)	Residual pressure (m)	Available flow (L/s)	Available flow pressure (m)
346/69	Dead end retic in Bembooka Close, Glen Eden	Zone D	Residential	100 mm	15	-1.0	6.8	12
328/70	Dead end retic in Glen Eden Drive, Glen Eden	Zone D	Residential	100 mm	15	-0.8	12.0	12
6023	Too high too service	Zone BC	Residential	100 mm	15	0.1	-24.1	12
520/33	Reticulation in Boyne Crescent, West Gladstone	Zone D	Residential	100 mm	15	1.1	5.4	12
6214	Dead end retic in Nash Street, West Gladstone	Zone BC	Residential	100 mm	15	1.5	11.6	12
6171/2/3/4/5	Cook Street, West Gladstone	Zone BC	Residential	100 mm	15	2.9	13.7	12
815	Intersection of Forest Place and Koppabella Street	Zone D	Residential	100 mm	15	3.0	13.2	12
6145	Dead end retic in Quarry Street, West Gladstone	Zone BC	Residential	100 mm	15	3.0	12.7	12
6212	Dead end retic in Kessell Street, West Gladstone	Zone BC	Residential	100 mm	15	3.8	11.2	12
649	Dead end retic in Cypress Close, Kin Kora	Zone D	Residential	100 mm	15	4.0	11.4	12
722	Dead end retic in Watson Close, South Gladstone	Zone D	Residential	100 mm	15	4.5	12.0	12
279	Dead end retic in Saint Clements Close, Telina	Zone D	Residential	100 mm	15	5.8	11.3	12
558	Dead end retic in Archer Street, Sun Valley	Zone D	Residential	100 mm	15	6.0	12.3	12
1575/6	Dead end retic in Dickinson Road, New Auckland	Zone D	Residential	100 mm	15	6.3	14.2	12
741	Dead end retic in Fitzsimmons Street, South Gladstone	Zone D	Residential	100 mm	15	6.7	12.5	12
6271	Dead end retic in Kellett Street, West Gladstone	Zone D	Residential	100 mm	15	7.6	13.5	12
1262	Dead end retic in Llewellyn Close, Clinton	Zone D	Residential	100 mm	15	8.2	14.4	12
6025	Dead end retic in Rigby Crescent, West Gladstone	Zone D	Residential	100 mm	15	8.7	14.7	12
4157	Too high to service	Zone	Residential		15	9.2	-77.8	12
674	Dead end retic in Franmaur Street, Sun Valley	Zone D	Residential	100 mm	15	9.9	13.7	12
6136	Williamson Street, West Gladstone	Zone BC	Residential	100 mm	15	9.9	14.5	12
6120	Dead end retic in Warren Street, West Gladstone	Zone BC	Residential	100 mm	15	10.5	14.5	12
353-362	Industrial area along South Trees Drive, South Trees	Zone D	Non-residential	150 mm	30	-245.9*	8.84	12
6400	Dead end retic in Blain Drive, West Gladstone (Regional Broadcasters Australia Pty Ltd)	Zone D	Non-residential	150 mm	30	-212.1	10.6	12

Node #	Location	Supply zone/area	Res/non-res fire	Supply pipe	Fire flow demand (L/s)	Residual pressure (m)	Available flow (L/s)	Available flow pressure (m)
4126	Dead end reticulation in Short Street, Barney Point (Toll North Pty Ltd)	Zone A	Non-residential	100 mm	30	-63.3	17.7	12
265	Dead end retic in Anson Close, Toolooa	Zone D	Non-residential	150 mm	30	-60.3	16.8	12
4192	Dead end retic in Barney Street, Barney Point	Zone A	Non-residential	100 mm	30	-56.9	19.0	12
263/4	Dead end retic in Soppa Street, Toolooa	Zone D	Non-residential	100 mm	30	-41.0	18.7	12
6364	Dead end retic in Rooksby Street, Gladstone	Zone A	Non-residential	100 mm	30	-35.1	21.6	12
4036	Lyons Street, South Gladstone	Zone A	Non-residential	100 mm	30	-19.8	21.2	12
4241	Dead retic in Off Street, Gladstone	Zone A	Non-residential	100 mm	30	-13.2	23.1	12
751	Dead retic in Bentley Street, South Gladstone	Zone D	Non-residential	100 mm	30	-11.2	23.7	12
753	Dead end retic in Hixon Street, South Gladstone	Zone D	Non-residential	100 mm	30	-9.9	24.7	12
4269	Dead end retic in Little Bramston Street, Gladstone	Zone A	Non-residential	100 mm	30	3.1	27.1	12
6358	Dead end retic in Palm Drive, Gladstone	Zone A	Non-residential	150 mm	30	3.9	28.1	12
4321	Endevour Street, Gladstone	Zone A	Non-residential	100 mm	30	4.3	24.5	12
4148	Dead end retic in Pier Street, South Gladstone	Zone A	Non-residential	100 mm	30	6.7	28.2	12
4237	Dead end retic in Herbert Street, Gladstone	Zone A	Non-residential	100 mm	30	10.1	29.6	12

** Note:- Worst residual pressure obtained from node range.*

As can been seen from these results, there are a number of areas that are not currently satisfying fire fighting requirements and further investigation is needed at these areas. Several of the locations are not capable of supplying a positive flow at 12m residual pressure. The augmentations required to satisfy the fire fighting requirements are as below in Table 12.2. It should be noted that this table is as agreed through discussions with Council. These augmentations will not rectify all of the deficiencies identified in Table 12.1 however will provide adequate fire fighting capabilities.

The unit rates used for the costing of the trunk main and reticulation infrastructure were agreed upon through discussions with Council. The unit rates do not allow for fluctuations in the price of pipe and assume the use of council workforce day labour for installation. It is recognised that North Queensland may not have been subject to the escalation of prices that has occurred in South East Queensland. It must be noted that the day labour may not be able to install all of the required infrastructure and subcontractors may be required.

Table 12.2 Augmentations to satisfy fire fighting requirements*

Item	Description	res/ non-res	Qty	Unit	Rate** ($/Unit)	Capital cost ($)	Node ID
1	Ø150mm, Off Barney Street, Barney Point	non-res	382	m	173	66,000	4126
2	Ø100mm, Young Street, Barney Point (from Wood St to Barney Street)	non-res	119	m	143	17,000	4192
3	Ø100mm, Barney Street, Barney Point (from Young Street to Powe Street)	non-res	245	m	143	35,000	4192
4	Ø150mm, Clinton (from Hayman Court to Rosslyn Close)	res	111	m	173	19,000	1047
5	Ø100mm, Rooksby Street, Gladstone	non-res	266	m	143	38,000	6364
6	Ø150mm, Gladstone Benaraby Road, Glen Eden (from Glen Eden Drive to South Trees Drive)	non-res	1,828	m	173	316,000	353-362
7	Ø150mm, South Trees Drive, Glen Eden (from Gladstone Benaraby Road to Wapentake Road)	non-res	652	m	173	113,000	353-362
8	Ø150mm, Wapentake Road, Glen Eden (from South Trees Drive)	non-res	242	m	173	42,000	353-362
9	Ø100mm, Cypress Close, Kin Kora (from Kauri Drive)	res	191	m	143	27,000	649
10	Ø150mm, Lyons Street, South Gladstone (from Oaka Street to Ward Close)	res	228	m	173	40,000	4037-8
11	Ø150mm, Mallard Court, South Gladstone (from Clipper Terrace to Oxley Drive)	res	254	m	173	44,000	788, 815-821
12	Ø150mm, Oxley Drive, South Gladstone (from Agnes Street)	res	234	m	173	41,000	788, 815-821
13	Ø150mm, Adelaide Street, South Gladstone (to Roberts Street)	res	145	m	173	25,000	785/6 792/9
14	Ø100mm, Maye Court, Sun Valley (from Cairncross Street)	res	105	m	143	15,000	703-5
15	Ø100mm, Saint Clements, Telina (from Watford Street)	res	64	m	143	9,000	279

Item	Description	res/ non-res	Qty	Unit	Rate** ($/Unit)	Capital cost ($)	Node ID
16	Ø100mm, Watford Street, Telina (from Dixon Drive to Saint Clements Close)	res	69	m	143	10,000	279
17	Ø150mm, Anson Close, Toolooa (from Gladstone Benaraby Road to end)	non-res	239	m	173	42,000	265
18	Ø100mm, Soppa Street, Toolooa (from Gladstone Benaraby Road)	non-res	273	m	143	39,000	263/4
19	Ø150mm, Gladstone Benaraby Road, Toolooa	res	460	m	173	80,000	375
20	Ø150mm, Boyne Crescent, West Gladstone (from Matson Crescent to Carron Street)	res	187	m	173	33,000	520 533
21	Ø100mm, Boyne Crescent, West Gladstone (from Carron Street)	res	110	m	143	16,000	520 533
22	Ø100mm, Laver Street, West Gladstone	res	172	m	143	25,000	6133
23	Ø150mm, Philip Street, South Gladstone (from Hurley Street to Windward Passage)	res	572	m	173	99,000	732-4
24	Ø150mm, Windward Passage, South Gladstone (from Philip Street to Helsal Place)	res	169	m	173	29,000	732-4
25	Ø150mm, Archer Street, Sun Valley (from Philip Street to Cairncross Street)*	res	55	m	173	10,000	703-5
26	Ø150mm, Cairncross Street, Sun Valley (from Archer Street to Nielson Street)*	res	99	m	173	17,000	703-5
27	Ø150mm, Cairncross Street, Sun Valley (from Nielson Street to Maye Court)*	res	218	m	173	38,000	703-5
28	Ø100mm, Higgens Street, West Gladstone (from Kellett Street to Kessell Street)	res	65	m	143	9,000	6214 6124 6271
29	Ø100mm, Higgens Street, West Gladstone (from Kessell Street to Nash Street)	res	105	m	143	15,000	6214 6124 6271
30	Ø100mm, Boles Street, West Gladstone (from Warren Street to Hunter Street)	res	93	m	143	14,000	520 533
	Total					**1,320,000**	

** Note:-Augmentations do not satisfy fire fighting requirements at all locations. As agreed by Council*

***Note: - Unit rates as agreed through discussions with Council. Assumes Council day labour*

12.3 ULTIMATE SYSTEM

The water supply network in the southern suburbs has significant portions of the development supplied via 100 mm diameter mains. Due to fire fighting requirements, it is recommended that 100 mm mains only be used in cul-de-sacs for short lengths. The fire fighting demand of 15 L/s results in approximately 50 m/km headloss through a 100 mm diameter main and as a result it is difficult to achieve satisfactory pressure. This is evident in many locations within Clinton, New Auckland, Telina and Glen Eden.

13 Constant flow water supply system

13.1 CONSTANT FLOW WATER SUPPLY SYSTEM

A conventional water supply system basically provides an on-demand generally unlimited water supply to all consumers with minimal restrictions in flow and pressure. This system avoids the need for on-site boosting of the incoming flow to low rise residential dwellings and also provides a high fire fighting capacity such that the fire-fighting authority can directly connect into the mains system.

A conventional water supply system should be provided to urban residential developments and in communities with medium to high commercial / industrial water demands.

Constant flow systems, on the other hand, provides a limited constant flow rate only, generally at average day demand, to all consumers, regardless of each individual consumer's demand. The system is provided to the property boundary only, from where the consumer is responsible to provide allotment buffer storage to cater for peak individual demands, transfer pumps and/or booster pumps to the dwelling itself. Minimum operating pressures provided to the property boundary should not be less than 12 metres head. Minimum recommended on-site storage is 22.5kL.

Constant flow systems do not make provision for fire hydrants within the scheme. Requirements for fire-fighting for individual areas should be determined in consultation with the local fire brigade. The location of tanker filling stations and reservoir storages for fire-fighting use only can be determined.

Constant flow systems are generally applicable to small communities with minimal commercial/industrial demands, and for rural residential developments with minimum allotment sizes greater than 4000m^2.

Constant flow systems, due to the fact that they provide a reduced level of service to a conventional water supply system, can be provided by local governments to the communities at a reduced cost through reduction in pipe diameters, pump and treatment plant capacities.

13.2 RURAL/RESIDENTIAL AREA - GLADSTONE CITY COUNCIL

The Gladstone City Council Transitional Planning Scheme has identified rural / non-urban and rural residential land within the Gladstone City boundaries most predominantly along the Calliope Shire / Gladstone City boundary to the south, south-west and west of the city.

An assessment of the possibility of a "constant flow" system is centred only on the suburb of O'Connell, in the southern areas of Gladstone City Council.

Future proposed works in this area, labelled as the O'Connell High Level Zone (HLZ) (as detailed in Clauses 10.2 and 10.3 of this report), for a conventional water supply system include a booster pump station (2006/07), a 2.27 ML Ground level storage (2023/24), and a total of 18.1km of trunk mains from 2011/12 to 2030/31 (pipe sizes ranging from 150mm dia. to 375mm dia.).

The alternative of a "constant flow" system which would provide the future developments with average day demands at the property boundaries only, would include the following augmentation works:-

- 1.7 km of 150mm dia trunk main along Glenlyon Road
- 1.8 km of 100mm dia trunk main along Kirkwood Road (including pipework in the extension of Kirkwood Road east of Glenlyon Road)
- 3 km of 100 mm dia trunk main in the north of Kirkwood Road and west of Glenlyon Road
- 2 km of 100mm dia trunk main along Booroo Road
- 2.1 km of 100mm dia trunk main along Haddock Drive
- 1.4 km of 100mm dia trunk main along Mt Rollo Road

These works, whilst providing a reduced level of service to consumers in the O'Connell HLZ, would represent a cost of $1,757,000.

While the proposed land use in the O'Connell land use in the O'Connell HLZ is primarily rural in nature, the possibility of a number of higher density developments occurring in the future can not be discounted. It would not be prudent to service these with a constant flow supply.

At this stage, it is recommended that the long term strategy for the O'Connell HLZ remain a conventional water supply. This decision can be reviewed in the future as a better understanding of the actual proposed land use for this area is obtained.

Figure 13.1 following provides an indicative layout of the required works for a "constant flow" system.

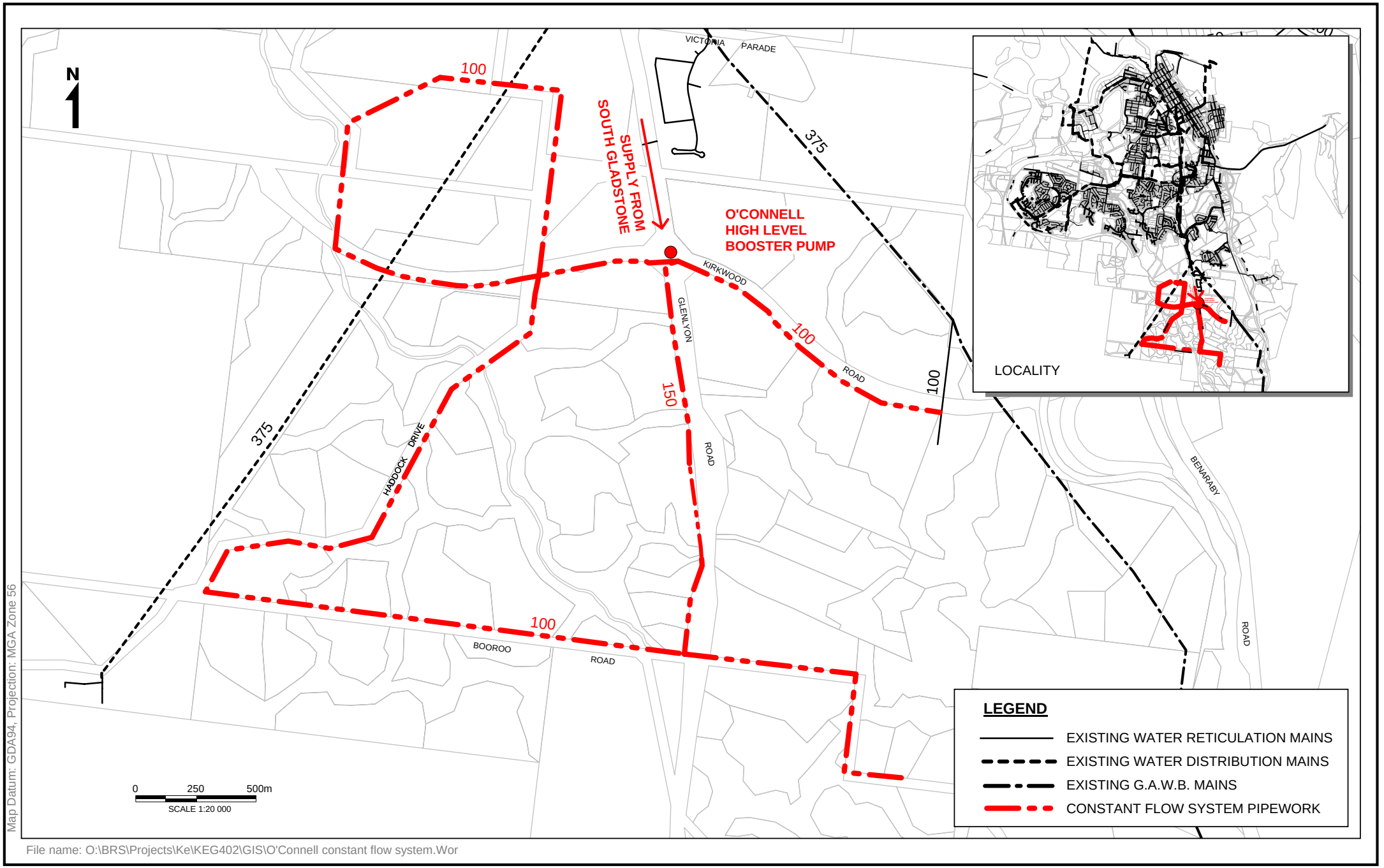


Figure 13.1
O'CONNELL CONSTANT FLOW SYSTEM

14 GAWB trunk main - O'Connell

Council has a total of twelve (12) water connections off the Gladstone Area Water Board's (GAWB) existing 300 mm diameter trunk main in the suburb of O'Connell. Each of the twelve allotments is rural / non-urban in accordance with the Transitional Planning Scheme for Gladstone City. Figure 14.1 provides details of these connections.

As discussed previously in this report, the suburb of O'Connell is generally at an elevation too high to be serviced by the South Gladstone Reservoir at TWL 91.4 mAHD. It has been proposed in this report that the O'Connell HLZ will initially be serviced via a variable speed drive (VSD) pump station that will directly supply maximum hour to the region. Upon O'Connell exceeding a population that can be serviced by the VSD pump station the reservoir and trunk system can be constructed to serve the high level zone. The timing of some of the augmentation works, based on population growth predictions in the area, as previously detailed is as follows:-

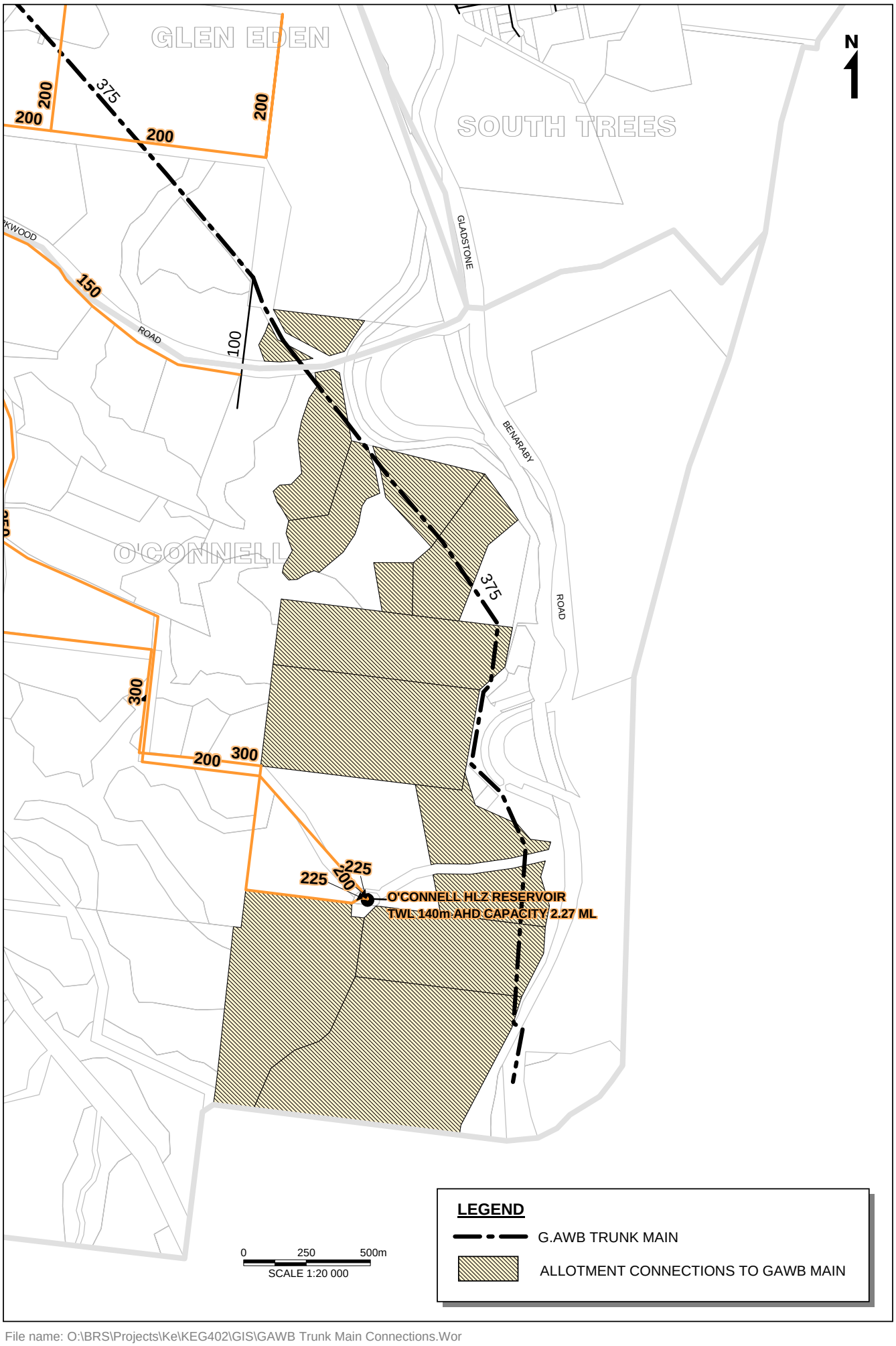
- O'Connell Booster Pump Station in 2006/07
- O'Connell HLZ reservoir in 2023/24
- 250mm dia. trunk main in 2016/17

Long term, relatively low cost alternatives for providing a water supply to these twelve connections, other than off the GAWB main could include:-

- connection of the six(6) northern allotments to the 250mm dia. trunk main in 2016/17
- connection of the six(6) southern allotments to the scheme from the new O'Connell HLZ reservoir in 2023/24

A possible short term alternative is to combine the six(6) northern allotments into a single connection off the GAWB trunk main and to combine the six(6) southern allotments also into a single connection off the GAWB trunk main i.e. a total of two (2) only connections off the main in lieu of the current twelve(12) connections. However, this would require substantial additional pipework.

It is recommended that as this area develops further, that connections be progressively removed from the GAWB trunk main, as other infrastructure is provided to serve new developments. This would be regarded moreso as an opportunistic approach.



File name: O:\BRS\Projects\Ke\KEG402\GIS\GAWB Trunk Main Connections.Wor

Map Datum: GDA94, Projection: MGA Zone 56

Figure 14.1
GAWB TRUNK MAIN
EXISTING CONNECTIONS

15 Raw water main

Industrial areas to the north of the city will be serviced by a new raw water main currently being constructed by Gladstone Area Water Board through Gladstone City. The location of this new main is shown in Figure 15.1 following.

The use of a portion of this raw water for irrigation of sports fields within Gladstone City has briefly been investigated.

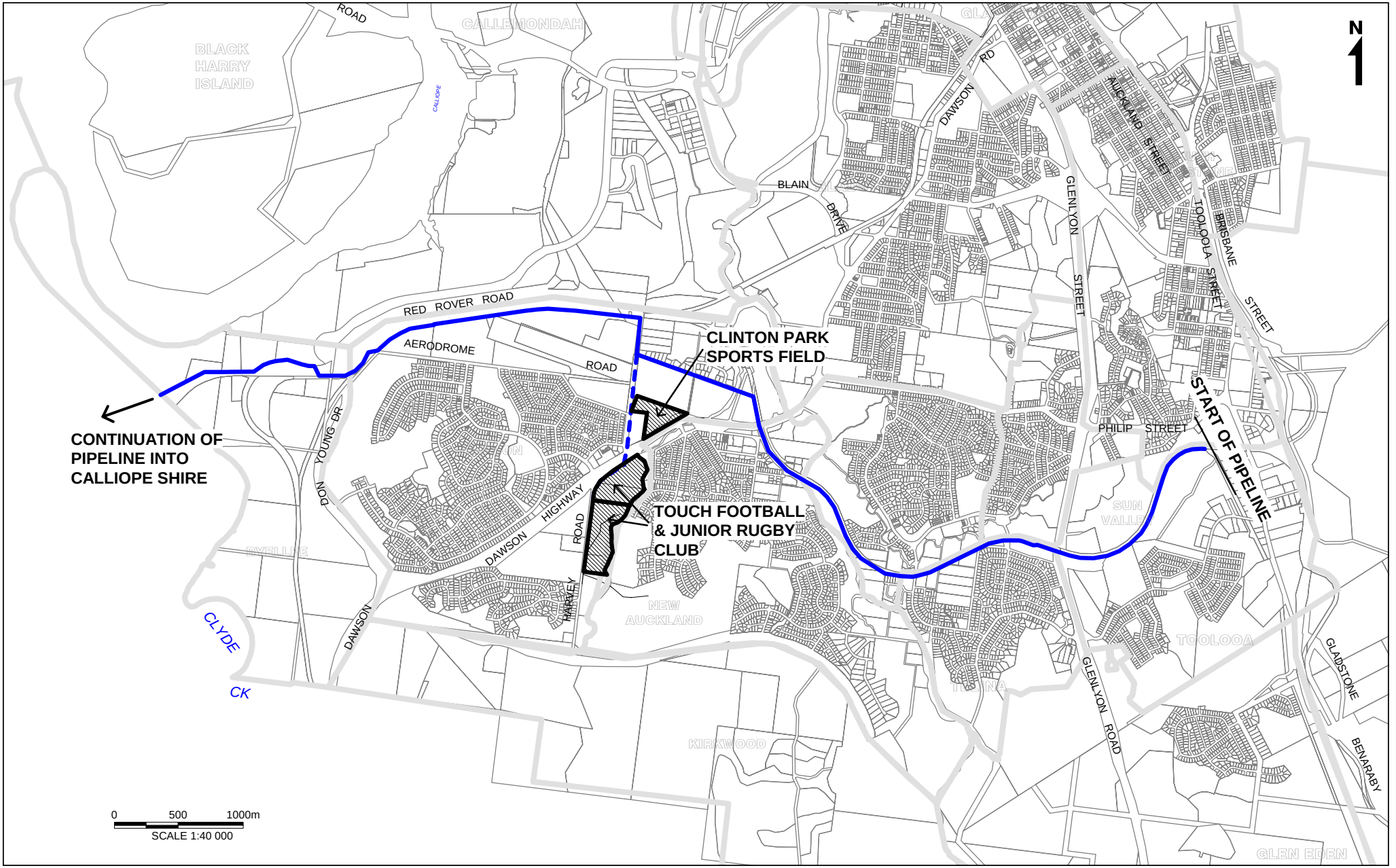
The Rugby League and Touch Football in Clinton and the Clinton Park Sports fields have been identified as having potential to be supplied via the raw water main. Other potential sites located along the alignment such as the golf course were not considered appropriate because of their low water usage.

This matter has previously been considered by Council as follows:

Excerpt from Technical Services Committee dated 13 April 2004

> With the construction of the Gladstone Area Water Board's new raw water main adjacent to the Moura Railway Line, it would be possible to connect raw water to the Rugby League and Touch Football fields and to also include the fields at Clinton Park Sports. The locations of these fields are shown on Figure 14.1.
>
> A 150 mm main would be required at an estimated cost of $267,000. Note that these costs are to provide a main and a metered connection point, and do not include any internal costs required to separate their irrigation systems from the existing treated water supply..

An analysis of the required main to supply these sports fields has been undertaken. A 150 mm diameter main would be required with a total length of 1.3 km. A preliminary cost of this main is $350,000—$380,000, which is more than the previous estimate. Given the high capital cost this venture is not considered feasible at this stage.



Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Raw Water Trunk Main.Wor

Figure 15.1
RAW WATER TRUNK MAIN

16 Conclusions

The conclusions that have been reached with regard to the Gladstone water supply system are as follows:

- Under existing demand conditions, only minor local deficiencies have been identified.
- Zone BC and Zone A should be rezoned to allow Paterson Street Reservoir to service Zone BC and Fisher Street Reservoir, Radar Hill Reservoir and Ferris Hill Reservoir to service Zone A. Fisher Street Booster Pump Station will be decommissioned with this rezoning and a flow control valve installed on the inlet to Paterson Street Reservoir to only allow MDMM flow from Round Hill Reservoir.
- A long term strategy to reduce the pressure received at the caravan park downstream of the Auckland Creek Pump Station is to rezone by connecting this area and the Callemondah industrial area to the suction side of the pump station.
- Zone D will not have the required storage capacity and will require an additional 9.1ML reservoir at a site which will need to be confirmed through a separate investigation.
- Significant trunk and reticulation infrastructure will be required to service the new development areas in Kirkwood, Glen Eden and O'Connell.
- O'Connell will be serviced initially via a VSD booster pump station that will supply maximum hour to the region. Once the capacity of this pump station is exceeded a HLZ reservoir will be constructed, at which time the booster pump will supply MDMM flow to the reservoir.
- A review of the separate merits of providing a constant flow supply and removing trunk main connections to land within the proposed O'Connell HLZ area be undertaken in the future, as better information regarding land development in the region becomes available.
- The capital cost requirements with a break down for the first four years have been summarised below.

Table 16.1 Capital works program

Program Year	Financial Year	Capital Cost
2	2005/06	1,215,000
3	2006/07	1,083,000
4	2007/08	786,000
5	2008/09	490,000
6	2009/30	8,438,000
Total		**12,012,000**

17 Recommendations

It is recommended that Gladstone City Council:

1. Adopts this report and the capital works program with approximate capital expenditure of **$ 12,012,000**.
2. Undertake a detailed investigation into the most appropriate site for the second South Gladstone Reservoir including geotechnical works and preliminary survey.
3. Use this report as the basis for the development of the Priority Infrastructure Plans.
4. Continues to actively apply and encourage demand management initiatives.
5. Forwards this report to the Gladstone Area Water Board
6. Forwards this report to the NRM&E for approval as a planning report.

18 References

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.

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

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Gladstone City Council 2004, CBD Study.

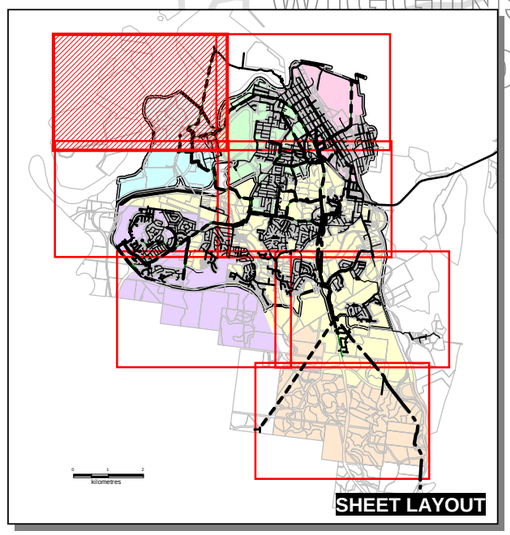
Gladstone City Council, 1997, Gladstone Water Supply—1997 Planning Report.

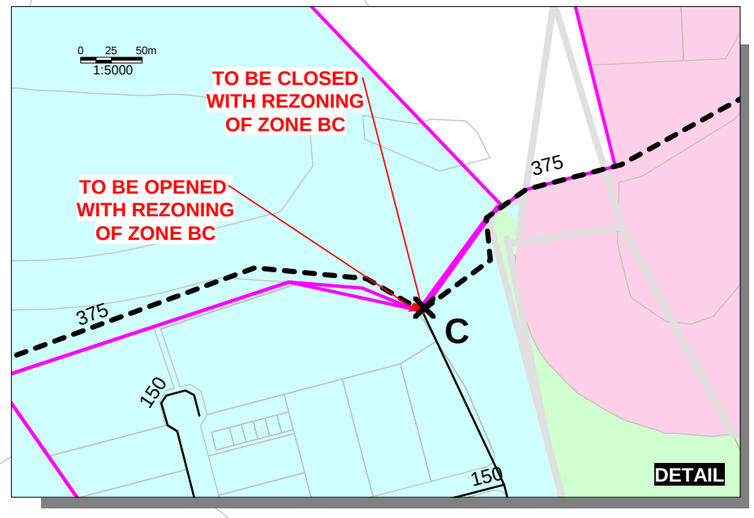
Gladstone City Council 2003, Water Supply Infrastructure Policy.

Water Resources Commission 1989 - Guidelines for Planning and Design of Urban Water Supply Schemes.

Appendix A

WATER SUPPLY SYSTEM INFRASTRUCTURE LAYOUTS





N

1

JOINS SHEET 2

JOINS SHEET 3

LEGEND

- EXISTING WATER RETICULATION MAINS
- EXISTING WATER DISTRIBUTION MAINS
- EXISTING G.A.W.B. MAINS
- EXISTING RESERVOIR
- EXISTING PUMP STATIONS
- EXISTING CLOSED VALVE
- PIPE AUGMENTATION FOR REZONING
- **2016** (year) / **150** (dia) FUTURE PIPE AUGMENTATIONS
- LOTS TOO HIGH TO SERVE
- BC EXISTING WATER SUPPLY ZONES

FUTURE WATER SUPPLY ZONES

- ZONE A
- ZONE BC
- ZONE D
- ZONE E
- ZONE F
- CLINTON PARK

0 250 500m

SCALE 1:12 500

Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Existing Water Supply Infrastructure Sheet 1.Wor

Figure A.1
EXISTING WATER SUPPLY INFRASTRUCTURE AND PROPOSED AUGMENTATIONS - SHEET 1 OF 7

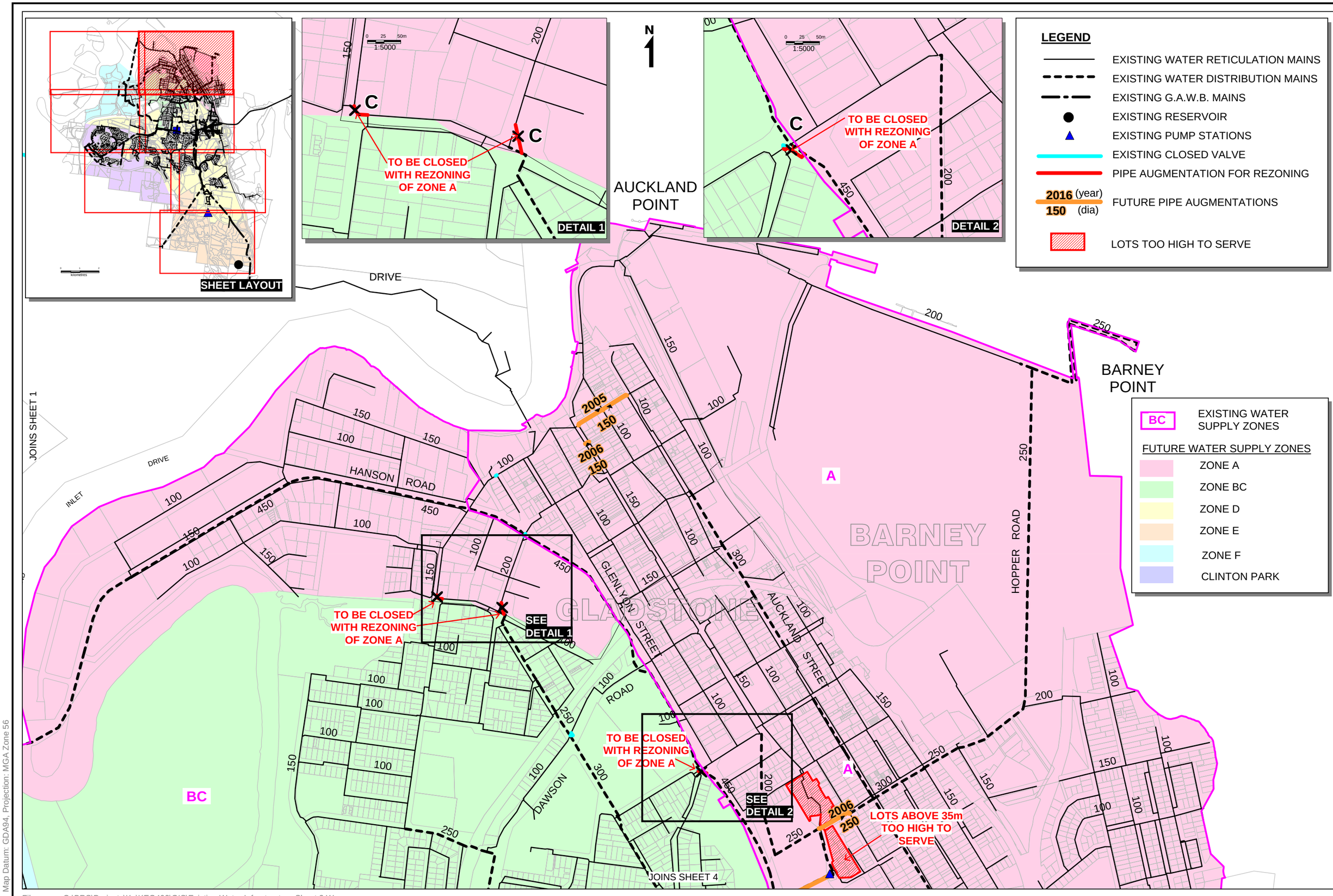


Figure A.2
EXISTING WATER SUPPLY INFRASTRUCTURE AND PROPOSED AUGMENTATIONS - SHEET 2 OF 7

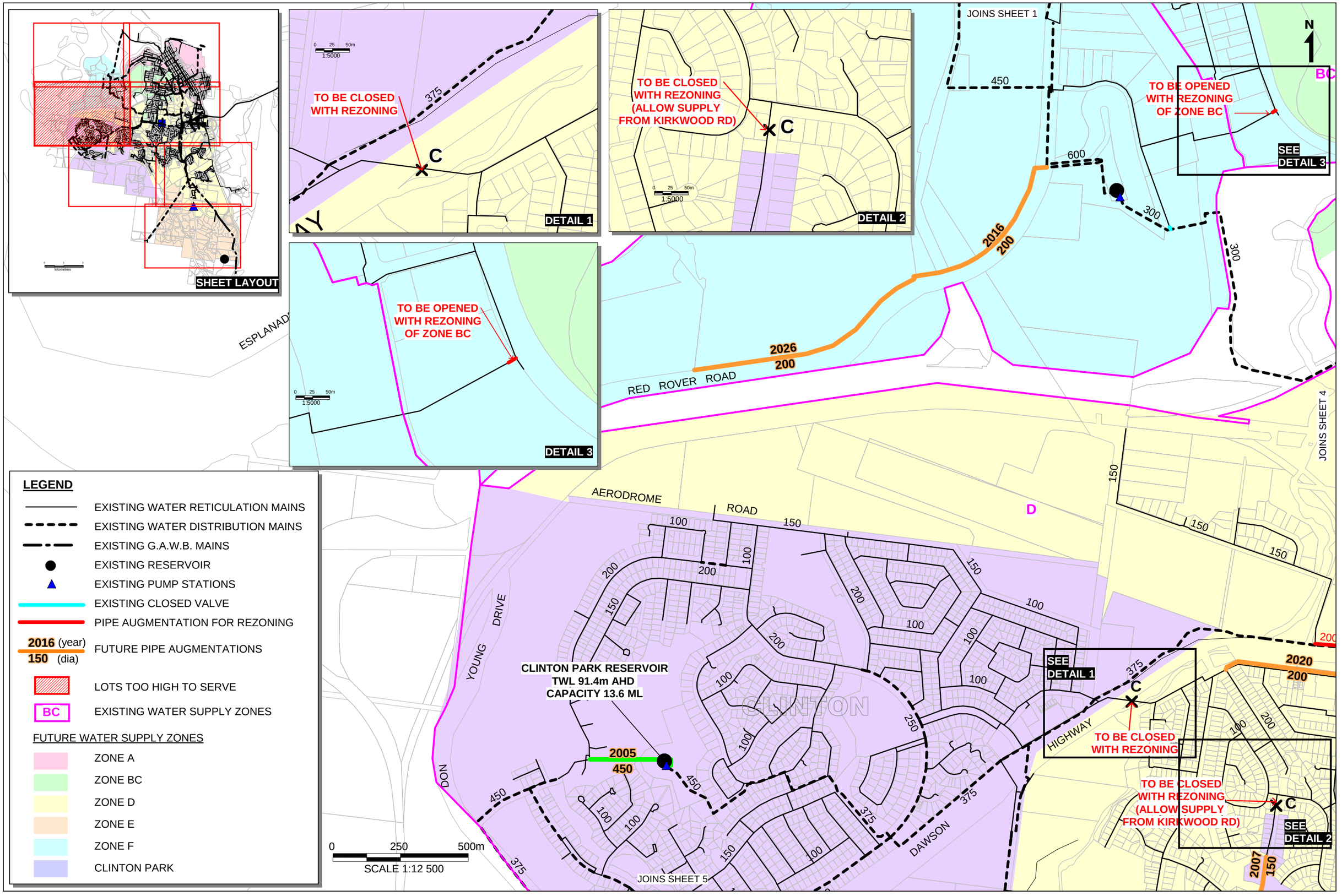
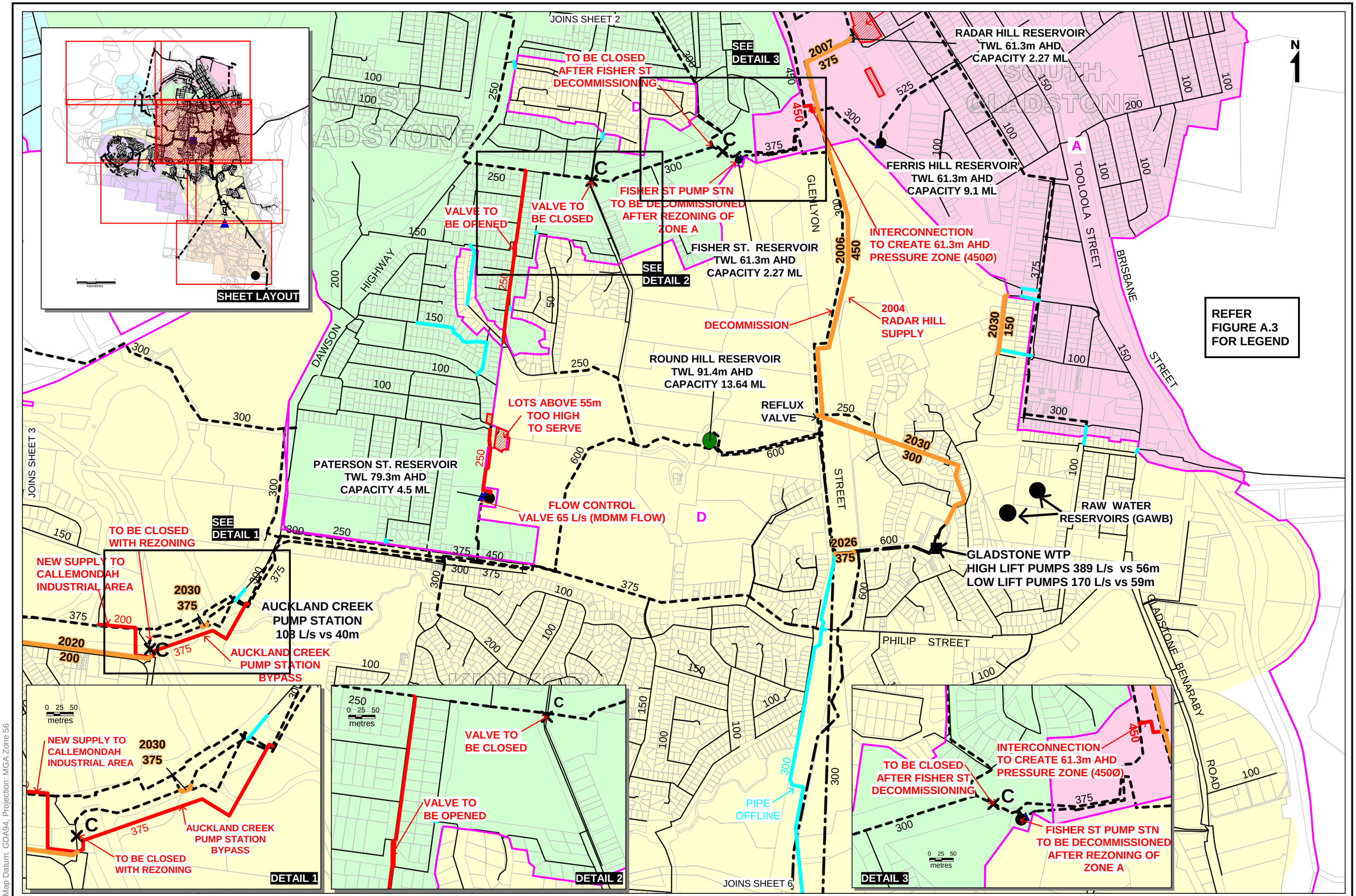


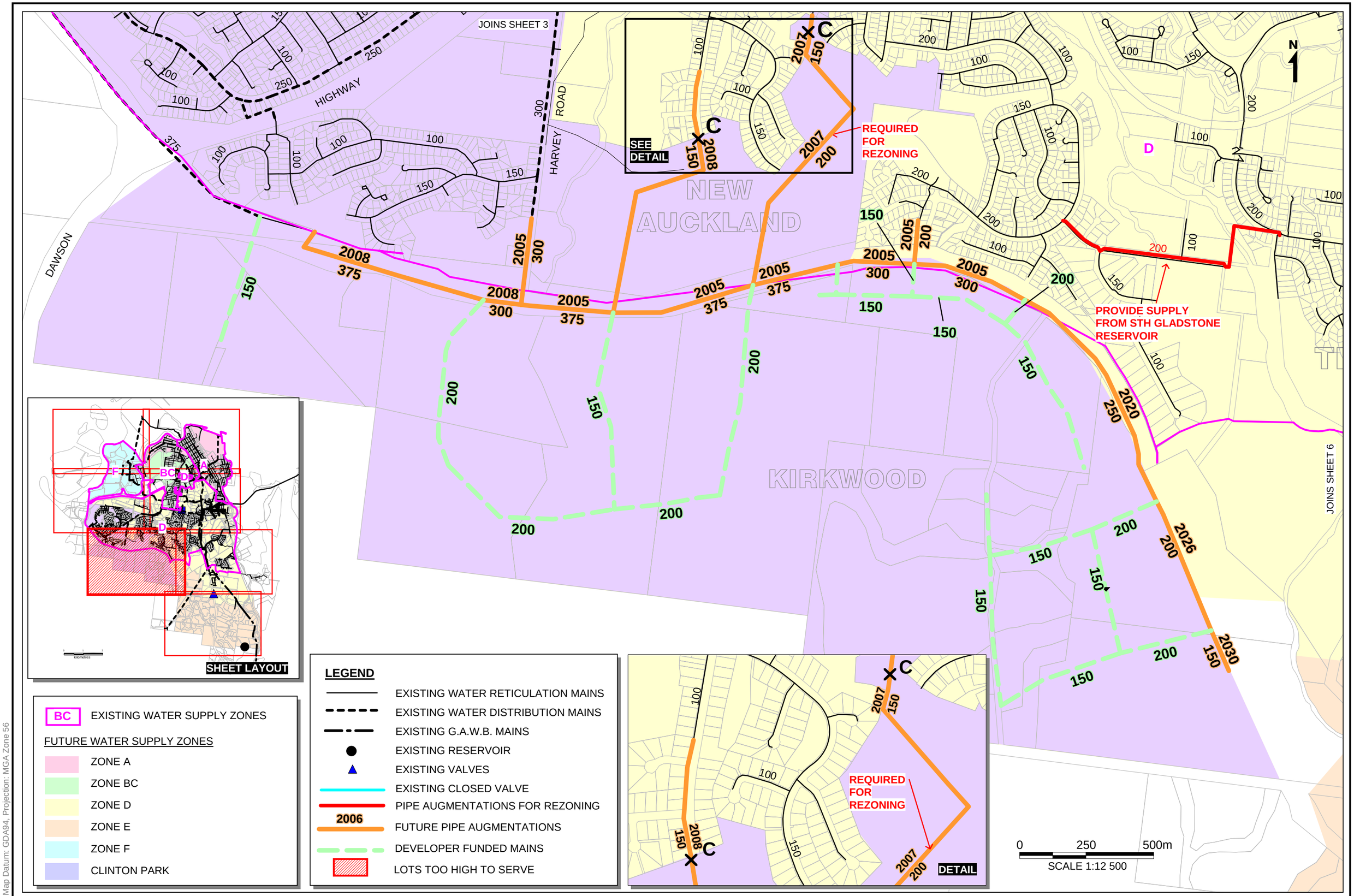
Figure A.3
EXISTING WATER SUPPLY INFRASTRUCTURE AND PROPOSED AUGMENTATIONS - SHEET 3 OF 7



Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Existing Water Supply Infrastructure Sheet 4.Wor

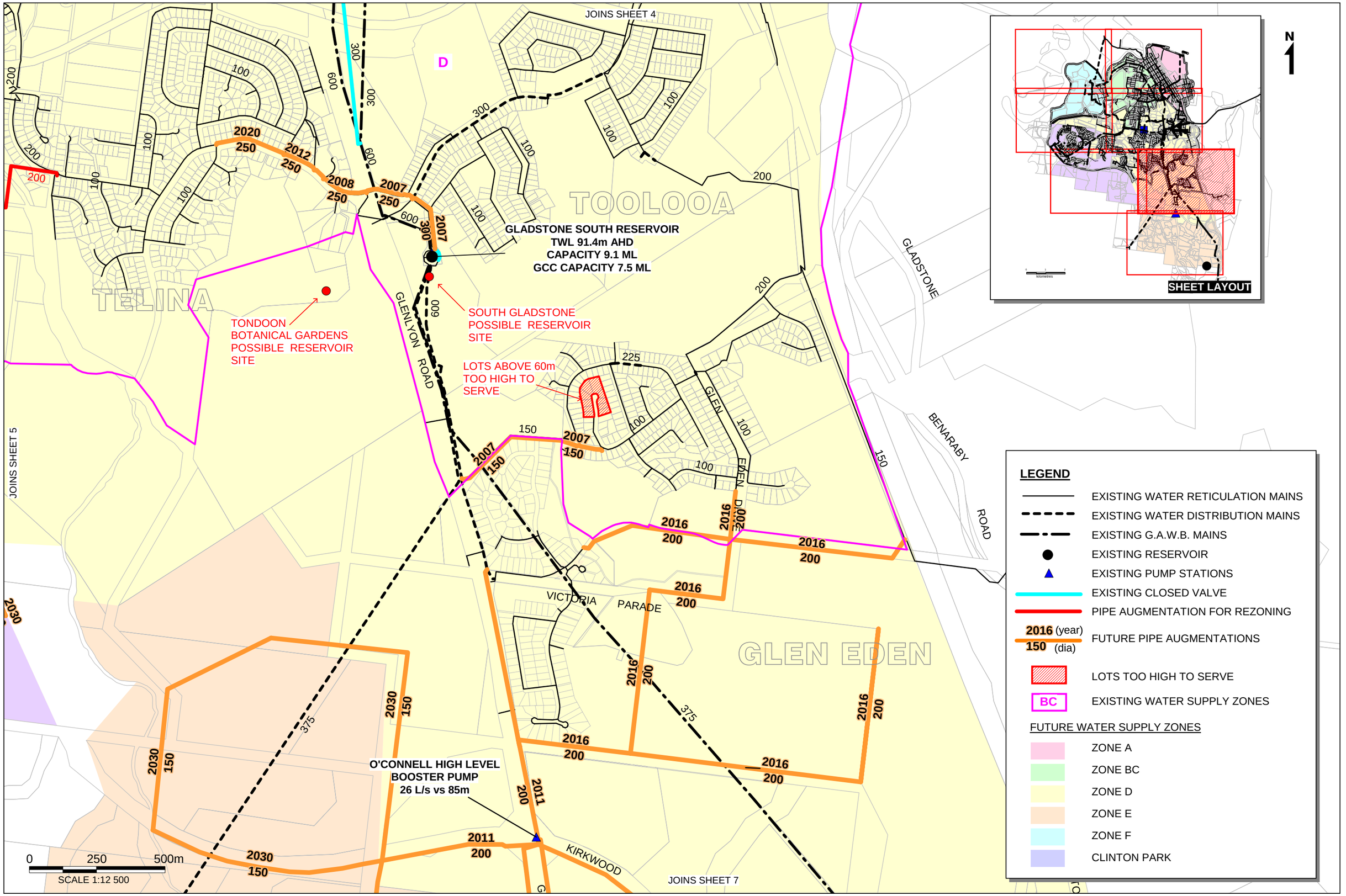
Figure A.4
EXISTING WATER SUPPLY INFRASTRUCTURE AND PROPOSED AUGMENTATIONS - SHEET 4 OF 7



Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Existing Water Supply Infrastructure Sheet 5.Wor

Figure A.5
EXISTING WATER SUPPLY INFRASTRUCTURE AND PROPOSED AUGMENTATIONS - SHEET 5 OF 7



Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Existing Water Supply Infrastructure Sheet 6.Wor

Figure A.6
EXISTING WATER SUPPLY INFRASTRUCTURE AND PROPOSES AUGMENTATIONS - SHEET 6 OF 7

JOINS SHEET 6

2030 157

2030 150

2011 200

KIRKWOOD ROAD

2016 150

GLENLYON ROAD

2016 250

2011 200

HADDOCK DRIVE

375

100

375

GLADSTONE

BENARABY

BOYNE ISLAND TANNUM SANDS

2011 150

2016 250

2016 250

2023 200

2011 150

BOOROO ROAD

O'CONNELL

2016 300

SILVERDALE RESERVOIR

MT ELIZABETH RESERVOIR

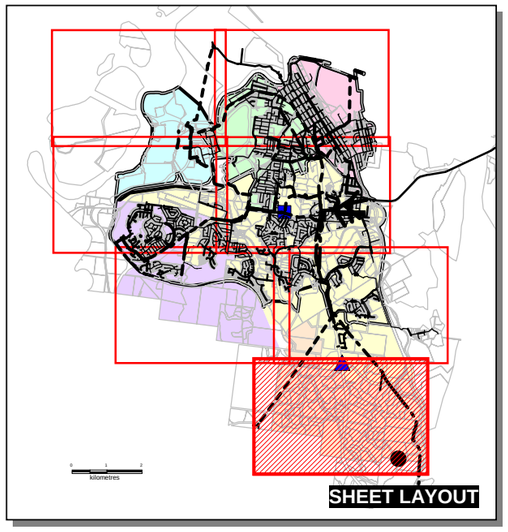
O'CONNELL HLZ RESERVOIR
TWL 140m AHD CAPACITY 2.27 ML

2023 300

N 1

0 250 500m

SCALE 1:12 500



LEGEND

- EXISTING WATER RETICULATION MAINS
- EXISTING WATER DISTRIBUTION MAINS
- EXISTING G.A.W.B. MAINS
- EXISTING RESERVOIR
- EXISTING VALVES
- EXISTING CLOSED VALVE
- PIPE AUGMENTATIONS FOR REZONING
- 2016 (year) / 150 (dia) FUTURE PIPE AUGMENTATIONS
- LOTS TOO HIGH TO SERVE

BC EXISTING WATER SUPPLY ZONES

FUTURE WATER SUPPLY ZONES

- ZONE A
- ZONE BC
- ZONE D
- ZONE E
- ZONE F
- CLINTON PARK

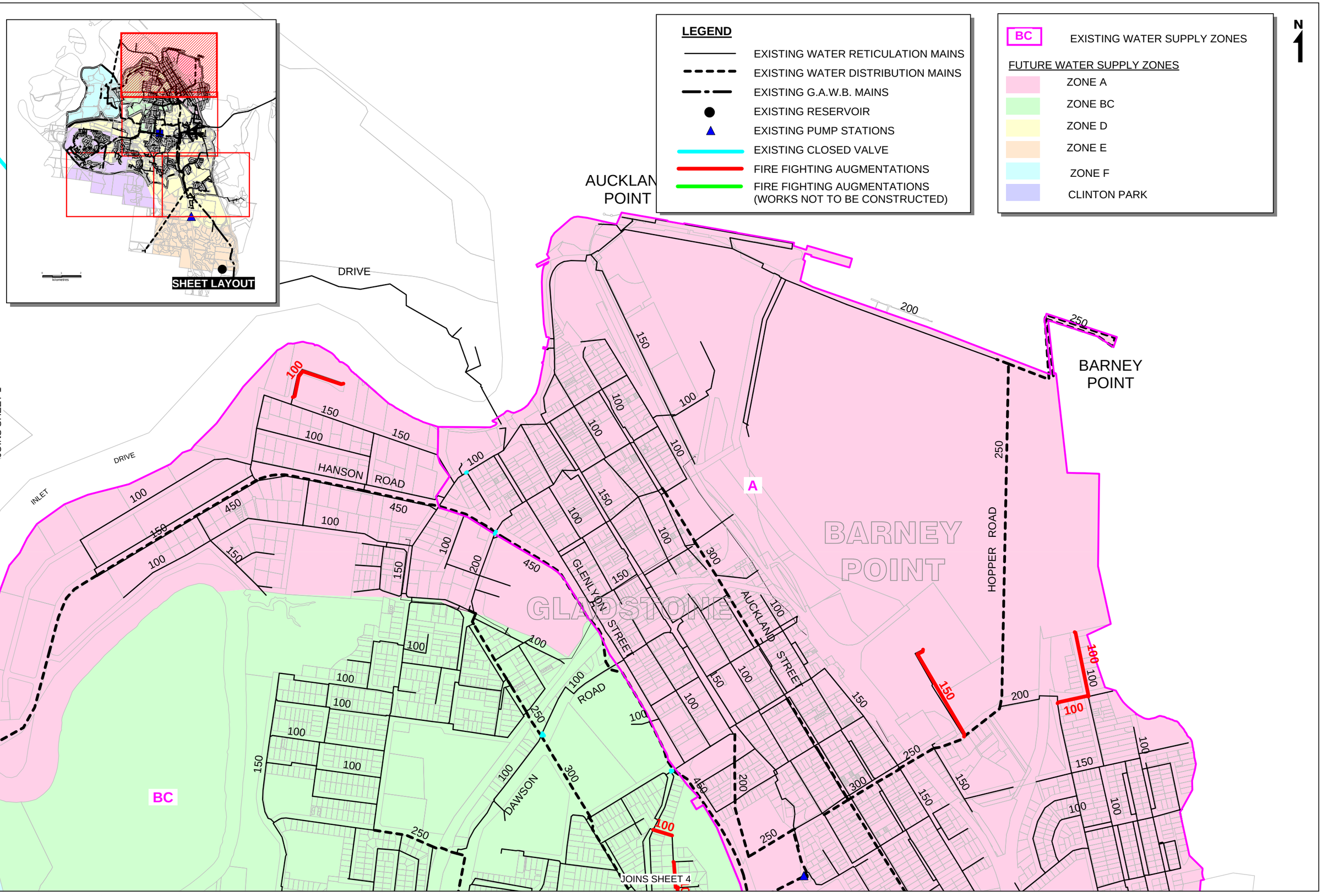
Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Existing Water Supply Infrastructure Sheet 7.Wor

Figure A.7
EXISTING WATER SUPPLY INFRASTRUCTURE AND PROPOSED AUGMENTATIONS - SHEET 7 OF 7

Appendix B

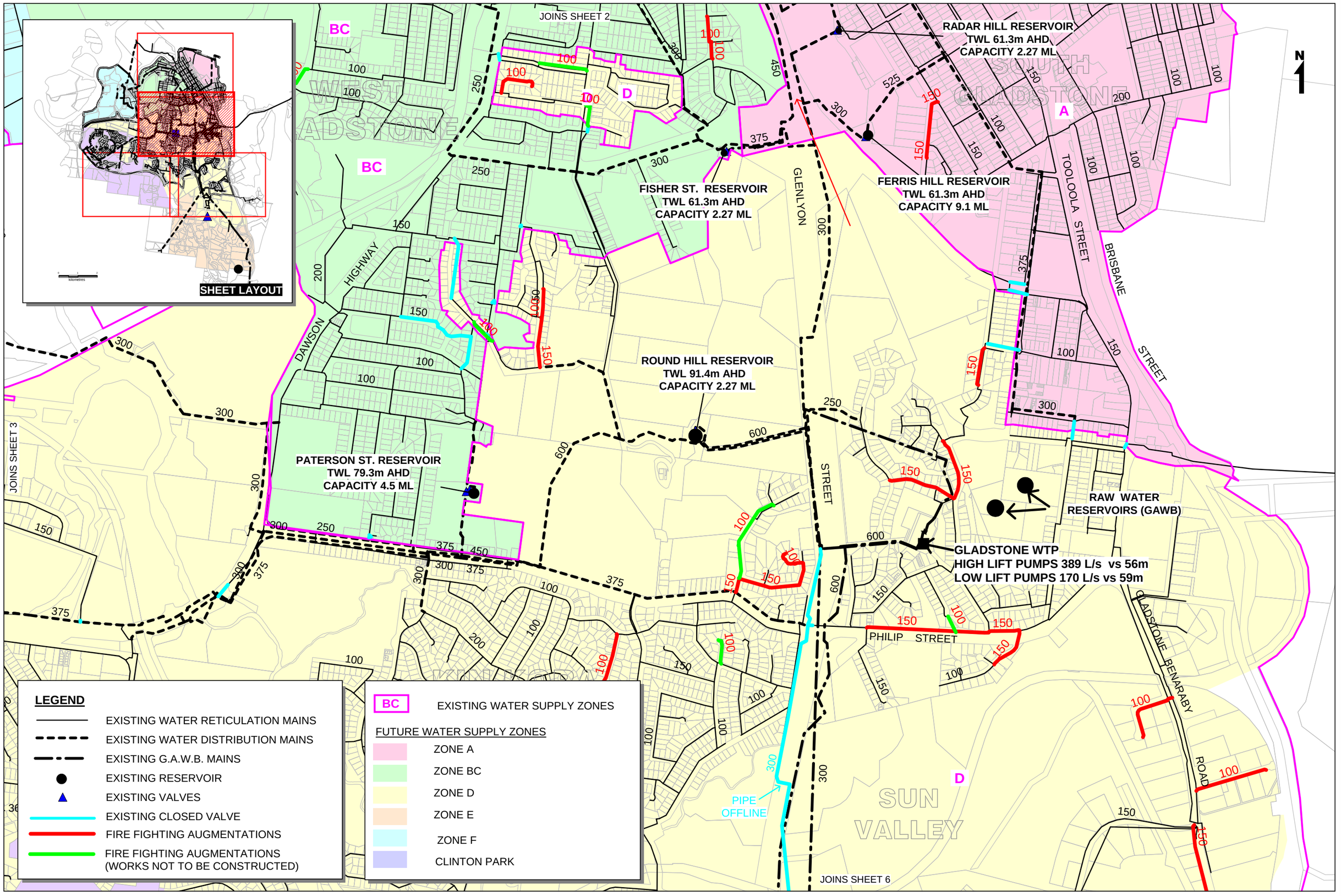
WATER SUPPLY FIRE FLOW AUGMENTATIONS



Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Fire Augmentations Sheet 1 of 4.Wor

Figure B.1
FIRE AUGMENTATIONS - SHEET 1 OF 4



Map Datum: GDA94, Projection: MGA Zone 56

File name: O:\BRS\Projects\Ke\KEG402\GIS\Fire Augmentations Sheet 2 of 4.Wor

Figure B.2
FIRE FIGHTING AUGMENTAtIONS - SHEET 2 OF 4

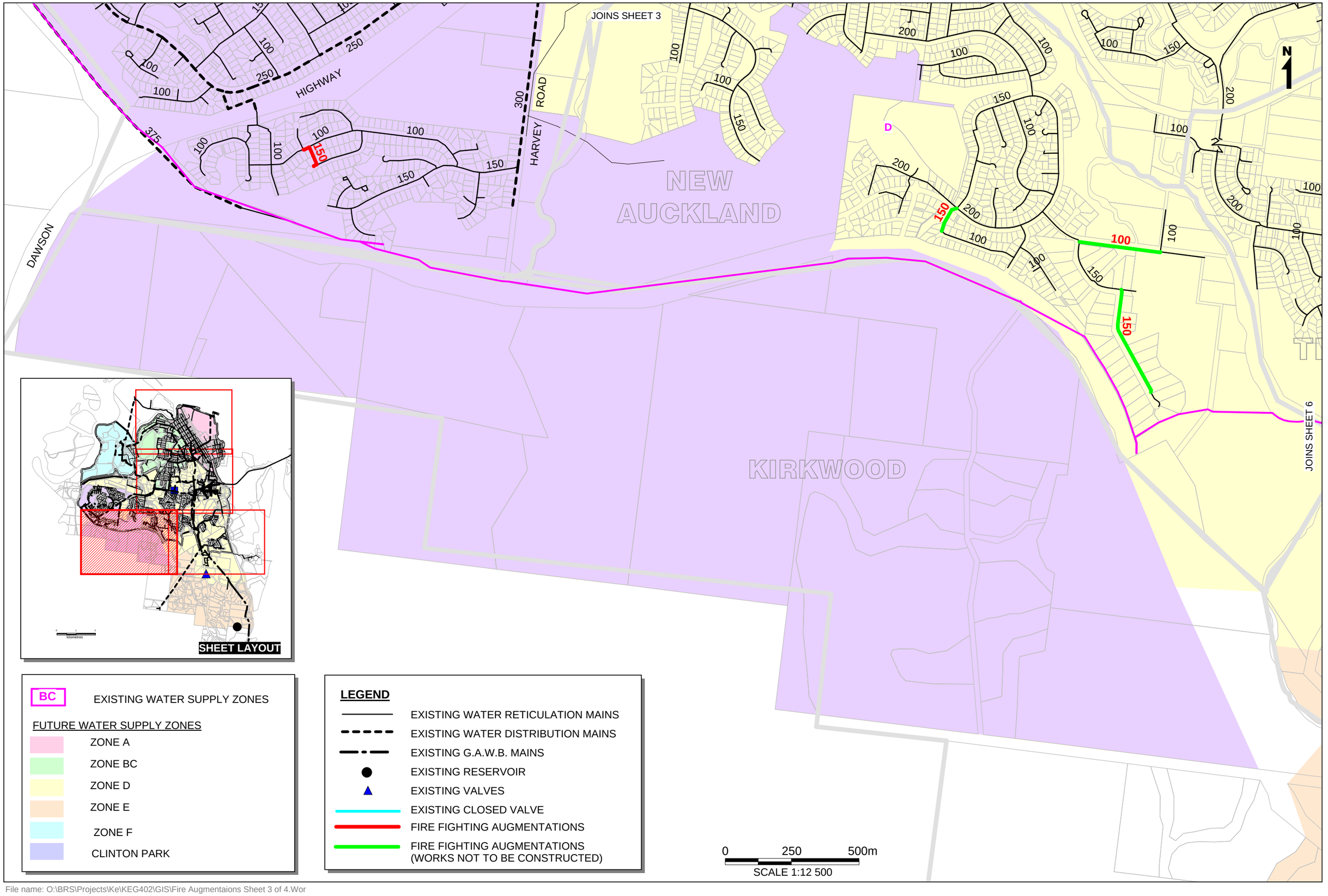


Figure B.3
FIRE FIGHTING AUGMENTATIONS - SHEET 3 OF 4

JOINS SHEET 4

JOINS SHEET 5

JOINS SHEET 7

D

TOOLOOA

TELINA

GLEN EDEN

SOUTH TREES

GLADSTONE SOUTH RESERVOIR
TWL 91.4m AHD
CAPACITY 91 ML
GCC CAPACITY 7.5 ML

O'CONNELL HIGH LEVEL
BOOSTER PUMP
26 L/s vs 85m

GLENLYON ROAD

VICTORIA PARADE

KIRKWOOD

GLEN EDEN DRIVE

GLADSTONE BENARABY ROAD

SHEET LAYOUT

N

LEGEND

- EXISTING WATER RETICULATION MAINS
- EXISTING WATER DISTRIBUTION MAINS
- EXISTING G.A.W.B. MAINS
- EXISTING RESERVOIR
- EXISTING VALVES
- EXISTING CLOSED VALVE
- FIRE FIGHTING AUGMENTATIONS
- FIRE FIGHTING AUGMENTATIONS (WORKS NOT TO BE CONSTRUCTED)

BC EXISTING WATER SUPPLY ZONES

FUTURE WATER SUPPLY ZONES

- ZONE A
- ZONE BC
- ZONE D
- ZONE E
- ZONE F
- CLINTON PARK

0 250 500m
SCALE 1:12 500

Map Datum: GDA94, Projection: MGA Zone 56

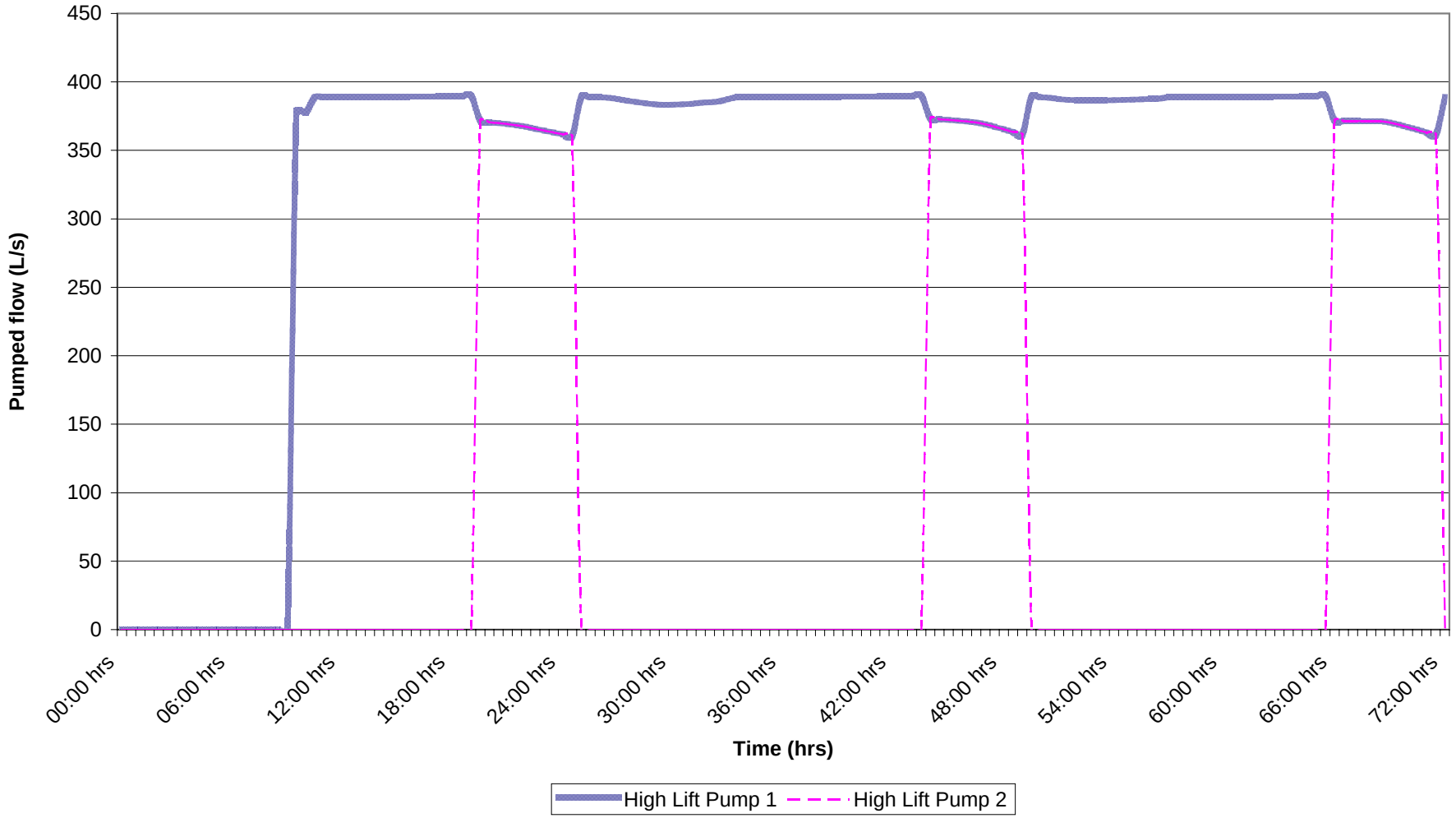
File name: O:\BRS\Projects\Ke\KEG402\GIS\Fire Augmentations Sheet 4 of 4.Wor

Figure B.4
FIRE FIGHTING AUGMENTATIONS - SHEET 4 OF 4

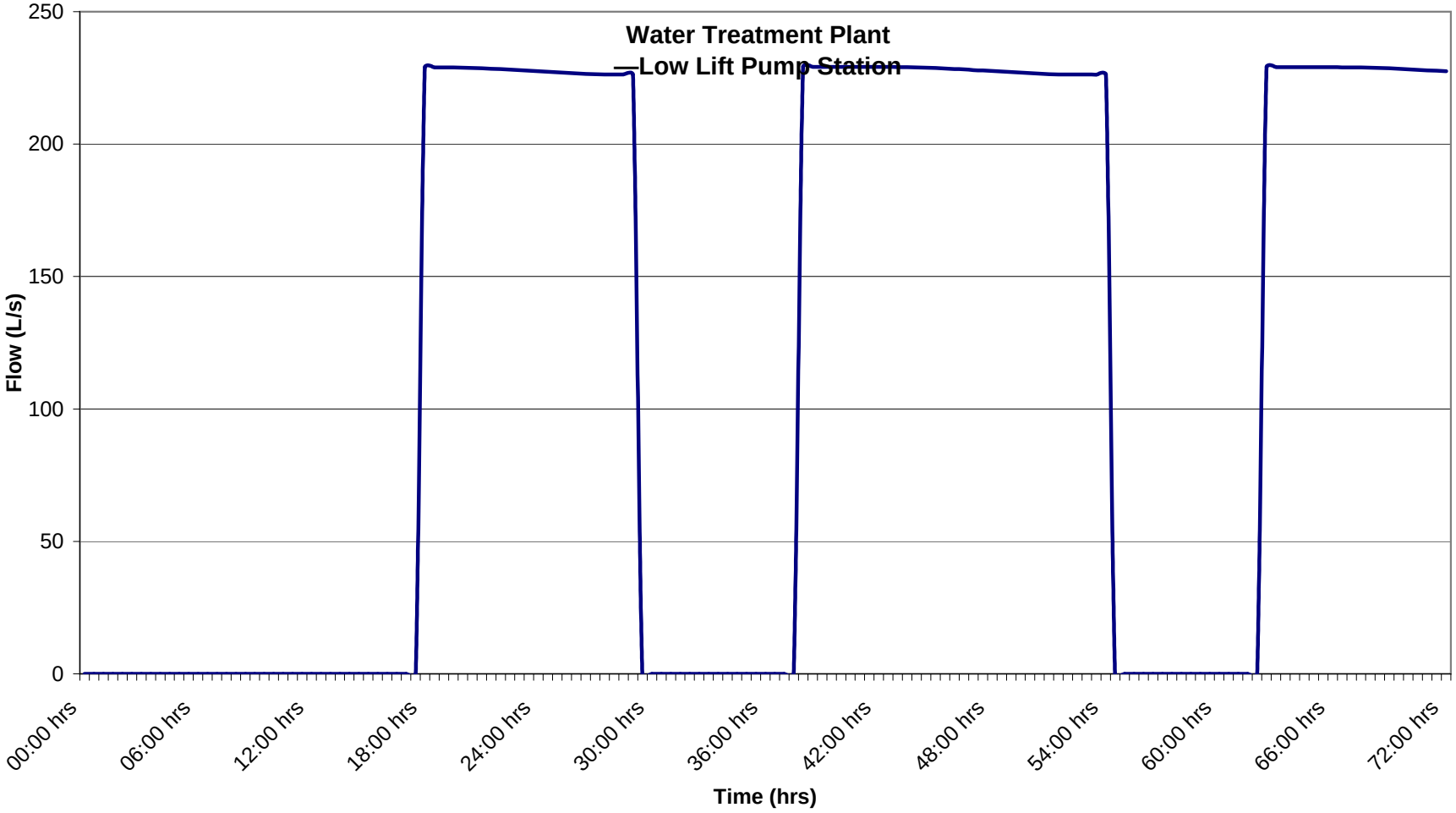
Appendix C

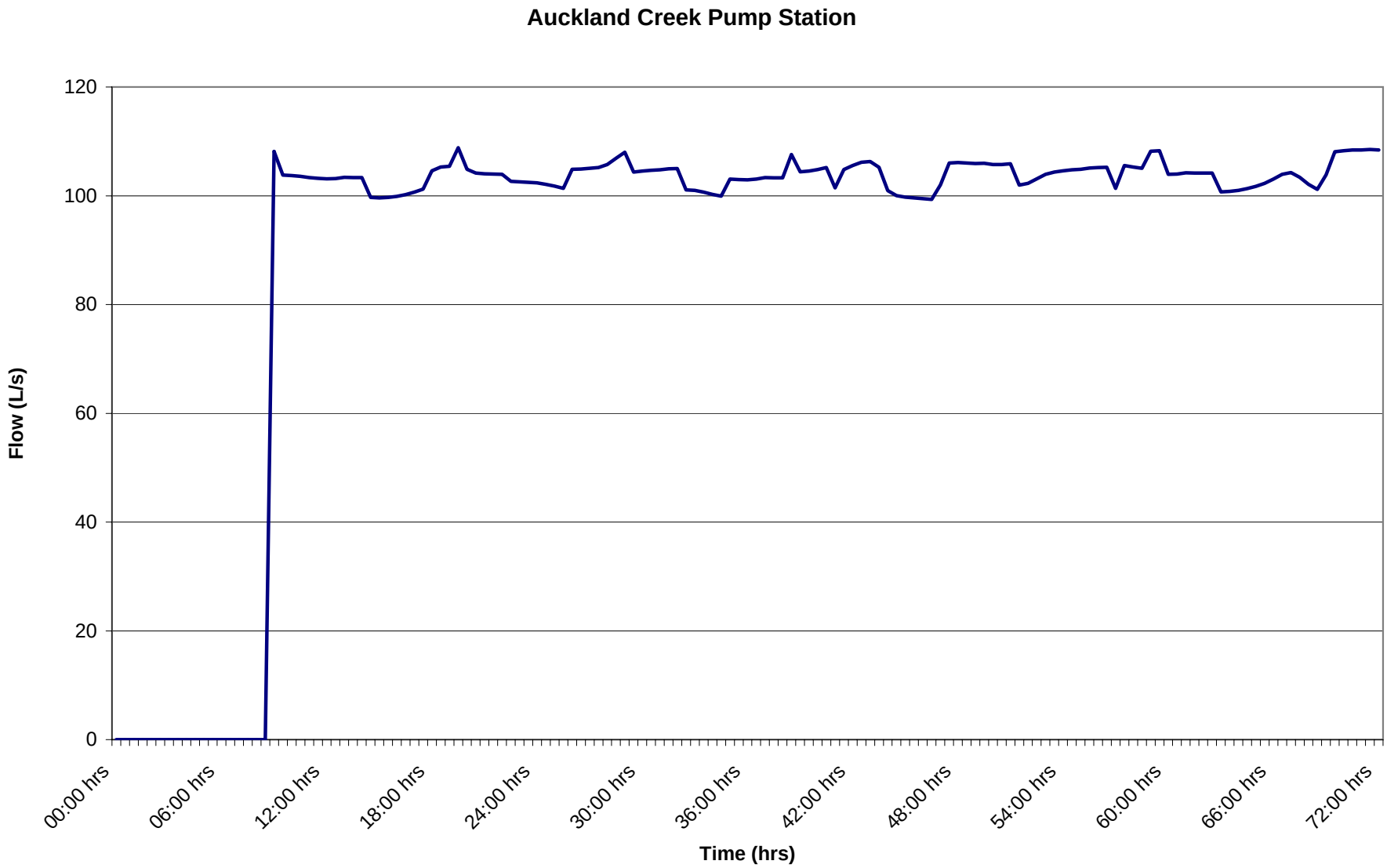
EXISTING WATER NETWORK ANALYSIS RESULTS

Water Treatment Plant
—High Lift Pumps

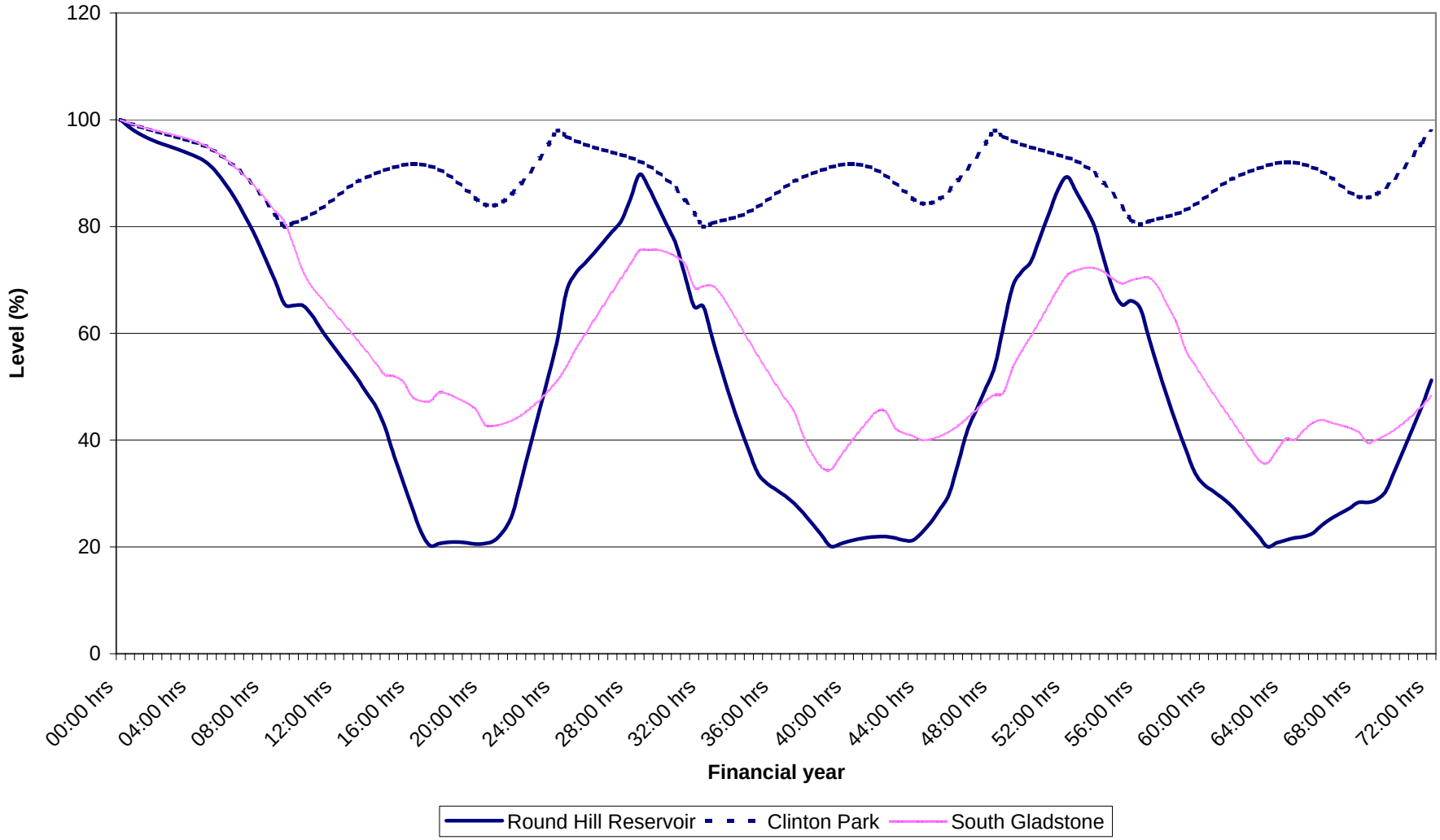


Yr 2004 Design simulation
Maximum hour results

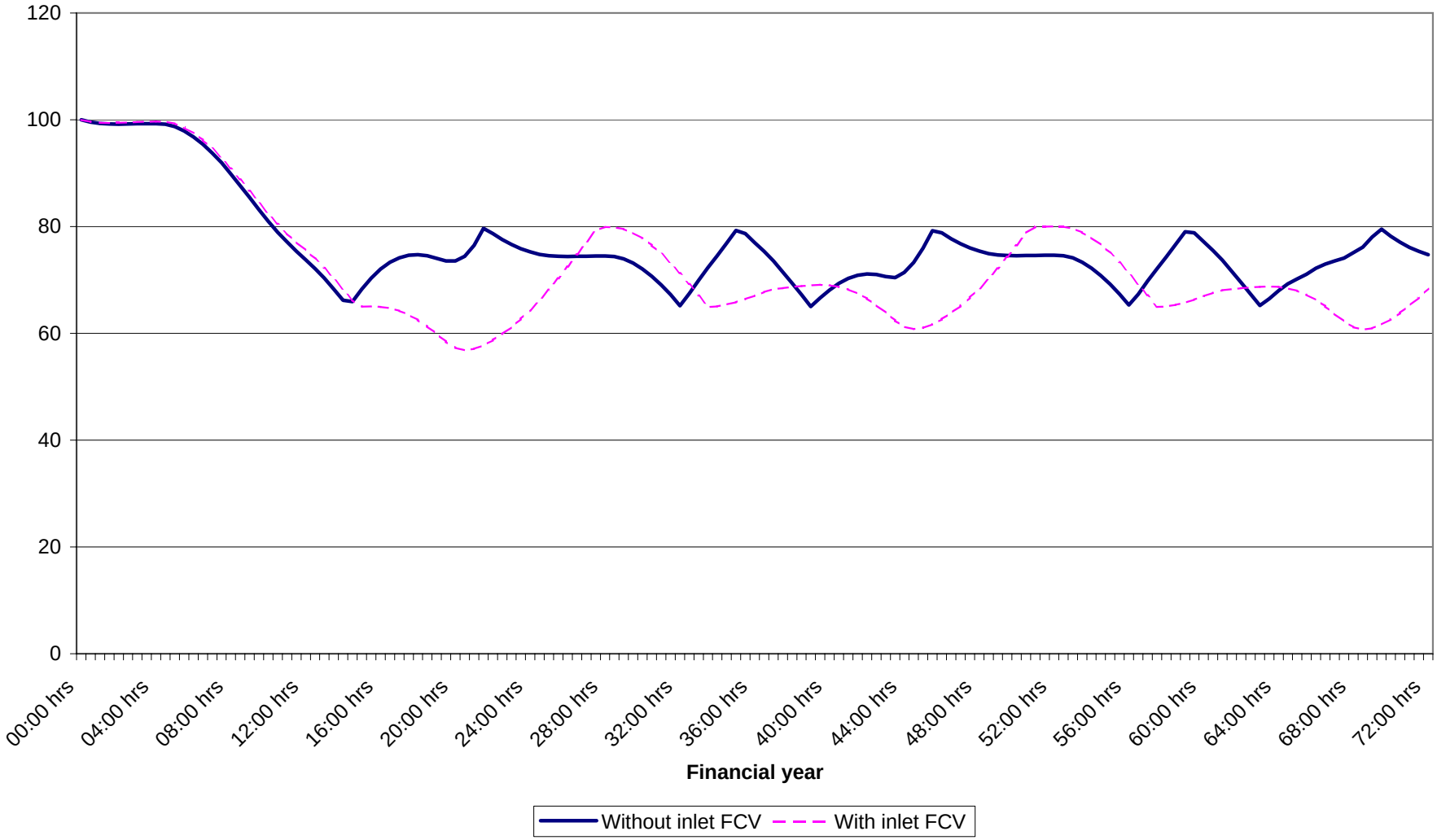

Water Treatment Plant
—Low Lift Pump Station
Flow (L/s)
250
200
150
100
50
0
00:00 hrs
06:00 hrs
12:00 hrs
18:00 hrs
24:00 hrs
30:00 hrs
36:00 hrs
42:00 hrs
48:00 hrs
54:00 hrs
60:00 hrs
66:00 hrs
72:00 hrs
Time (hrs)


Auckland Creek Pump Station
120
100
80
60
40
20
0
Flow (L/s)
00:00 hrs
06:00 hrs
12:00 hrs
18:00 hrs
24:00 hrs
30:00 hrs
36:00 hrs
42:00 hrs
48:00 hrs
54:00 hrs
60:00 hrs
66:00 hrs
72:00 hrs
Time (hrs)

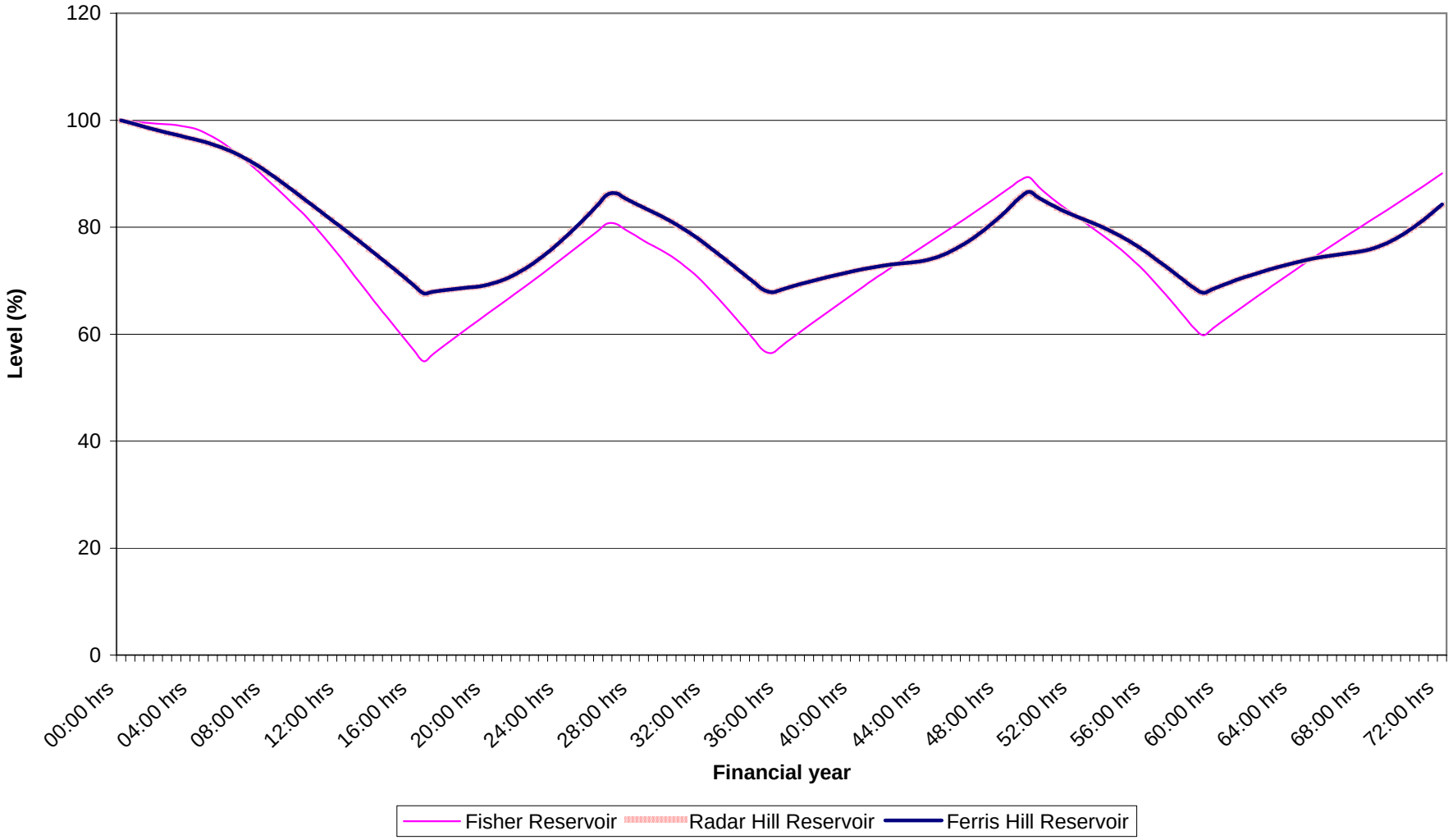
91.4 m Pressure Zone Reservoirs



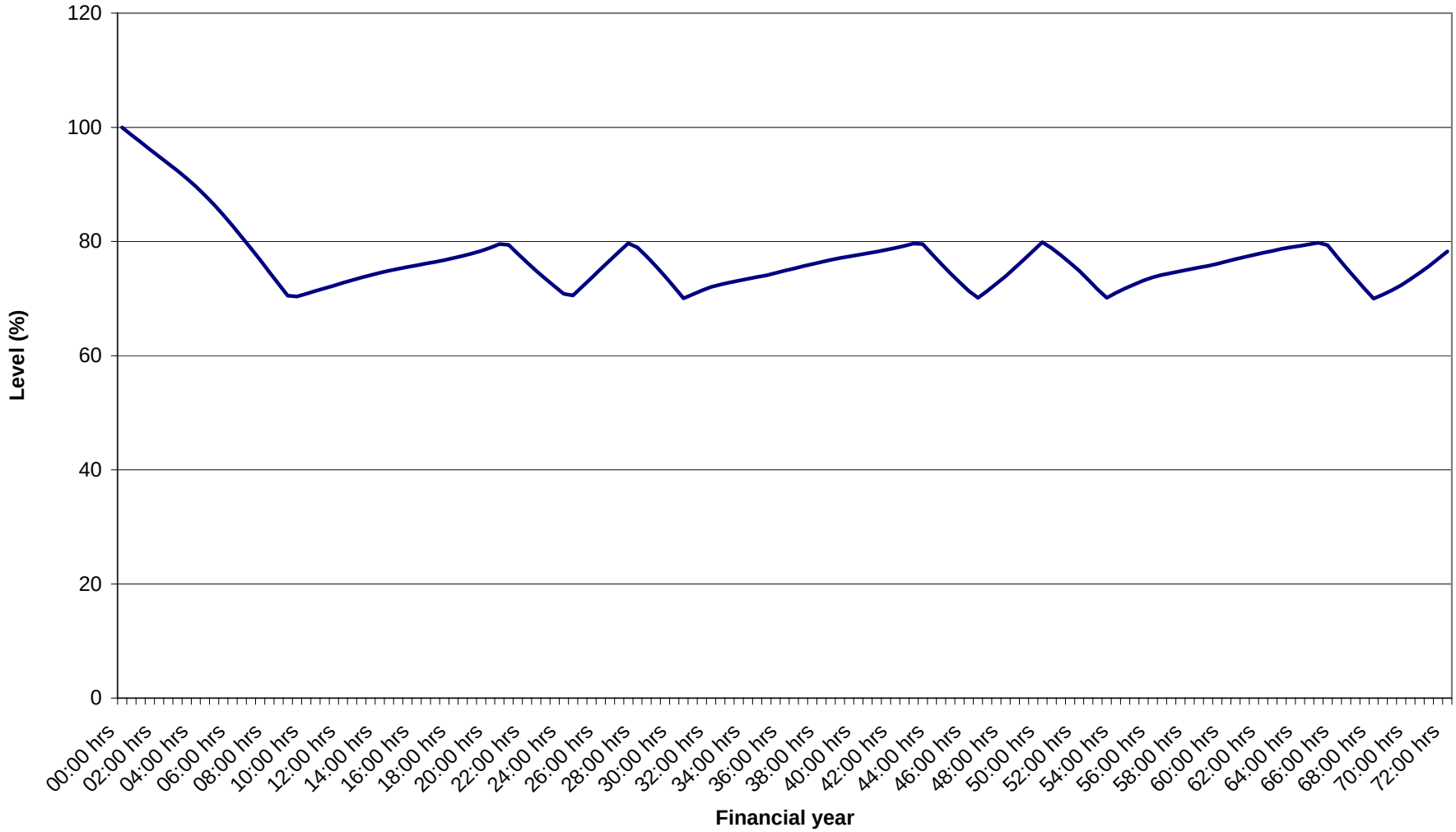
Paterson Street Reservoir 71.4 mAHD



61.3m Pressure Zone Reservoirs



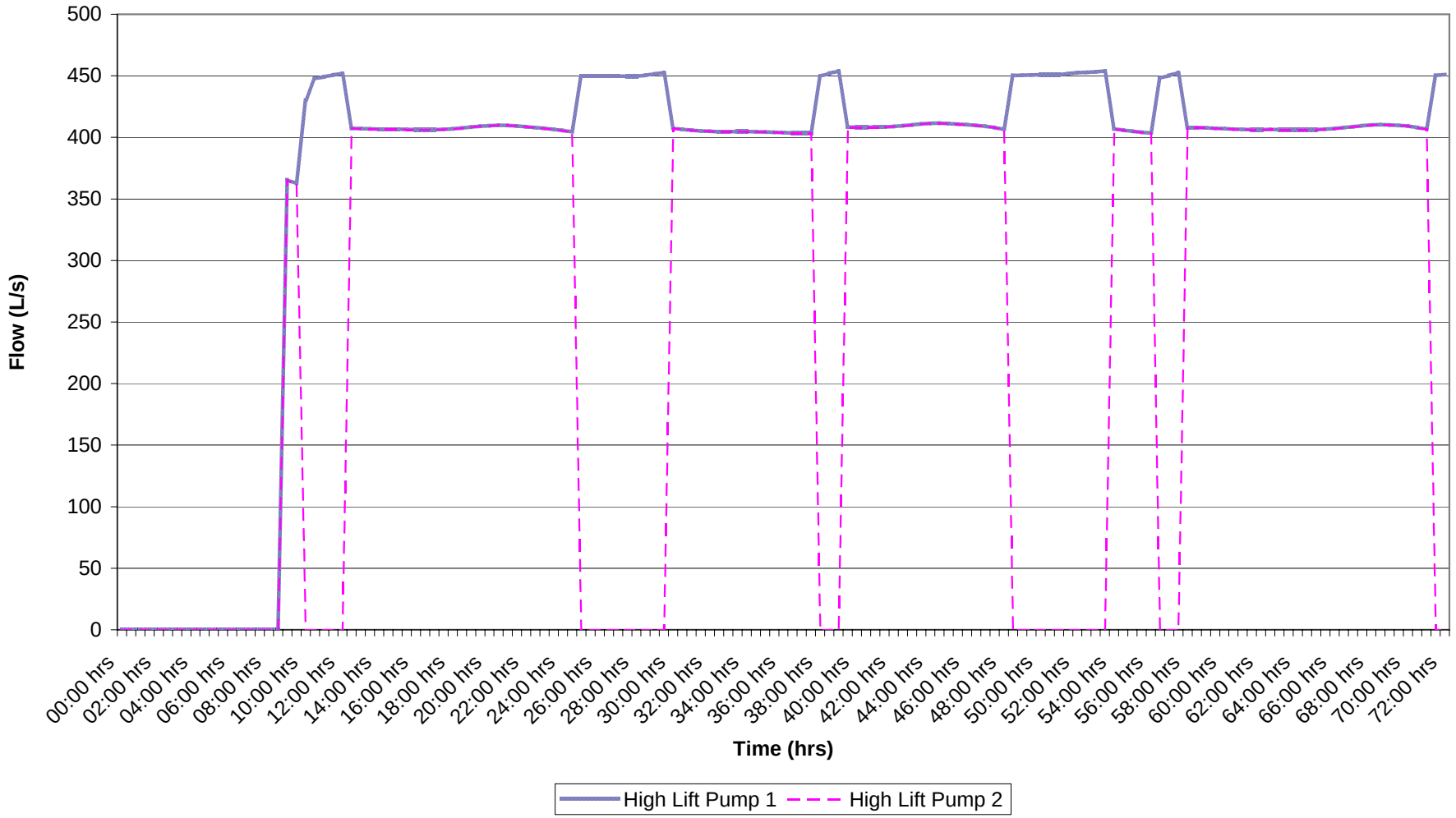
Clinton Industrial Reservoir 51.4 mAHD



Appendix D

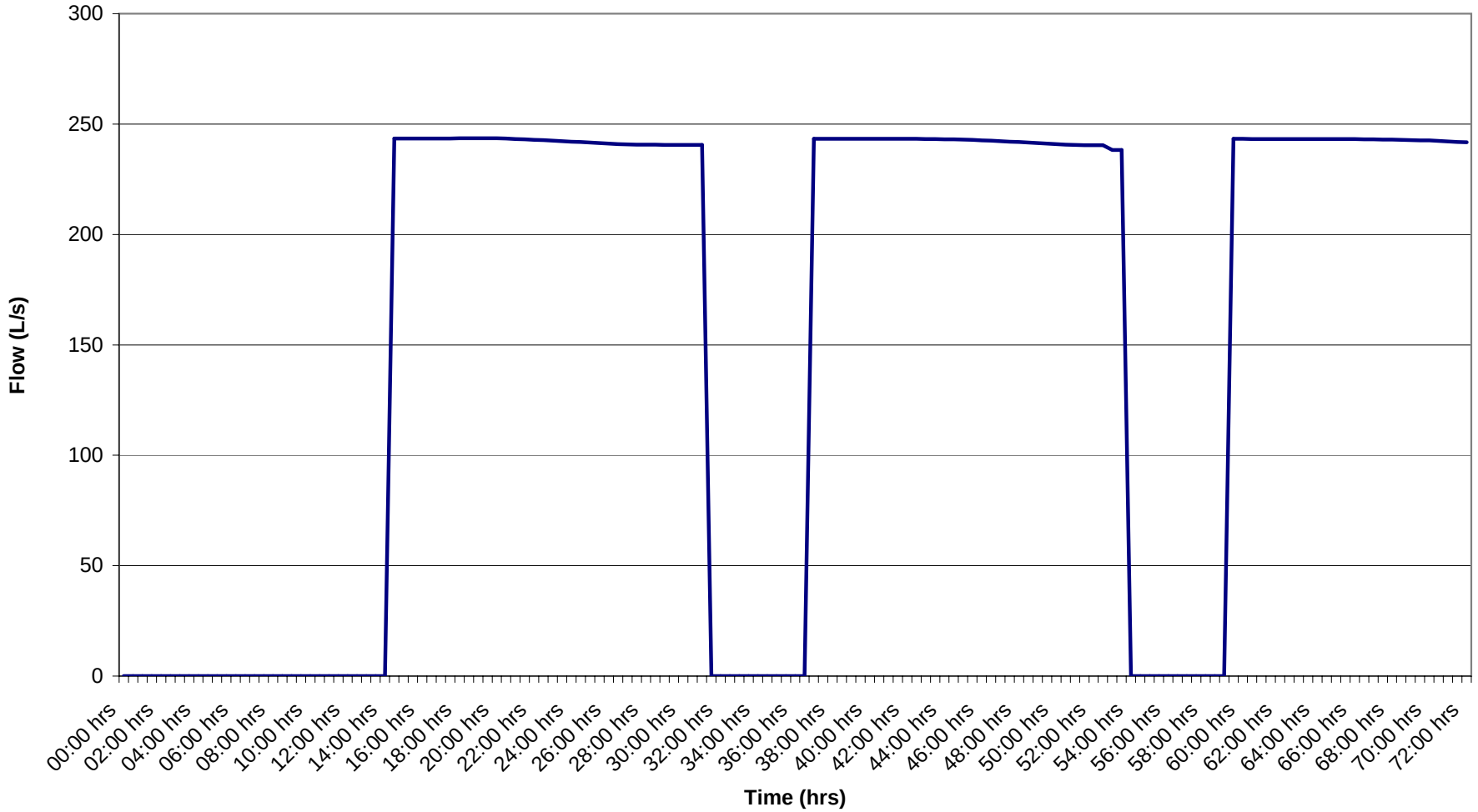
YEAR 2030 WATER NETWORK ANALYSIS RESULTS

Water Treatment Plant
—High Lift Pumps

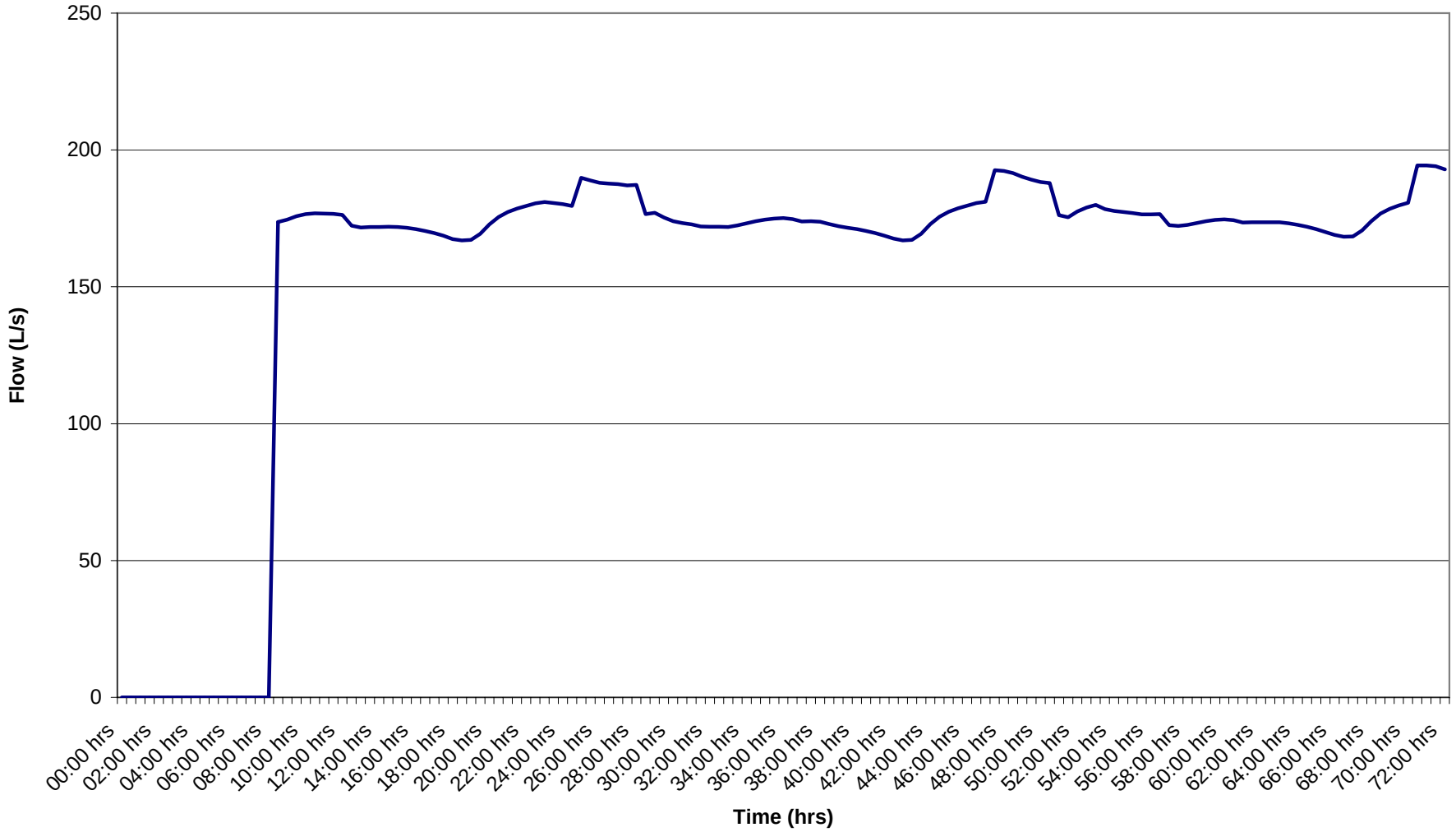


Yr 2030 Design simulation
Maximum hour results

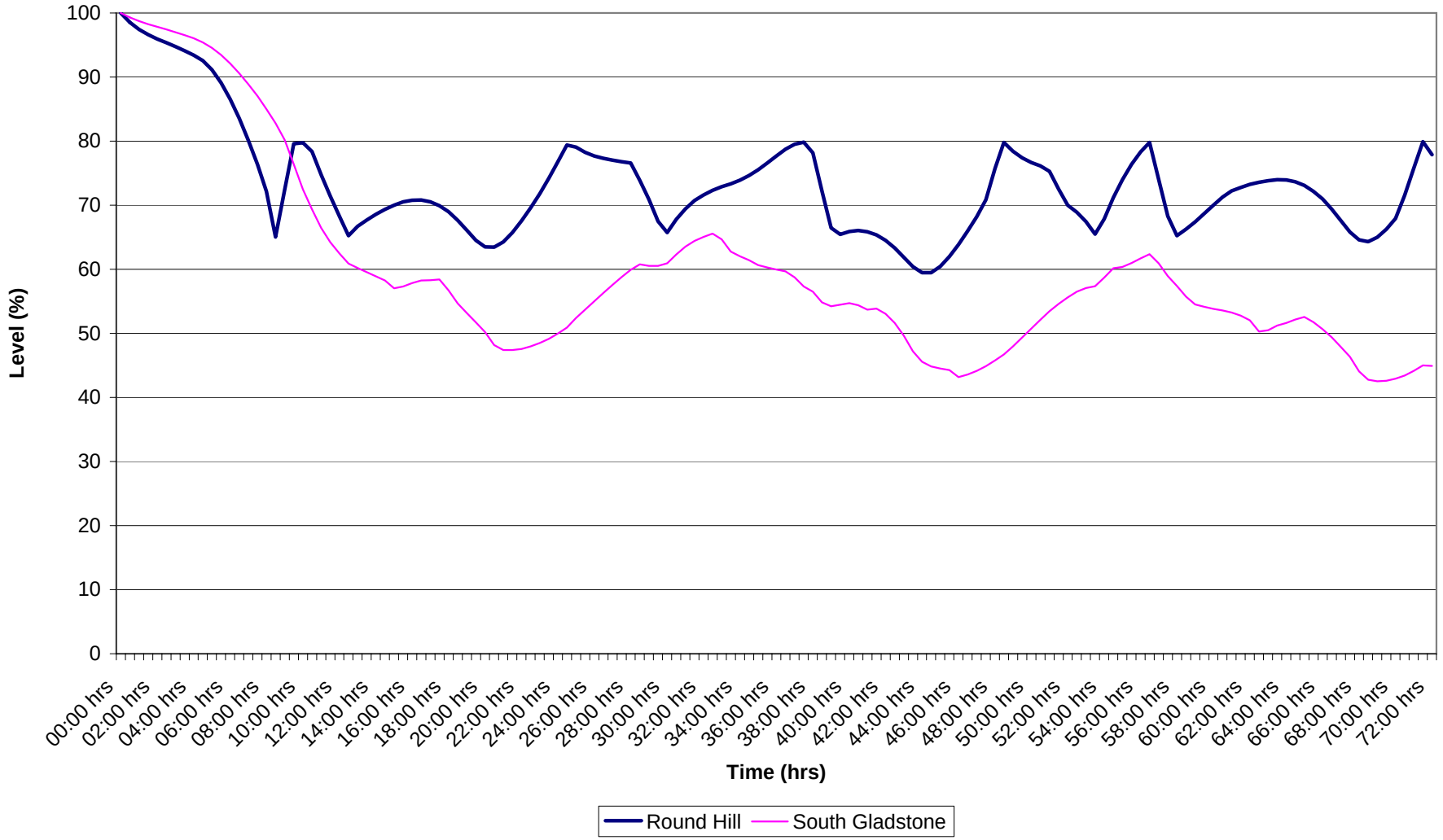
Water Treatment Plant
—Low Lift Pump 1



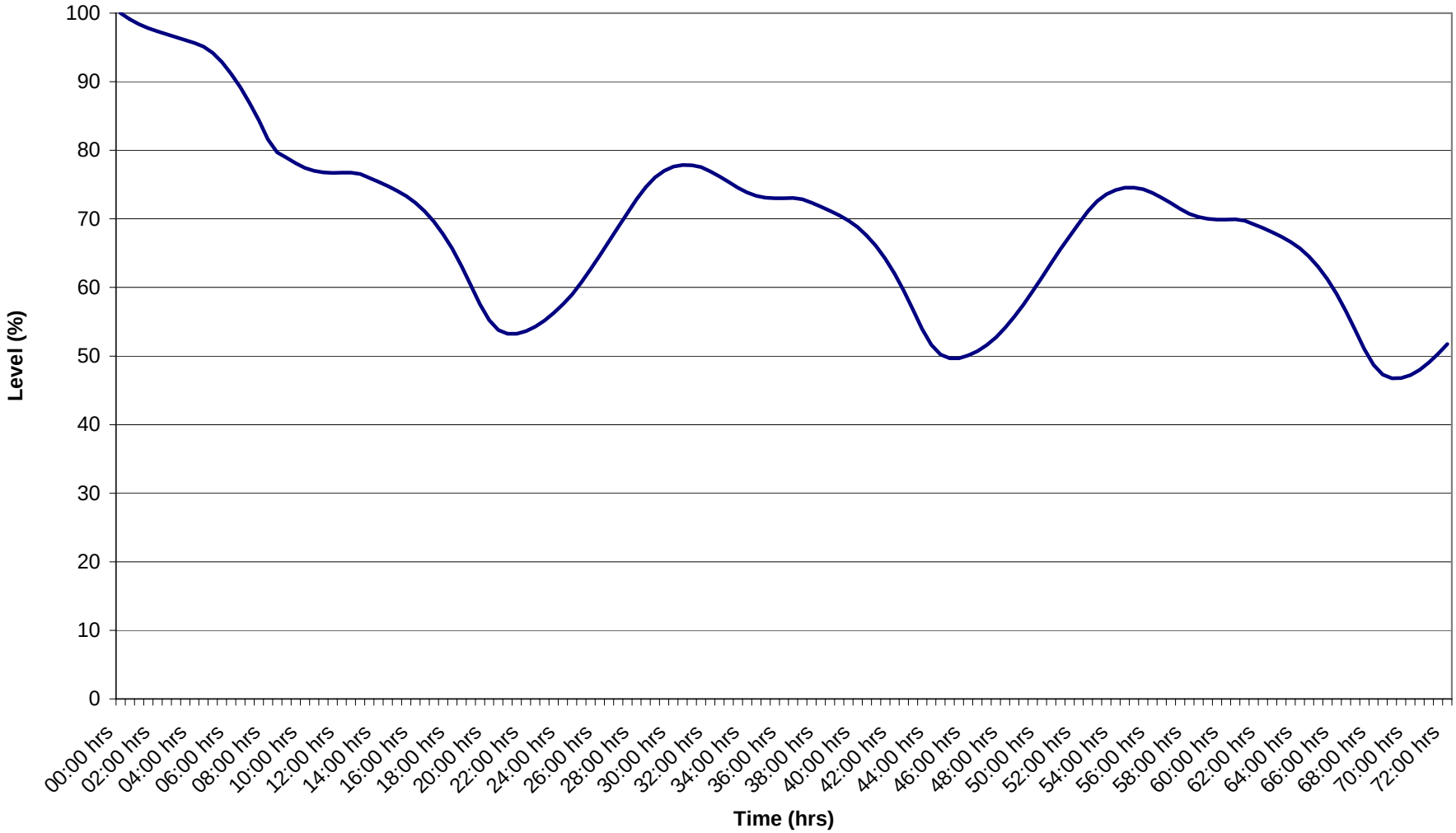
Auckland Creek Pump Station



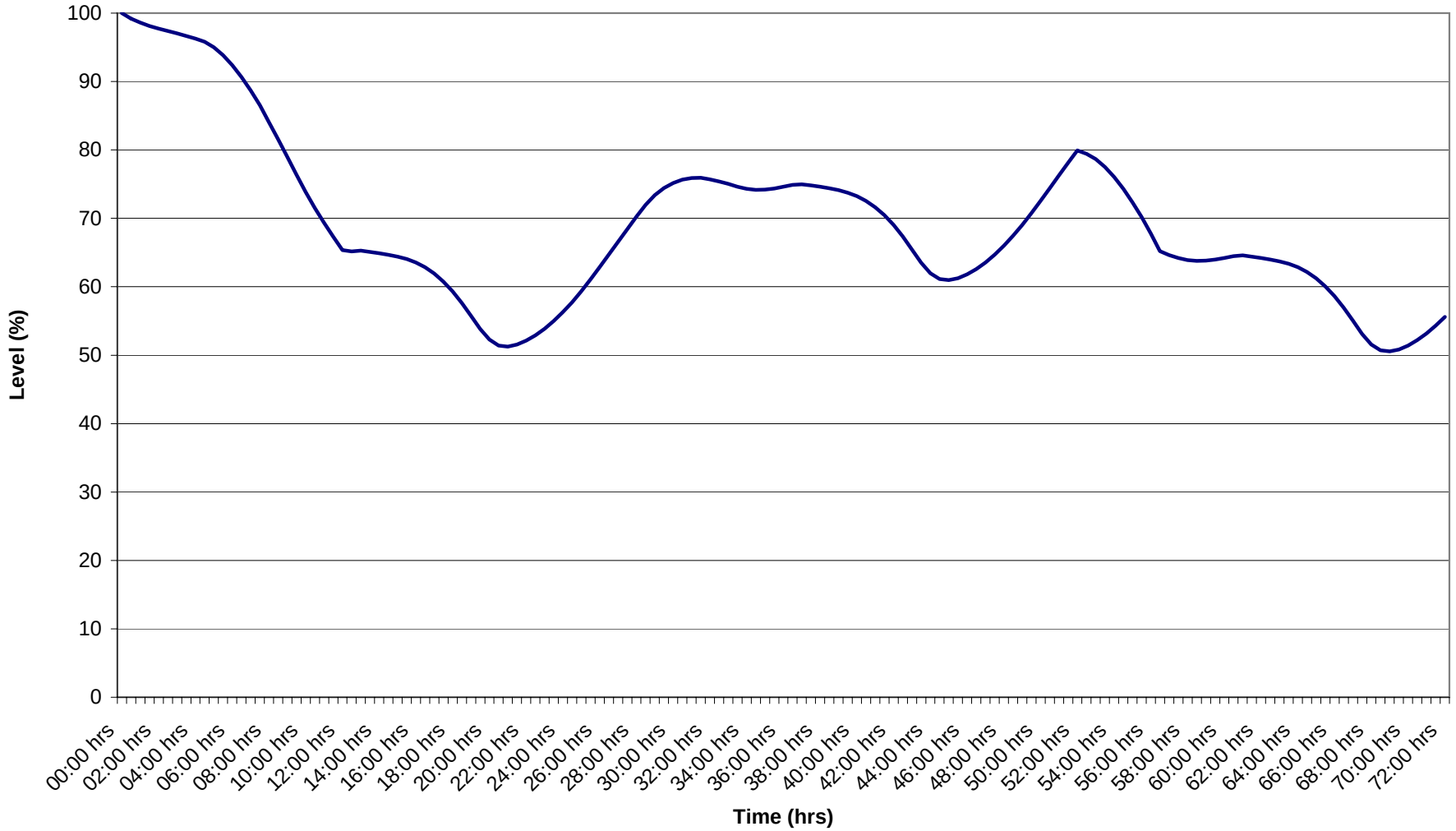
91.4 m Pressure Zone Reservoirs



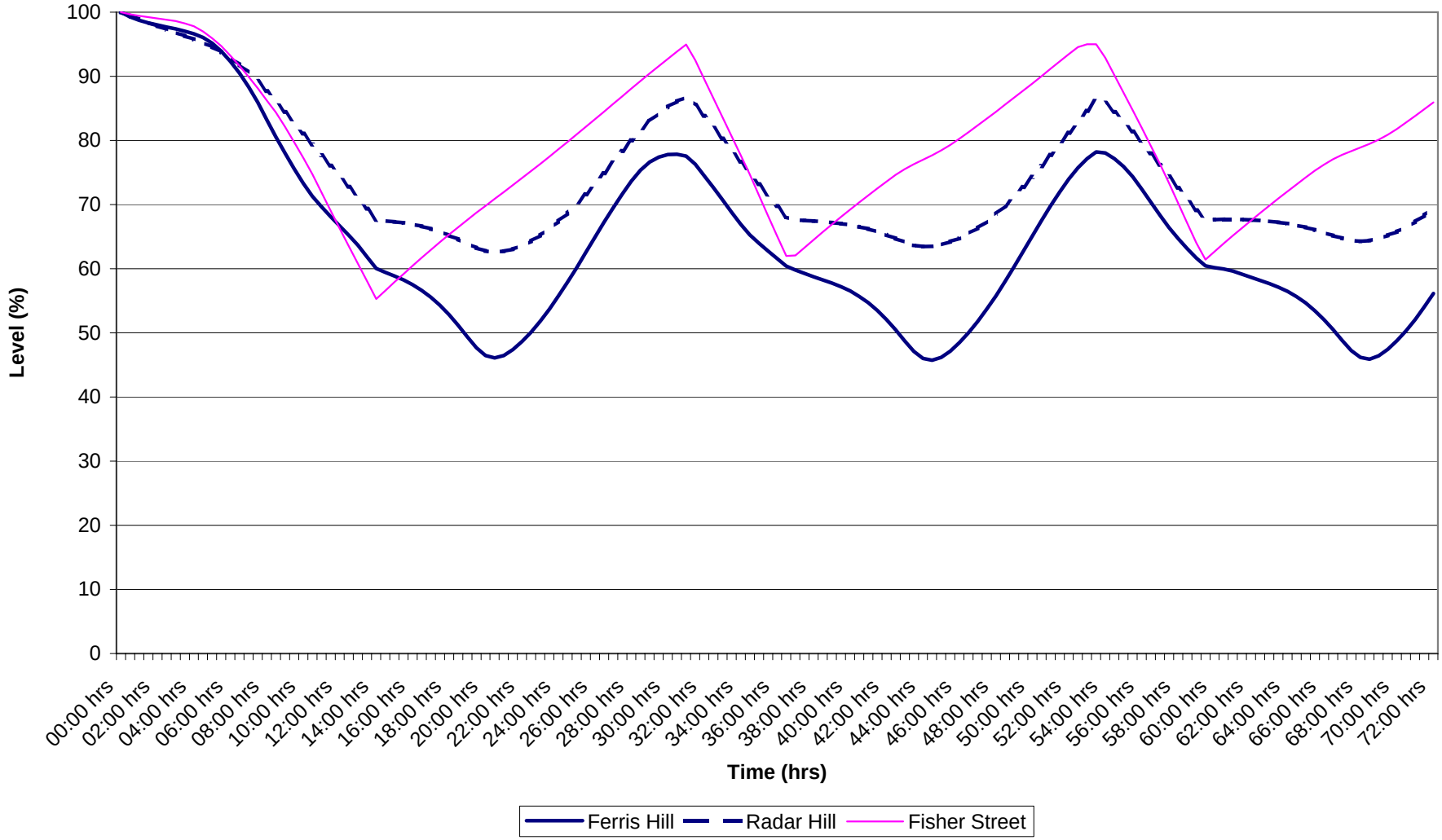
Clinton Park Reservoir 91.4 mAHD



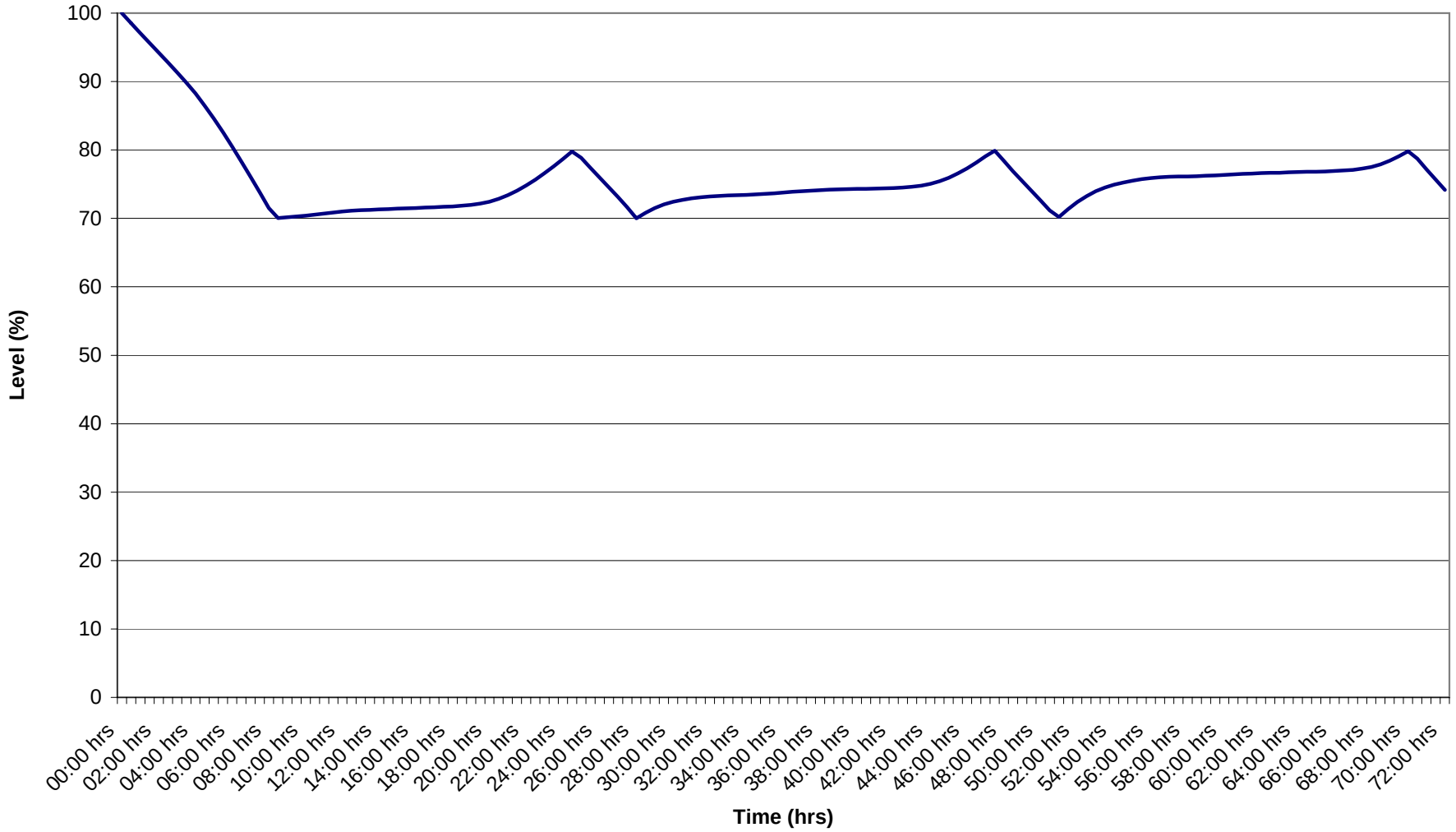
Paterson Street Reservoir 71.4 mAHD



61.3m Pressure Zone Reservoirs



Clinton Industrial Reservoir 51.4 mAHD



Appendix E

GLADSTONE CITY COUNCIL ADOPTED CONSUMPTION

The adopted consumption for the Gladstone City Council is as follows:

Table E.1 Average Day annual demand projections

Zone	Year 2004 Demand (ML/annum)	Year 2016 Demand (ML/annum)	Year 2030 Demand (ML/annum)
A	3,219	3,567	3,786
BC	1,002	990	986
D	3,718	4,515	4,515
Clinton Park Sub–zone	973	1,220	1,898
E		236	423
F	2,657	2,739	2,739
Total	**11,570**	**13,266**	**14,347**

Table E.2 Mean Day Maximum Month (MDMM) demand projections

Zone	Year 2004 Demand (ML/day)	Year 2016 Demand (ML/day)	Year 2030 Demand (ML/day)
A	9.9	11.2	12.1
BC	4.0	3.9	3.9
D	13.5	16.8	19.1
Clinton Park Sub–zone	4.0	5.0	7.8
E		1.0	1.7
F	7.3	7.5	7.9
Total	**38.7**	**45.4**	**52.6**

Table E.3 Maximum Day (MD) demand projections

Zone	Year 2004 Demand (ML/day)	Year 2016 Demand (ML/day)	Year 2030 Demand (ML/day)
A	11.0	12.7	13.9
BC	5.2	5.2	5.1
D	16.9	21.1	24.2
Clinton Park Sub–zone	5.3	6.7	6.7
E		1.3	2.3
F	7.3	7.5	7.9
Total	**45.8**	**54.5**	**60.1**

Table E.4 Maximum Hour (MH) demand projections

Zone	Year 2004 Demand (L/s)	Year 2016 Demand (L/s)	Year 2030 Demand (L/s)
A	252.7	245.0	272.8
BC	123.0	120.2	119.6
D	371.0	461.2	527.3
Clinton Park Sub–zone	123.2	154.6	239.0
E		29.9	53.7
F	88.4	90.9	96.1
Total	**958.3**	**1,102.0**	**1,308.5**