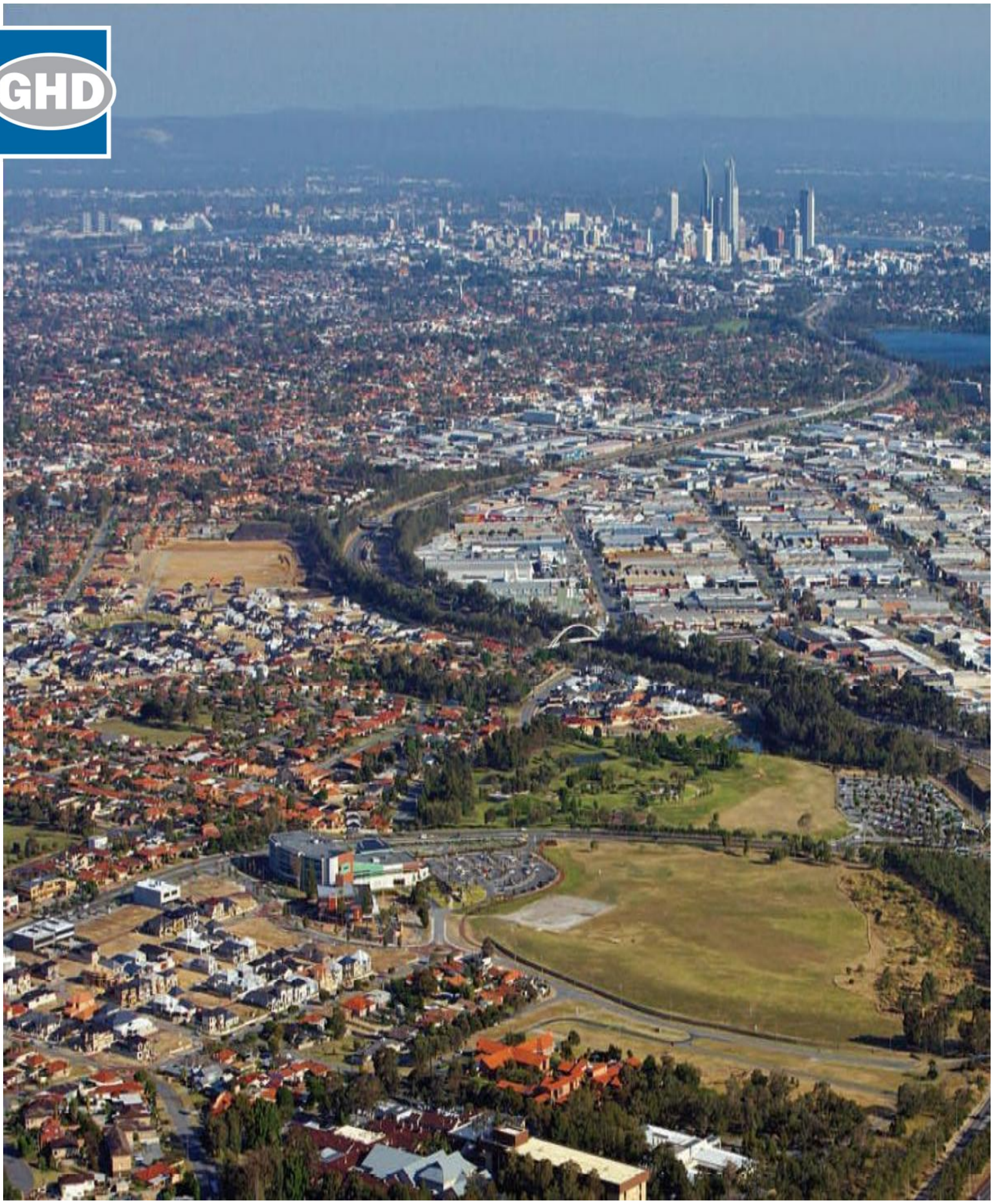


# Stirling Alliance

## Stirling City Centre

## Utilities Infrastructure Strategy

## Preferred Concept - Volume 2

December 2013

# Executive summary

*This Executive Summary is subject to, and must be read in conjunction with, the limitations set out in Section 1.6 and the assumptions and qualifications contained throughout the Report.*

## Background

Stirling City Centre (SCC) is a designated Strategic Metropolitan Centre under Directions 2031 and aims to create an active and diverse urban centre within the inner metropolitan area of Perth. The Centre will be a transit oriented development accommodating 25,000 residents and 30,000 workers.

GHD has been commissioned to develop a Utilities Infrastructure Strategy for the SCC to meet these aims.

Volume 1 of this report documents the strategy development for the entire Structure Plan area. This companion document (Volume 2) sets out how the strategy will be applied to Stage 1 of the Structure Plan area.

## Business as Usual Utility Service Provision

The Stirling Alliance has revised the estimated yields and the report is based on these. These latest yields are still estimates derived from the latest configuration of developable area and car parking limitation mechanisms. The key information is reproduced in the table below. Residential population figures are based on the assumption of 1.8 persons per dwelling, and Nett Lettable Area (NLA) is assumed to be 85.5% of gross floor area (GFA).

| | Dwellings | | Population | Office | Health / Welfare / Community | Retail | Entertainment / Recreation / Culture | Total Non-residential | Total |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Floor Space (m2 NLA) | | | | | | | |
| | Stage 1 Development | | | | | | | | |
| Distributed services | | | | | | | | | |
| Central Zone | 900 | 72,000 | 1,620 | 69,231 | 2,769 | 18,605 | 1,395 | 92,000 | 164,000 |
| Western zone | 1,000 | 83,500 | 1,800 | 12,064 | 1,826 | 105,477 | 6,633 | 126,000 | 209,500 |
| Stage 1 - Totals | 1,900 | 155,500 | 3,420 | 81,295 | 4,595 | 124,081 | 8,029 | 218,000 | 373,500 |

### Power

The existing Western Power substation at Osborne Park is part of the Northern Terminal Load Area. The substation is served by 3 no. 132kV overhead transmission lines. The current load supplied by the substation is 65 MVA. According to Western Power's Network Capacity Mapping Tool at the time of writing, the residual capacity of the substation is ≤ 10 MVA. High voltage distribution feeders emanating from the substation currently service surrounding buildings.

The development of the SCC will add significant additional demand to the local power grid. Peak loads from Stage 1 conventional development are depicted below.

| Land Use | Peak Electrical Demand | Total Peak Demand |
|---|---|---|
| | (VA/m2) | (MVA) |
| Residential | 13 | 2.0 |
| Office | 51 | 4.1 |
| Retail | 67 | 8.3 |
| Entertainment and Community | 43 | 0.5 |
| Peak Demand on Grid | | 15.0 |

The annual electricity demand arising from this approach (Business as Usual) would be approximately 73 GWh per annum.

The power infrastructure upgrades originally quoted by Western Power include:

- expansion of the existing Osborne Park substation with two additional 66MVA transformers by 2017/18;
- installation of an additional 66MVA transformer within Osborne Park by 2028/29;
- two 66MVA transformers will be required to supplement the existing Osborne Park substation by 2055/56; and
- approximately 20 new distribution feeders over time.

The load from the SCC Stage 1 is now only a small proportion of the Western Power estimate. However for the purposes of this report it has been assumed that these upgrades will still be required on a similar timetable, although only a portion of the costs would accrue to the SCC.

Based on this assumption, a new substation site to house all the expansions set out above would be needed by 2017/18. The location of the new substation has not been determined, but is likely to be sited on industrial land in the area.

The application of 5 star building efficiency measures could significantly reduce the peak load.

| Land Use | % Reduction | Peak Electrical Demand | Total Peak Demand |
|---|---|---|---|
| | | (VA/m2) | (MVA) |
| Residential (5 Star NABERS) | 45% | 7 | 1.1 |
| Office (5 Star NABERS) | 27% | 38 | 3.1 |
| Retail (5 Star NABERS) | 63% | 25 | 3.1 |
| Entertainment and Community (5 Star NABERS) | 83% | 7 | 0.1 |
| Peak Demand on Grid | | | 7.4 |

### Gas

A comprehensive medium, and medium / low pressure system currently services the site, with service pressure between 15 and 70kPa. The major pipes are located along Karrinyup Road, Odin Street, Hertha Road, Ellen Stirling Boulevard, Oswald Street, Scarborough Beach Road, King Edward Road, and Cedric Street.

The closest high pressure gas main is located west on Northstead Street, approximately 2.5km away from the western boundary of the site. Additional high pressure gas mains are located in Balcatta Road and Dumfries Road; both located approximately 3.5km north and south of the site respectively.

Based on information provided to ATCO Gas about the proposed yield, they have estimated that the gas demand for BaU development for Stage 1 will be 76,000 GJ per annum.

### Water

The SCC spans three water supply zones, these being:

- West Yokine – Hamersley in the north;
- Bold Park in the west; and
- Mount Hawthorn in the east.

An extensive water distribution main system surrounds the boundary of the proposed development.

The reticulation networks currently source water from various mains, and no single main dominates the servicing to the current site. The 150mm reticulation mains are primarily found in the south east industrial portion of the site, which sources water from the main in Scarborough Beach Road.

The Stage 1 development will increase the water demand on the system by approximately 0.54 GL pa. The Water Corporation are planning to construct a new 600mm diameter steel main pipe line from the existing pipeline located at the junction of Karrinyup Road and Cedric Street. This pipe is to extend south down Cedric Street. It is then to continue south, under the freeway, ending on the east side of Flax Way. A 400mm diameter and 300mm diameter steel branch is to extend off the proposed 600mm pipe. It has been assumed these upgrades will be necessary for Stage 1.

The adoption of "waterwise" measures for the SCC Stage 1 would reduce the required quantity of water significantly as shown in the table below.

| **Totals** (ML/year) | Waterwise demand | | Conventional demand |
|---|---|---|---|
| Ttl Drinking water | 202 | | 276 |
| Total NDW | 184 | | 262 |
| **Total** | **386** | | **538** |

### Wastewater

The SCC area spans the catchments of several Water Corporation wastewater pump stations, which are ultimately serviced by two wastewater treatment plants (WWTP). Flows from the southern portion of the area (generally the area south of Scarborough Beach Road) are pumped to the Perth Main Sewer, which gravitates wastewater to the Subiaco WWTP. The majority of the site pumps into the Hamersley Main Sewer, which gravitates wastewater to the Beenyup WWTP. Each existing catchment zone (with one exception) gravitates to a downstream pump station.

Business as usual wastewater flows are estimated at 465 ML pa, reducing to 330 ML pa for waterwise development.

The required wastewater infrastructure required to meet this demand has been based on an initial Water Corporation study, subsequently updated to reflect the yield analysis for Stirling. The assessments are preliminary only, and cannot be taken to be definitive at this stage.

The full SCC development will have a significant impact on long term flows. Flows associated with pump stations that are within the catchment of the Beenyup WWTP are significantly greater than those assumed in current long term wastewater conveyance planning.

The Water Corporation has presented two options that may be implemented to upgrade the wastewater headworks to accommodate for the projected yield. Both options have been projected to have similar cost implications for the project. For the purposes of this report and in respect of servicing the Stage 1 development it has been assumed that the following upgrades will be required:

- upgrade of the gravity line between the Twyford Place Pump Station (PS10) and the Sheldrake Street Pump Station (PS2) from 300mm / 450mm diameter pipes to 600mm / 750mm diameter pipes; and
- upgrade of the Sheldrake Street Pump Station (PS2), increasing its pump rate to approximately 245 L/s (its eventual required capacity under full development).

It has been assumed that for Stage 1 the Main Sewer itself will not require upgrading.

### Drainage

The current site is serviced by underground reinforced concrete pit and pipe systems that accommodate minor storm events, and an overland flow path governed by the road reserves that manage the major storm events, which eventually flow into the main drain.

The current site drains into the Water Corporation owned 5m wide open channel / reinforced concrete pipe main drain which is proposed to be converted to an urban stream as part of the SCC development. This main drain runs from the north east to the south west of the development. The majority of the site utilises this main drain, with the exception of a small northern portion of the site which will drain into smaller basins located north in the Birralee Reserve and Yuluma Park.

All new road reserves will require a pit and pipe system to keep stormwater off the road pavement during medium frequency events.

### Telecommunications

Telstra and Optus 3G wireless coverage currently exists throughout the Precinct with typical speeds being between 1.1Mbps and 20Mbps. 4G coverage in the Precinct is very limited at present. However, optical fibre has significant speed and capacity advantages over both mobile and copper services. Therefore the roll-out of the NBN within the SCC over the next 3 years, will significantly benefit most businesses and residents if they opt for fibre.

Services currently are being provided via satellite within the precinct (e.g. Foxtel) will remain. Over the next 3 years it is expected that Foxtel will migrate to the NBN infrastructure. These services will then be provided by NBN Co.

### Waste

The City of Stirling operates a single bin system for domestic waste collection. Council’s Balcatta Transfer Station (6 km from the SCC) is a large but simple facility and is currently operating at full capacity. Council has a contractor that separates organic material and recyclables using simple waste separation technology; trommels, magnets, eddy current and screens. The organic material is composted by the contractor Atlas on its farm outside Perth.

Residual waste is disposed of at the Anaeco DiCOM AWT facility commissioned by the Western Regional Metropolitan Council (WMRC). This facility has a capacity of 55,000 tonnes per year of which Stirling provides 22,000 tonnes. Any overflow is disposed of at the Red Hill Landfill, operated by the Eastern Regional Metropolitan Council (EMRC).

GHD has modelled waste generation rates in the proposed SCC Development area and for the City of Stirling as a whole. GHD estimates that for the Stage 1 ultimate development, about 11,270 tonnes of waste will be generated from the SCC area.

If the SCC development went ahead without any changes to the waste collection and processing system, Council would continue to collect kerbside waste from residential dwellings. Council, and other commercial contractors, would also continue to collect waste from businesses, offices and other commercial premises in the SCC area. The greatest effect of this will be more collection vehicle movements.

## Best Available Technology Servicing Solution

Graphics depicting the proposed concept alternatives are set out in the attached figures.

As described in Volume 1 of this report it is proposed to service the mixed use areas of the project through distributed thermal energy and non-drinking services (referred to in the following as the distributed services zone).

## Energy

### *Energy Efficiency*

Energy efficient building design is a core requirement of the BAT strategy. It is assumed that this will be accompanied by best practice measures in respect of occupant behaviour, including the use of smart grid / meter technology to provide feedback on energy consumption and comparisons with other consumers at a local and metropolitan wide basis. Energy efficient building design will need to be mandated within the planning approval process.

Two options for energy supply are proposed for further consideration.

### *Trigeneration / Solar PV*

In the first scenario, a trigeneration scheme will produce electricity generated through a gas engines. The feedstock will be natural gas. The electricity supply from trigeneration will be supplemented with solar photovoltaics (PV) and associated electrical storage.

Under this scenario, heat produced from the gas engines will provide a thermal energy source for circulation to the SCC buildings via a district hot water loop. This heat will be used for space heating and water heating. Co-located absorption and electric chillers will utilise the heat to produce cold water, which will similarly be circulated through a district cold water loop. Chilled water storage will supplement the system.

### *Geothermal / Solar PV*

Under the second scenario, electricity will be supplied entirely from grid connected rooftop solar. Sufficient roof space is available both within the development area (Innaloo shopping centre, Ikea and new developments) and in the adjacent Osborne Park light industrial area. A total of approximately 75,000m2 would be required to meet the peak electrical load of the Stage 1.

In this scenario the thermal heat source will be derived from geothermal energy. Based on interpretation from the Geothermal Centre of Excellence at the University of WA, this would require a geothermal bore depth of 1,500 - 3,000m for the source to be sufficient to provide the necessary energy to drive the absorption chillers to meet the cooling load.

Under both scenarios biogas will be produced from anaerobic digestion of the organic fraction of the waste stream and used as feedstock for gas engines as a supplement to the electricity produced through trigeneration and / or solar PV.

## Water

### *Water Efficiency*

It is assumed and recommended that best practice water efficiency practices will be mandated in the development, including appliances meeting the highest available Water Efficiency Labelling Standards (WELS), and for irrigation. This will be complemented with measures in respect of occupant behaviour, including the use of smart water meter technology to provide feedback on energy consumption and comparisons with other consumers at a local and metropolitan wide basis.

### *Water and Wastewater*

Various alternative water supply options were evaluated; including roof collected rainwater, stormwater, groundwater and recycled wastewater. It was determined that only recycled wastewater was available in sufficient quantities to be a complete solution.

The preferred scenario is therefore to recycle all wastewater and return this as a non-drinking water source for irrigation, toilet flushing and cold water for clothes washing. These uses are likely to be acceptable to the Department of Health, subject to appropriate risk management.

The demand analysis shows that there is sufficient recycled water to meet the total non-drinking water demand in summer, while in winter when the irrigation demand is small / negligible, there is a significant excess of recycled water. This high quality excess water will be locally discharged to the superficial aquifer and hence contribute to offsetting other abstraction in the area (from irrigation of public open space) and retaining groundwater levels.

It is proposed that scheme water provided by the Water Corporation through the Integrated Water Supply Scheme (IWSS) is used for all other uses (i.e. those requiring drinking water quality).

### Drainage

The draft District Water Management Strategy requires best practice water sensitive urban design (WSUD) features for the development. Where possible, all stormwater from frequent events will be collected / treated on lots, and street drainage will incorporate rain gardens, swales and other management devices. Less frequent, higher rainfall events will utilise the street drainage system to convey water through the existing stormwater system. Stormwater within the relevant catchment will be discharged into the urban stream corridor where it will be naturally treated and conveyed into the steam channel.

Design of the streetscape WSUD features and of the urban stream are the subject of separate commissions, and are accordingly described elsewhere.

### Waste

It is proposed that mixed bagged waste (including all recyclables) from multi-unit dwellings in the more densely populated areas, and commercial premises will be connected to a vacuum waste collection system. Waste placed in the vacuum system will be transported through the system's pipes to a central terminal in the SCC area. From here it will be collected by Council or a contractor, and taken by road to a Central Waste Processing Facility (CWPF). At the CWPF materials recovery facilities will separate recyclables, organics and high calorific value materials (plastics etc.) from other wastes.

Recyclables will be processed through existing markets. The organic fraction will be feedstock to an anaerobic digester which will produce biogas and a solid digestate suitable for use as a soil conditioner.

High calorific value materials will be separated and could be gasified offsite by others to produce a syngas, which will be the feedstock for electrical production.

### Telecommunications

The NBN rollout at Stirling offers the opportunity to utilise smart meter enabled technology. This will facilitate the use of smart meters for electricity and water, which will be used as part of a consumer behaviour program by providing feedback to building occupants on energy and water use.

Smart meters will be essential in establishing a smart grid network within Stirling. Smart grids involve the installation of smart distribution networks, smart infrastructure such as car charging stations and software for sophisticated control energy management; network shut downs, network stability and network reliability.

### Implementation

Identifying an implementation strategy for delivery of the preferred concept is beyond the scope of this study. A detailed discussion of the options for implementation and governance are set out in Section 6 of Volume 1 of this report. These include:

- Separate implementation of each component through existing agencies, i.e. electricity (Western Power, Synergy / other retailers and generators), gas (ATCO and Alinta), water (Water Corporation) and waste (City of Stirling);
- Separate implementation of each component through involvement of the private sector (electricity generation / retail, recycled water, waste-to-energy); and
- A new utility formed specifically to provide services at SCC which would provide integrated energy, water and waste services.

### Performance

The sustainability performance of the options is discussed in detail in Volume 1 of this report.

The trigeneration option involves the use of fossil fuels (natural gas) as a feedstock. As the use of fossil fuels will be constrained during the life of this infrastructure due to climate change and / or depletion, this option does not offer the same sustainability performance or risk profile of the geothermal option which is potentially an inexhaustible non-polluting form of energy.

### Land

A preliminary estimate has been made of the required land for the required facilities under the BAT options in Stage 1. Assumptions are:

- waste facilities at existing Balcatta site (approx. 2.2 ha);
- trigeneration plants to be distributed across Stage 1 development (2no. by 1600m2);
- recycled water plant needs to be as central as possible but assumed to be in the Osborne Park Industrial Area (0.95ha); and
- a second sub-station site of 0.35 ha, probably located adjacent to or in the nearby industrial area.

## Costs

Approximate all-encompassing costs have been determined for the provision of infrastructure under the BaU and BAT options considered in the report. Costs have been estimated from a large number of sources, and the assumptions embedded in the external sources cannot be fully determined in every case. For those costs built up by GHD, a contingency of 30% has been added to direct costs, and a further 15% added to cover preliminaries.

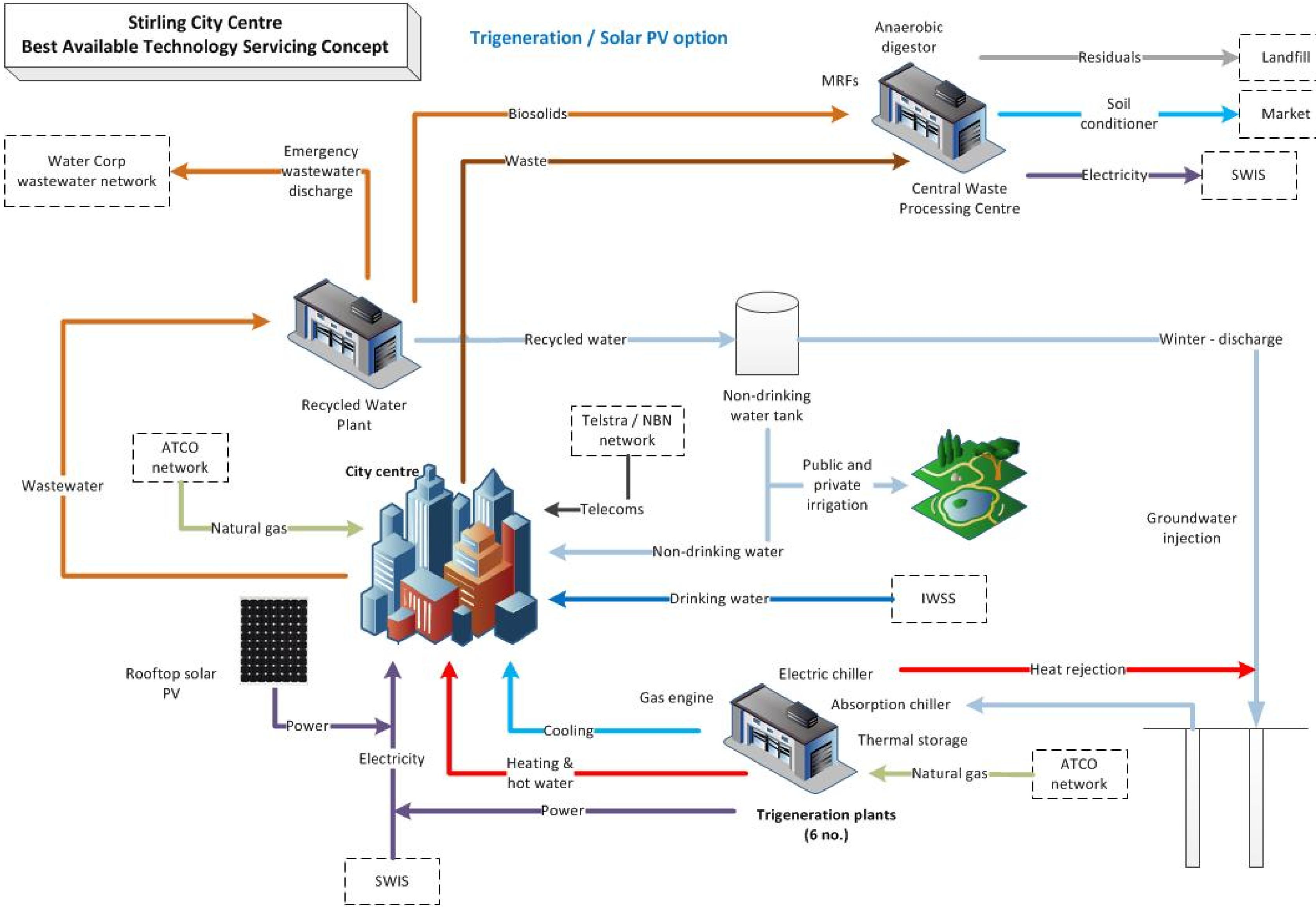
Capital and estimated operating costs are presented here for BaU and BAT options in 2013 dollar terms (million). This information does not readily facilitate a life cycle cost comparison between the options as the timing of capital and operating spend is different for the options. In particular the BaU option involves costs which are difficult to forecast, including the future mix of generation on the SWIS, fuel costs and carbon costs.

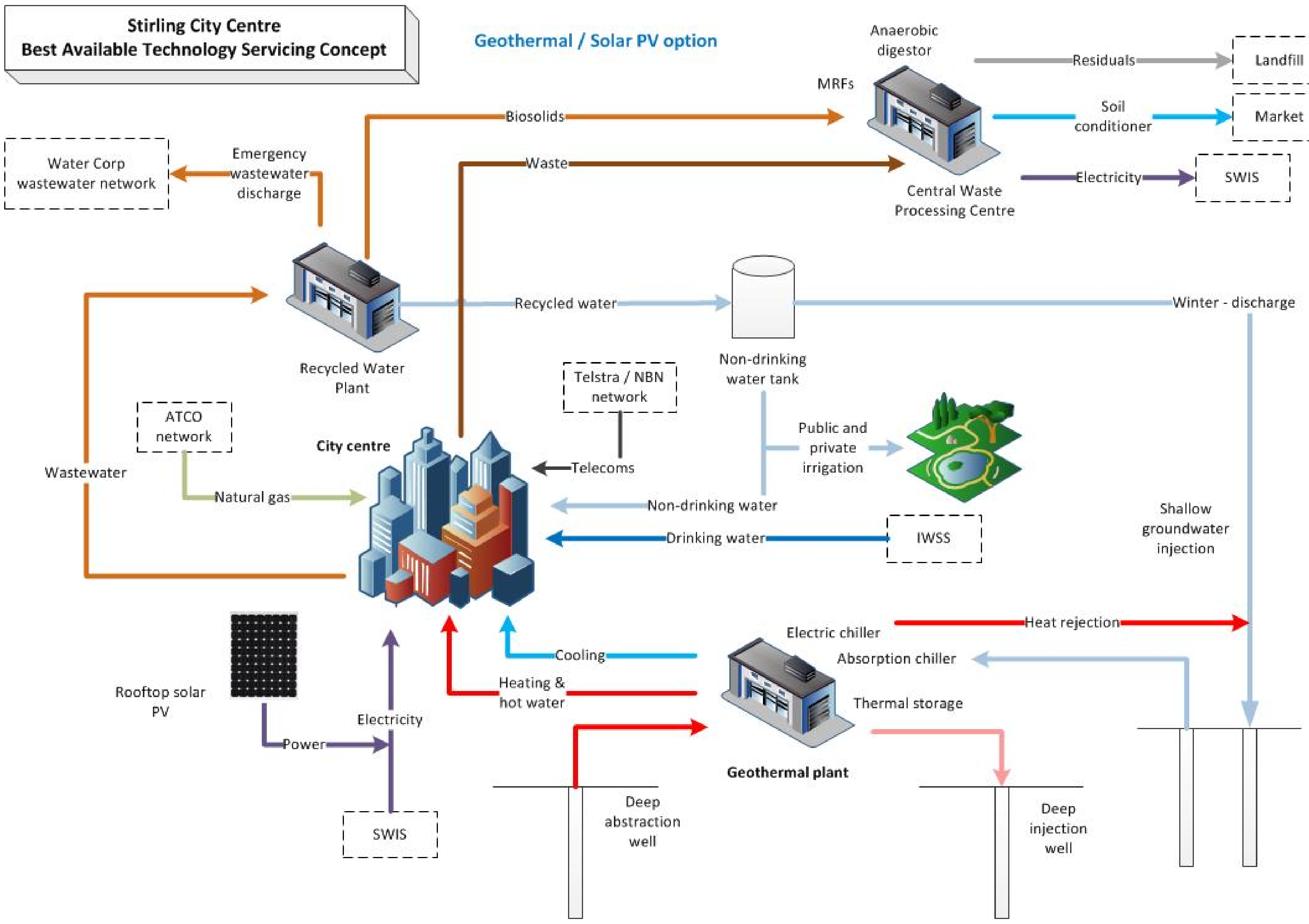
### Summary of Costs

| | | BaU | | Trigen / Solar | | Solar / Geothermal | |
|---|---|---|---|---|---|---|---|
| | | Capex | Opex | Capex | Opex | Capex | Opex |
| Water | | | | | | | |
| | Potable (1) | 10.700 | 1.111 | 9.200 | 0.350 | 9.200 | 0.350 |
| | Wastewater | 21.444 | 0.093 | 8.745 | - | 8.745 | - |
| | Drainage | 2.500 | | 2.500 | | 2.500 | |
| | Non-drinking water | | | 21.200 | 0.508 | 21.200 | 0.508 |
| | | 34.644 | | 41.645 | | 41.645 | |
| Energy | | | | | | | |
| | Electricity | 16.688 | 0.434 | 11.968 | 0.270 | 11.968 | 0.270 |
| | SWIS generation | 31.000 | 17.300 | | | | |
| | Local Generation | | | 28.354 | 0.627 | 23.405 | 0.419 |
| | Thermal Network | | | 33.223 | 1.164 | 63.123 | 1.914 |
| | Gas | 1.803 | 1.003 | 1.803 | 5.433 | 1.803 | 1.003 |
| | | 49.471 | | 75.348 | | 104.909 | |
| Waste | | - | 2.100 | 98.750 | 13.857 | 98.750 | 13.857 |
| Telecoms | | 3.900 | 0.098 | 3.900 | 0.098 | 3.900 | 0.098 |
| | **Ttl infrastructure** | **88.015** | | **219.643** | | **249.204** | |
| Building costs | | 50.400 | 1.260 | 13.500 | - | 13.500 | - |
| | **Total** | **138.415** | | **233.143** | | **262.704** | |

(1) The Opex figures represent annualised costs for IWSS upgrades based on the current long run marginal cost (LRMC) of water determined by the Water Corporation and agreed with the Economic Regulatory Authority. This per kL figure incorporates both capital and operating costs.

These figures show significantly higher capital costs for the BAT infrastructure options, reflecting the initial cost of establishing the local energy, water and waste technologies. Therefore, an assessment of the financial impacts of the above solutions should also consider the lifecycle costs associated with each solution. A discounted cash flow of costs for the whole development is included in Volume 1 of this report.


Stirling City Centre
Best Available Technology Servicing Concept
Trigeneration / Solar PV option
Anaerobic digestor
MRFs
Residuals
Landfill
Soil conditioner
Market
Electricity
SWIS
Central Waste Processing Centre
Biosolids
Waste
Water Corp wastewater network
Emergency wastewater discharge
Recycled Water Plant
Recycled water
Non-drinking water tank
Winter - discharge
Wastewater
ATCO network
Natural gas
City centre
Telstra / NBN network
Telecoms
Public and private irrigation
Groundwater injection
Non-drinking water
Drinking water
IWSS
Rooftop solar PV
Power
Electricity
Cooling
Heating & hot water
Gas engine
Electric chiller
Heat rejection
Absorption chiller
Thermal storage
Natural gas
ATCO network
Trigeneration plants (6 no.)
Power
SWIS


Stirling City Centre
Best Available Technology Servicing Concept
Geothermal / Solar PV option
Anaerobic digestor
Residuals
Landfill
MRFs
Biosolids
Soil conditioner
Market
Waste
Electricity
SWIS
Central Waste Processing Centre
Water Corp wastewater network
Emergency wastewater discharge
Recycled water
Winter - discharge
Recycled Water Plant
Non-drinking water tank
Telstra / NBN network
ATCO network
City centre
Telecoms
Public and private irrigation
Wastewater
Natural gas
Non-drinking water
Drinking water
IWSS
Shallow groundwater injection
Electric chiller
Heat rejection
Cooling
Absorption chiller
Rooftop solar PV
Heating & hot water
Thermal storage
Electricity
Power
Geothermal plant
SWIS
Deep abstraction well
Deep injection well

# Table of contents

# Table index



# Figure index

# 1. Introduction

## 1.1 Project Background

The Stirling City Centre (SCC) is a designated Strategic Metropolitan Centre under Directions 2031 and aims to create an active and diverse urban centre within the inner metropolitan area of Perth. The Centre will be a transit oriented development potential to accommodate 25,000 residents and 30,000 workers.

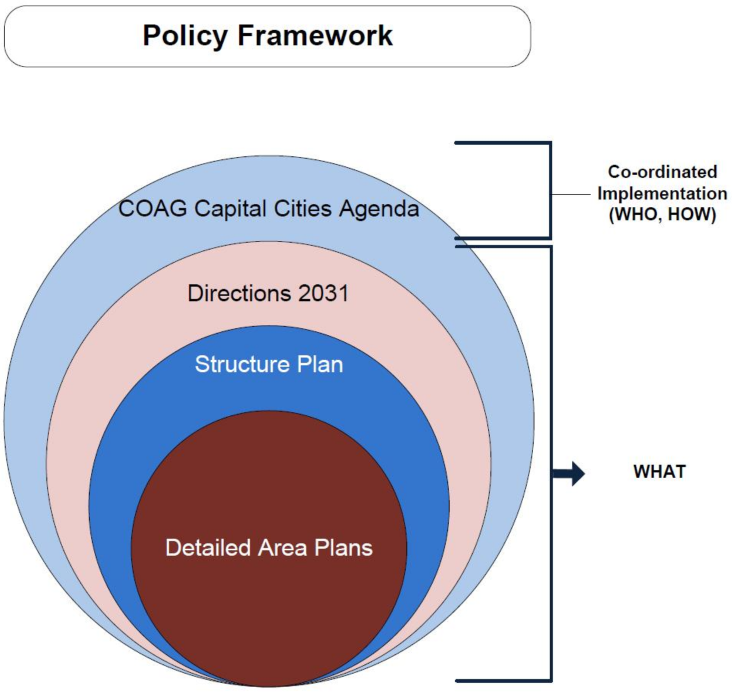
The City of Stirling and the Western Australian Planning Commission are co-sponsoring the development with partners Western Power, Water Corporation, Department of Planning, Department of Transport, Main Roads WA, Public Transport Authority and Landcorp. This novel partnership offers a unique opportunity to integrate infrastructure with land use planning in one of Perth's most important Activity Centres.

Delivery of the vision for the SCC will be guided by the SCC Structure Plan, which is currently being prepared by the Stirling Alliance (the Alliance) to provide the framework for the redevelopment of the SCC. It aims to deliver innovative urban design and development that ensures an enduring, natural environment and water management system, underpinned by new technologies and approaches to the management of water, waste, energy and the environment.

GHD has been commissioned to develop a Utilities Infrastructure Strategy for the SCC to meet these aims.

## 1.2 Stirling City Centre Performance Framework

The Stirling Alliance has prepared a comprehensive Performance Framework to guide the planning of the SCC.




The framework defines the objectives, Key Result Areas (KRAs) and Key Performance Indicators (KPIs) for each of the Areas of Strategic Focus. A number of targets are defined for the KRAs/KPIs. The Performance Framework establishes aspirational, agreed, minimum and current targets.

The framework and targets provide guidance on development of the servicing strategy in respect of sustainability performance.

## 1.3 Purpose of this report

Two previous studies have identified the potential for innovative initiatives and technologies to service the SCC:

- PB Green Infrastructure Report (Parsons Brinckerhoff 2010); and
- Kinesis Reports (Kinesis 2012):-
  - CCAP Precinct Analysis of Stage 1 land area
  - CCAP Precinct Sustainability Analysis Report.

GHD built on these studies to provide a comprehensive list of potential initiatives and technologies (Review of Sustainable Initiatives & Technologies – GHD April 2013). This report was used to inform the development of a Best Available Technology (BAT) strategy to service the SCC. This BAT strategy is documented in the previous report (Stirling Utilities Infrastructure Strategy, Volume 1 – GHD Oct 2013) together with a Business-as-Usual (BaU) approach to servicing. The primary purpose of documenting the BaU approach was to benchmark the BAT strategy in respect of life cycle costs and sustainability performance.

The alternative strategies set out in that report were presented to the SCC Master Strategy Workshop in August 2013, and subsequently to a workshop of the Stirling Alliance's Infrastructure Working Group in September 2013.

Following the workshop, the BAT approach has been refined into a final preferred servicing strategy for the SCC which is presented in Volume 1 of this report. That report documents the strategy development for the entire Structure Plan area.

This companion document (Volume 2) sets out how the strategy will be applied to Stage 1 of the Structure Plan area.

## 1.4 Development Yield

The previous report was based on yields developed by Hassell in 2011. These yields have been revised by the Stirling Alliance (September 2013) and this report is based on that revised yield information.

## 1.5 Layout of report

Section 2 describes the demands on utility services arising from the development of Stage 1 of the SCC. These have been revised from the previous report.

Section 3 sets out the likely upgrades required to conventional centralised services necessary to meet the future demands with these revised yields.

Section 4 provides a detailed description of the preferred concept and a high level assessment of the total costs of best available technology servicing of the development, including capital and operating costs in comparison with a business as usual approach, for which revenues have also been assessed.

Other aspects of the strategy such as regulatory and implementation issues are addressed in Volume 1 of this report.

## 1.6 Scope and limitations

This report: has been prepared by GHD for Stirling Alliance and may only be used and relied on by Stirling Alliance for the purpose agreed between GHD and the Stirling Alliance as set out in section 1.3 of this report.

GHD otherwise disclaims responsibility to any person other than Stirling Alliance arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Stirling Alliance and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared the preliminary cost estimates set out in this report (“Cost Estimate”) using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD. The Cost Estimate has been prepared mainly for the purpose of comparing the options considered and must not be used for any other purpose.

The Cost Estimate is an order of magnitude estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

# 2. Future Service Demand

## 2.1 Existing Service Provision

A full description of the existing services in respect of power, water, wastewater, telecommunications and waste is set out in Volume 1 of this report. A summary is provided below.

### Power

The existing Western Power substation at Osborne Park is part of the Northern Terminal Load Area. The substation is served by 3 no. 132kV overhead transmission lines. The current load supplied by the substation is 65 MVA. According to Western Power's Network Capacity Mapping Tool at the time of writing, the residual capacity of the substation is ≤ 10 MVA. High voltage distribution feeders emanating from the substation currently service surrounding buildings.

### Gas

A comprehensive medium, and medium / low pressure system currently services the site, with service pressure between 15 and 70kPa. The major pipes are located along Karrinyup Road, Odin Street, Hertha Road, Ellen Stirling Boulevard, Oswald Street, Scarborough Beach Road, King Edward Road, and Cedric Street.

The closest high pressure gas main is located west on Northstead Street, approximately 2.5km away from the western boundary of the site. Additional high pressure gas mains are located in Balcatta Road and Dumfries Road; both located approximately 3.5km north and south of the site respectively.

### Water

The SCC spans three water supply zones, these being:

- West Yokine – Hamersley in the north;
- Bold Park in the west; and
- Mount Hawthorn in the east.

An extensive water distribution main system surrounds the boundary of the proposed development.

The reticulation networks currently source water from various mains, and no single main dominates the servicing to the current site. The 150mm reticulation mains are primarily found in the south east industrial portion of the site, which sources water from the main in Scarborough Beach Road.

### Wastewater

The SCC area spans the catchments of several Water Corporation wastewater pump stations, which are ultimately serviced by two wastewater treatment plants (WWTP). Flows from the southern portion of the area (generally the area south of Scarborough Beach Road) are pumped to the Perth Main Sewer, which gravitates wastewater to the Subiaco WWTP. The majority of the site pumps into the Hamersley Main Sewer, which gravitates wastewater to the Beenyup WWTP. Each existing catchment zone (with one exception) gravitates to a downstream pump station.

### Drainage

The current site is serviced by underground reinforced concrete pit and pipe systems that accommodate minor storm events, and an overland flow path governed by the road reserves that manage the major storm events, which eventually flow into the main drain.

The current site drains into the Water Corporation owned 5m wide open channel / reinforced concrete pipe main drain which is proposed to be converted to an urban stream as part of the SCC development. This main drain runs from the north east to the south west of the development. The majority of the site utilises this main drain, with the exception of a small northern portion of the site which will drain into smaller basins located north in the Birralee Reserve and Yuluma Park.

### Telecommunications

Telstra and Optus 3G wireless coverage currently exists throughout the Precinct with typical speeds being between 1.1Mbps and 20Mbps. 4G coverage in the Precinct is very limited at present. However, optical fibre has significant speed and capacity advantages over both mobile and copper services. Therefore the roll-out of the NBN within the SCC over the next 3 years, will significantly benefit most businesses and residents if they opt for fibre.

Services currently are being provided via satellite within the precinct (e.g. Foxtel) will remain. Over the next 3 years it is expected that Foxtel will migrate to the NBN infrastructure. These services will then be provided by NBN Co.

### Waste

The City of Stirling operates a single bin system for domestic waste collection. Council's Balcatta Transfer Station (6 km from the SCC) is a large but simple facility and is currently operating at full capacity. Council has a contractor that separates organic material and recyclables using simple waste separation technology; trommels, magnets, eddy current and screens. The organic material is composted by the contractor Atlas on its farm outside Perth. Council advises that diversion is about 65%.

Residual waste is disposed of at the Anaeco DiCOM AWT facility commissioned by the Western Regional Metropolitan Council (WMRC). This facility has a capacity of 55,000 tonnes per year of which Stirling provides 22,000 tonnes. Any overflow is disposed of at the Red Hill Landfill, operated by the Eastern Regional Metropolitan Council (EMRC). This landfill has just been extended and the EMRC has no plans for an AWT facility.

## 2.2 Draft Structure Plan

The draft SCC Structure Plan was released in July 2011 (Stirling Alliance 2011). The draft plan describes a vibrant, mixed use, green, transit oriented development, combining mixed use and residential development.

The proposed Stage 1 area of the development is depicted in Figure 2.1.

As described in Volume 1 of this report it is proposed to service the mixed use areas of the project through distributed thermal energy and non-drinking services (referred to in the following as the distributed services zone).

The proposed boundaries of the distributed services zone are set out in Figure 2.2.

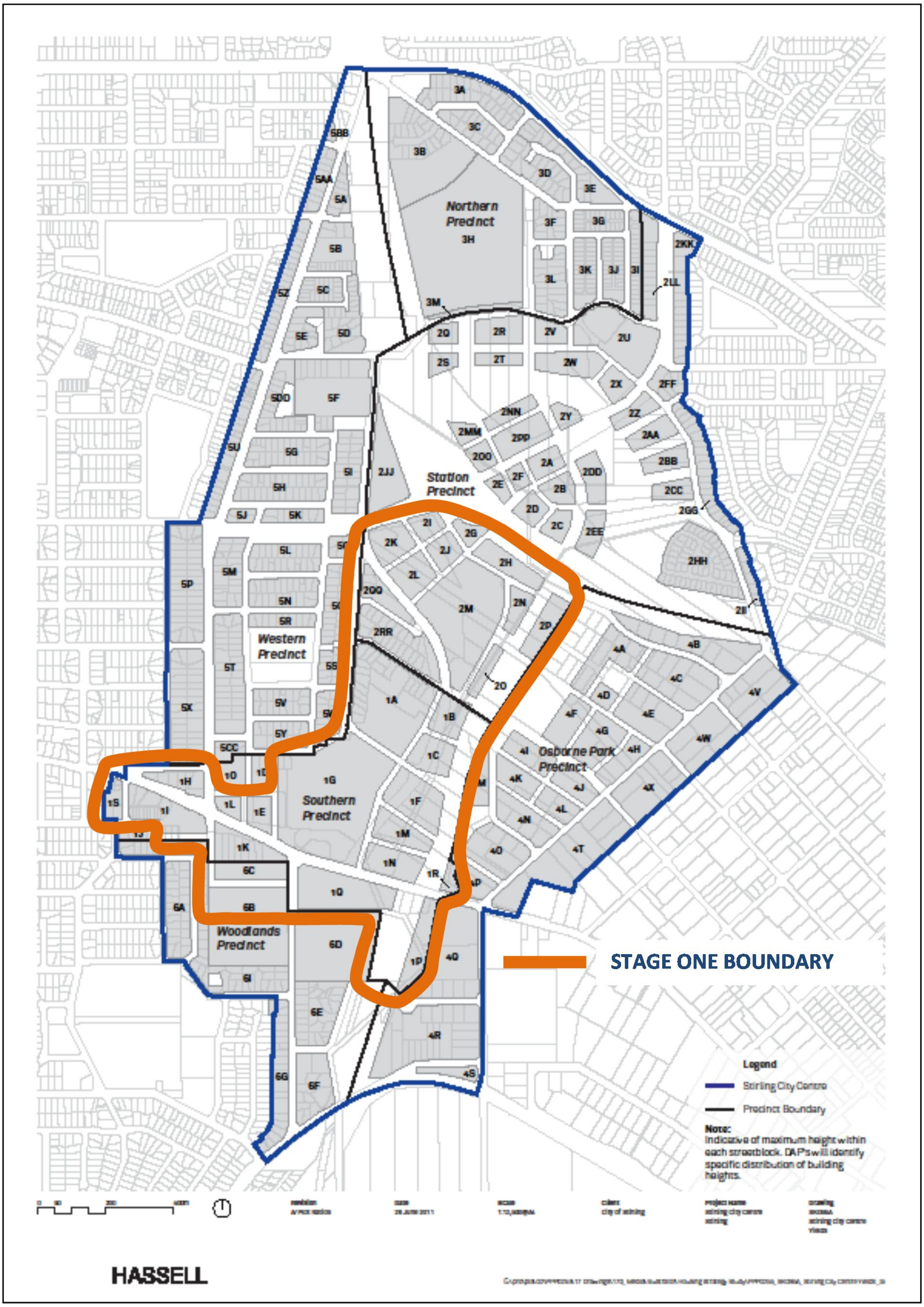



Figure 2.1 Stage One Area

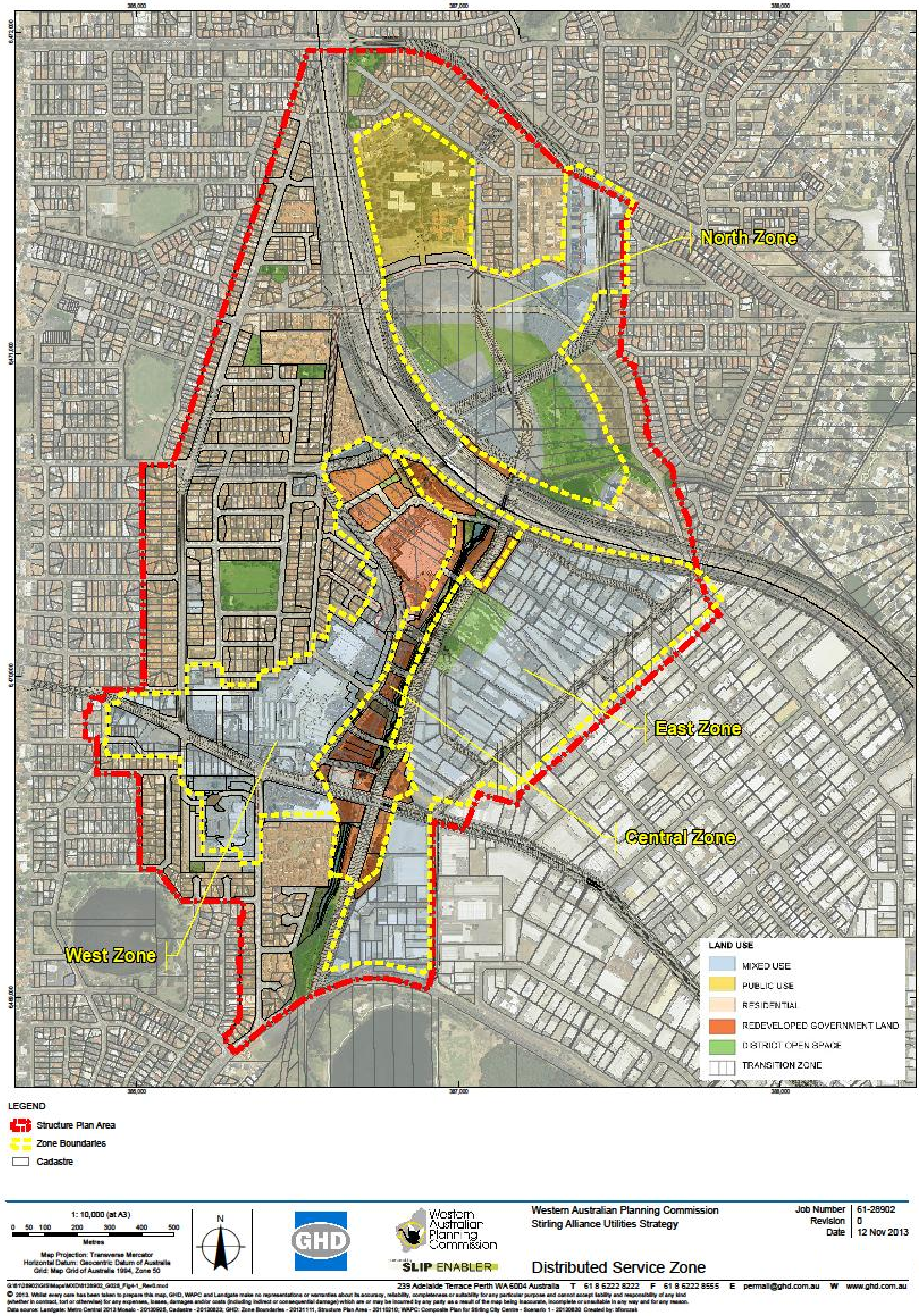



Figure 2.2 Distributed Services Zone

It can be seen that the Stage 1 area constitutes the central and western zones of the proposed distributed services zone.

## 2.3 Yield

The Stirling Alliance has revised the estimated yields and the report is based on these. These latest yields are still estimates derived from the latest configuration of developable area and car parking limitation mechanisms. The key information is reproduced in Table 2.1. Residential population figures are based on the assumption of 1.8 persons per dwelling, and Nett Lettable Area (NLA) is assumed to be 85.5% of gross floor area (GFA).

### Table 2.1 Stage 1 Development Yield

| | Dwellings | | Population | Office | Health / Welfare / Community | Retail | Entertainment / Recreation / Culture | Total Non-residential | Total |
|---|---|---|---|---|---|---|---|---|---|
| | **No.** | Floor Space (m2 NLA) | | | | | | | |
| | Stage 1 Development | | | | | | | | |
| Distributed services | | | | | | | | | |
| Central Zone | 900 | 72,000 | 1,620 | 69,231 | 2,769 | 18,605 | 1,395 | 92,000 | 164,000 |
| Western zone | 1,000 | 83,500 | 1,800 | 12,064 | 1,826 | 105,477 | 6,633 | 126,000 | 209,500 |
| Stage 1 - Totals | 1,900 | 155,500 | 3,420 | 81,295 | 4,595 | 124,081 | 8,029 | 218,000 | 373,500 |

The total Stage 1 development has reduced considerably (about one third) from that assumed in the earlier report, and now represents about 20% of the full development yield (originally 25%). This difference is reflected in the varying requirements for services.

It should be noted that the split between residential and non-residential land uses is somewhat different between the full development and Stage 1. Residential development is about 40% of the Stage 1 area, compared with the full development consisting of 53% residential component.

## 2.4 Demand Assumptions

The demand for services is dependent on a number of factors including:

- resident, worker and visitor population;
- the number and type of buildings;
- the “performance” of each building type in respect of energy and water efficiency; and
- the behaviour of occupants.

Each of these has been taken into account in the development of the demand calculations set out below. Inherently, a BAT approach to development includes adoption of best practice in respect of energy and water efficiency. Accordingly the BAT demand assessment assumes these practices. The BaU approach to servicing development adopts conventional demands for energy and water.

The opportunities for waste reduction are mainly related to factors outside the direct influence of urban development, and so both BaU and BAT waste volumes are based on existing City of Stirling data.

## 2.5 Power – Future Demand

Volume 1 sets out the approach to determining the peak and annual power loads for the development. The tables below identify the relevant loads for the Stage 1 area.

### Table 2.2 Peak (coincident) power – conventional demand

| Land Use | Peak Electrical Demand | Total Peak Demand |
|---|---|---|
| | (VA/m2) | (MVA) |
| Residential | 13 | 2.0 |
| Office | 51 | 4.1 |
| Retail | 67 | 8.3 |
| Entertainment and Community | 43 | 0.5 |
| Peak Demand on Grid | | 15.0 |

### Table 2.3 Peak (coincident) power – energy efficient demand

| Land Use | % Reduction | Peak Electrical Demand | Total Peak Demand |
|---|---|---|---|
| | | (VA/m2) | (MVA) |
| Residential (5 Star NABERS) | 45% | 7 | 1.1 |
| Office (5 Star NABERS) | 27% | 38 | 3.1 |
| Retail (5 Star NABERS) | 63% | 25 | 3.1 |
| Entertainment and Community (5 Star NABERS) | 83% | 7 | 0.1 |
| Peak Demand on Grid | | | 7.4 |

### Table 2.4 Annual energy consumption

| | | Weighted average demand per m2 | | | Total demand per annum | | |
|---|---|---|---|---|---|---|---|
| | | (We) | (Wth) | (Wth) | (GWhe) | (GWhth) | (GWhth) |
| | Area (m2) | Electrical (1) | Heating / HW | Cooling | Electrical (1) | Heating / HW | Cooling |
| **Conventional demand (BaU)** | | | | | | | |
| Residential | 155,500 | 7.01 | 1.53 | 6.98 | 9.65 | 2.11 | 9.61 |
| Office | 81,295 | 10.45 | 0.30 | 11.15 | 16.55 | 0.47 | 17.66 |
| Retail | 124,081 | 14.75 | 0.30 | 23.15 | 42.56 | 0.87 | 66.80 |
| Community and Entertainment | 12,624 | 2.25 | 0.05 | 3.29 | 4.31 | 0.10 | 6.33 |
| | | | | | 73.08 | 3.55 | 100.40 |
| Street lights | | | | | 0.12 | | |
| | | | | | 73.20 | | |
| **Energy efficient buildings (BAT) DGA Area** | | | | | | | |
| Residential | 155,500 | 1.86 | 0.54 | 2.48 | 4.34 | 1.27 | 5.79 |
| Office | 81,295 | 4.89 | 0.21 | 7.65 | 8.29 | 0.35 | 12.96 |
| Retail | 124,081 | 2.66 | 0.11 | 8.11 | 7.98 | 0.31 | 24.30 |
| Community and Entertainment | 12,624 | 0.18 | 0.01 | 0.48 | 0.78 | 0.03 | 2.10 |
| | | | | | 22.54 | 2.03 | 43.99 |
| Street lights, waste and recycled water | | | | | 5.18 | | |
| | | | | | 27.72 | | |

## 2.6 Gas – Future Demand

Based on information provided by ATCO Gas about the proposed yield for full development, GHD has estimated that the gas demand for BaU Stage 1 development will be 76,000 GJ per annum.

## 2.7 Water & Wastewater – Future Demand

Water usage estimates were undertaken using a combination of current water use data, the Water Corporation water demand calculator and current industry knowledge (in respect of irrigation of public open space).

Two residential demand scenarios were developed to provide a potential range of consumption figures for infrastructure sizing and water source requirements.

***Scenario 1 – Waterwise***

Assumes all internal fixtures and fittings are waterwise and the landscaped areas consist of waterwise plants. This demand is assumed for the BAT option.

***Scenario 2 – Conventional***

Assumes all internal fixtures and fittings are conventional and the landscaped areas consist of European plants.

The demands adopted for “conventional” are similar to the measured data for existing residential multi-unit dwellings. Demand for commercial development is based on existing unit consumption figures. This demand is assumed for the BaU option.

There is a more complete explanation of how these demands were calculated in GHD’s *Total Water Cycle Options* report.

### Table 2.5 Stage 1 Water Demands

| | QUANTITIES | | ANNUAL DEMANDS (ML/year) | | | |
|---|---|---|---|---|---|---|
| | | | Conventional Demand | | | |
| | | | Drinking water | NDW - internal | NDW - Irrigation | Total |
| Dwellings | no. | 1,900 | 114 | 103 | 32 | 249 |
| Office | m2 GFA | 81,295 | 65 | 38 | 5 | 109 |
| Health / Welfare / Community | m2 GFA | 4,595 | 12 | 6 | 2 | 21 |
| Retail | m2 GFA | 124,081 | 79 | 39 | 13 | 132 |
| Entertain't / Recreation / Culture | m2 GFA | 8,029 | 5 | 3 | 1 | 9 |
| Public Open space | ha | 0.9 | - | - | 7 | 7 |
| Verges | ha | 2.6 | - | - | 13 | 13 |
| | | | 276 | 189 | 73 | 538 |
| | | | Waterwise Demand | | | |
| Dwellings | | | 82 | 65 | 22 | 168 |
| Office | | | 39 | 23 | 3 | 65 |
| Health / Welfare / Community | | | 2 | 1 | 0 | 4 |
| Retail | | | 74 | 37 | 12 | 124 |
| Entertain't / Recreation / Culture | | | 5 | 2 | 1 | 8 |
| Public Open space | | | - | - | 4 | 4 |
| Verges | | | - | - | 13 | 13 |
| | | | 202 | 128 | 56 | 386 |

In line with the development yield, these demands represent around 20% of the full development demand.

## 2.8 Waste – Future Waste Quantities

The contribution of Stage 1 to the waste quantities is set out in below.

### Table 2.6 Stage 1 Waste Quantities

| Location | Collected by | Qty (tonnes) |
|---|---|---|
| **Stirling City Centre Stage 1** | | |
| Low rise residential | Council / contractor | 1,030 |
| High rise residential | Council / contractor | 1,920 |
| Non-residential | | 8,320 |
| **Total** | | **11,270** |

# 3. Business as Usual – Conventional Servicing Concept

## 3.1 Power

### 3.1.1 Approach and Assumptions

The required upgrade to the existing distribution system has been determined by Western Power. GHD provided a future load assessment which Western Power reviewed and used as a basis for establishing required power upgrades[1].

It is assumed that the low voltage reticulation system currently powering the existing site will be insufficient to power the multi storey, mixed use development, and will be have to be replaced with a new system with greater capacity. Furthermore, it is assumed that all high voltage infrastructure upgrades will be constructed at the cost of the developer, as the high density, multi storey development does not conform to Western Power's energisation fee requirements (which are more applicable to single storey 300m$^2$ to 1,000m$^2$ properties).

For estimate purposes, it is assumed that:

- all existing overhead low voltage power lines will be replaced with an underground network;
- the existing overhead transmission lines connecting to / from the Osborne Park Substation will remain (no allowance has been made for the undergrounding of any existing transmission); and
- 630kVA transformers are to service the future site (in lieu of 1MVA transformers).

### 3.1.2 Upgrades Required

***Distribution***

From the GHD energy load data based on the original yields, Western Power provided a layout of the upgrades to the high voltage network that would be required to service future increased demands. GHD has interpreted this information to revise the previous estimate based on the original yield.

An ultimate peak demand forecast of 163 MVA was made by Western Power for the Stage 1 area serviced by the Osborne Park substation, of which 37 MVA came from the SCC Stage 1 redevelopment. With the revised yield and lower density Stage 1 area, this figure reduces to 15 MVA.

The upgrades originally quoted by Western Power include:

- expansion of the existing Osborne Park substation with two additional 66MVA transformers by 2017/18;
- installation of an additional 66MVA transformer within Osborne Park by 2028/29;
- two 66MVA transformers will be required to supplement the existing Osborne Park substation by 2055/56; and
- approximately 20 new distribution feeders over time.

[1] Reported in "Stirling Utilities Infrastructure Strategy, Volume 1 – GHD Oct 2013"

The load from the SCC Stage 1 is now only a small proportion of the Western Power estimate. However for the purposes of this report it has been assumed that these upgrades will still be required on a similar timetable.

Based on this assumption, a new substation site to house all the expansions set out above would be needed by 2017/18. The location of the new substation has not been determined, but is likely to be sited on industrial land in the area.

Based on an ultimate peak demand forecast of 15 MVA for the Stage 1 area, the site will require approximately 25 630kVA transformers and switchgears.

***Power Generation***

The BaU approach will also require the generation of the equivalent amount of electricity on the South West Interconnected System (SWIS).

The costs of this have been evaluated using data from a report by Sustainable Energy Now (SEN)[2]. This report evaluates renewable energy opportunities to the year 2029. This analysis is set out in the previous report (Stirling City Centre Utilities Infrastructure Strategy - Volume 2 Stage One Area).

***Transmission***

The generation of 15 MVA will also require additional transmission capacity within the SWIS, with accompanying capital and operating costs. However, as this development is only a small increment of the total, these costs have not been estimated.

### 3.1.3 Costs

Western Power has provided an estimate of $90 million (in 2012/13 dollars) for the design and construction of the required high voltage / transmission upgrades listed above. This is an all-inclusive figure representing ± 50% accuracy. The SCC share for the ultimate development will be approximately $35m based on load share. The share of costs for this infrastructure to the SCC project for Stage 1 will be around $8m including for a new substation site. Operating costs for these assets can be assumed at around 3% or $0.24 m pa.

The following costs have been estimated for local upgrades, including contingency and preliminaries:

$4.4m low voltage transformers and switchgear;

$4.0m the cost of undergrounding power at SCC for existing and new roads; and

$268k the cost of removing and replacing low and high voltage overhead lines.

Based on the data provided in the SEN report referred to above, the following costs have been determined for the generation of an additional 15 MW on the SWIS.

| | |
|---|---|
| $31m | Capital costs. |
| $1 m | Operating costs (per annum) |
| $4.8m | Fuel costs (per annum) |
| $0.95m - $11.5m | Carbon costs (2015 – 2065) |

Total capital costs for power generation and local system upgrades is therefore estimated at $48m.

[2] http://www.sen.asn.au/

## 3.2 Gas

### 3.2.1 Approach and Assumptions

An upgrade to the existing high pressure gas network has been determined by ATCO Gas, who was asked to base their future demand projections on the yield analysis originally produced in the 2011 Hassell Stirling City Centre Detailed Yield Analysis.

ATCO Gas has based their upgrades on the assumption that the Station Precinct will be the first precinct to be constructed.

For estimation purposes, it is assumed that:

- no upgrades to the existing medium and medium / low pressure network will be required;
- gas pipelines will be laid in all new and existing road reserves that currently do not have medium or medium / low pressure gas piping;
- no allowance has been made for the reinstatement of crossovers, based on the assumption that all existing lots will be demolished before or during the time of gas construction;
- there will be no additional pavement removal / remediation and trenching costs for gas pipe installation as it will be covered in the water reticulation installation; and
- all new medium and medium / low pressure gas piping costs will be absorbed by the developer.

### 3.2.2 Upgrades Required

From the ATCO Gas assessment GHD has assumed a total demand of 76,200 GJ / year for the Stage 1 area. At this load, it is not clear whether the current medium pressure network has the capacity to accommodate the increased demand of the high density development. Although more detailed assessment is required, it has been assumed here that the system will require an upgrade for Stage 1.

ATCO Gas proposes an extension of the high pressure main from Northstead Street to feed the medium and medium / low pressure network within the site. This will require the installation of approximately 2.5km of high pressure polyethylene pipe and a high pressure regulator set through existing road pavements in Beatrice and Cedric Street.

Extensions of the existing medium and medium / low pressure network will be necessary to service the whole site and will be designed based on the water reticulation network. ATCO Gas will provide developers with a gas reticulation design during time of development.

### 3.2.3 Costs

**Cost Breakdown**

**High Pressure Gas Mains:** Due to the commercial nature of the development, ATCO Gas states that the cost will be to the developer, however the total cost may be reduced if ATCO Gas is requested to provide a contribution to the costs of the main, in which their incurred costs will presumably be recovered through headworks charges.

ATCO Gas has provided an estimate of $1.24 million for the design and construction of the required pressure main upgrade.

**Medium and Medium / Low Pressure Gas Pipes:** Due to the commercial nature of the development, ATCO Gas states that it is likely that the costs will be incurred by the developer.

The cost of extending the medium and medium / low pressure network is estimated at $563k including contingency and preliminaries.

Approximately 76,200 GJ per annum of gas will be consumed within the Stage 1 area which, which involves a cost of $0.94 m per annum at a gas price of $12.30/GJ.

## 3.3 Water

### 3.3.1 Approach and Assumptions

The required distribution system upgrades have been based on a preliminary Water Corporation study which has been summarised in a letter originally prepared for Opus Consulting dating 19 May 2011. GHD has liaised with the Water Corporation since March 2013, and have confirmed that the proposed upgrades stated in this study are still reasonable under the yield projections provided in the Hassell Stirling City Centre Detailed Yield Analysis.

The original study (Opus Consulting) only assumes an upgrade that has limited extension into the site. However the Water Corporation confirmed with GHD that for Stage 1 it is reasonable to assume that a new water trunk main will required throughout the site from Cedric Street near the northern boundary to Scarborough Beach Road.

The reticulation upgrades, concerning water pipes smaller than 300mm, in diameter will be based on Water Corporation Standard No. DS63. Clause 2.2.1.2. It is currently assumed that the pipe sizes specified in this standard will suffice, and therefore no water reticulation modelling has been conducted.

For estimation purposes, the assumptions are:

- all existing pipes smaller than 150mm diameter will be removed and replaced with at 150mm diameter pipes. Existing pipes that are 150mm diameter or greater that are within the existing road reserve will be retained;
- water reticulation piping will be laid for every metre of both new and existing road (if not already provided);
- no allowance has been made for removing redundant water reticulation;
- allowance for one short and one long connection every 40m has been provided;
- standard headwork charges apply per connection;
- no allowance has been made for the reinstatement of crossovers, based on the assumption that all existing lots will be demolished before or during the time of construction;
- all private networks that are not shown in the maps will not be reused in the new fit out and will be made redundant;
- allowance for one fire hydrant every 200m of pipe has been included; and
- fire services will utilise the same reticulation system, and will be boosted with the use of building scale storage tanks where necessary.

### 3.3.2 Upgrades Required

As noted in Volume 1 of this report, a new distribution main will be required to service the full development. More detailed assessment is required to determine whether this would be triggered by the Stage 1 development. It has been assumed here that this would be fully built as part of Stage 1.

The Water Corporation plan on constructing a 600mm diameter steel main pipe line from the existing 610mm diameter steel pipeline located at the junction of Karrinyup Road and Cedric Street. This 600mm pipe is to extend south approximately 730m down Cedric Street. It is then to continue an additional 560m south, under the freeway, ending on the east side of Flax Way. A 400mm diameter and 300mm diameter steel branch is to extend off the proposed 600mm pipe.

Table 3.1 Future Water Supply Upgrade

| Section | Start | End | Size of Main | Material | Length |
|---|---|---|---|---|---|
| 1 | Junction of Karrinyup Road / Cedric Street | Cedric Street (south of start) | 600mm | Steel | 730m |
| 2 | Cedric Street | East of Flax Way (Next to current Ikea building) | 600mm | Steel | 560m |
| 3 | Cedric Street – End of Section 1 | Cedric Street (south of start) | 400mm | Steel | 150m |
| 4 | East of Flax Way – 100m from southern end of Section 2 | Flax Street (west of start) | 300mm | Steel | 200m |

It is currently assumed that the new 600mm diameter main pipe line will extend further south to connect into the existing 460mm diameter steel main pipe line located in Scarborough Beach Road. The Water Corporation have confirmed that this is a valid assumption.

Additional water distribution main upgrades are likely to be necessary in the area to service the development; however these have not been sized at present.

For estimation purposes regarding small diameter water reticulation pipes GHD have adopted the following pipe sizing rule:

- 100mm minimum diameter pipes will be used for residential areas;
- 150mm minimum diameter pipes will be used for areas within industrial and commercial zones; and
- 200mm minimum diameter pipes will be used for central business districts.

### 3.3.3 Costs

**Cost Breakdown**

**Headworks:** All water distribution mains (pipes of diameter 300mm or greater) are usually initially funded by the Water Corporation, who would normally be reimbursed through headworks charges, paid for by developers. Further investigation and consultation with the Water Corporation will be required to accurately project the final headworks costs attributable to the SSC, as standard headworks fees are not applicable to mixed use, multi storey developments.

The capital cost of the proposed headworks upgrades is estimated at $3m for the mains upgrades set out in Table 3.1. A provisional amount of $2m has been assumed for additional distribution upgrades. It has been assumed that these upgrades will be necessary for Stage 1, although further investigation may show that this is not necessary.

The cost of additional source has been estimated at the value of the long run marginal cost (LRMC) of water. This amount effectively recovers the capital and operating costs of new sources of water on the IWSS and includes treatment and conveyance. The Water Corporation uses two figures for LRMC: one for demand reduction ($1.51/kL), and one for demand increases ($1.90/kL). For the purposes of this report we have used the average of these figures, escalated slightly for 2013/14, i.e. $1.75.

This rate leads to a cost of $0.93 m pa for the 0.53GL pa BaU demand for Stage 1.

**Reticulation:** All water reticulation pipes (pipes of diameter smaller than 300mm) and lot connections are usually funded by the developer. In situations such the SCC redevelopment which may occur on a lot-by-lot basis over many years an alternative arrangement may need to be established to fund the works usually undertaken at the cost of developers.

The cost of reticulation is estimated at $5.7m including contingency and preliminaries.

## 3.4 Wastewater

### 3.4.1 Approach and Assumptions

The required wastewater headworks infrastructure has been based on the recent study 'Water Corporation Stirling City Wastewater Advice', originally provided to GHD on the 29th of May 2013. GHD provided Water Corporation with the Hassell Stirling City Centre Detailed Yield Analysis, and the Water Corporation refined their ultimate wastewater flow estimates to reflect this analysis.

GHD has estimated reticulation requirements with pipe sizes based on the yield analysis and Water Corporation Standard No. DS50 Tables 4.1, 4.2 and 4.3.

For estimation purposes, assumptions include:

- all existing reticulation that is adequately sized within existing road reserve will be retained;
- no allowance has been made for removal of redundant sewer;
- all existing connections on reusable pipe will be made redundant. New 150mm diameter connections are to be used. A short and long connection is to be provided every 40m;
- reticulation is to be laid at a conservative average of 3m depth;
- no provision has been made for dewatering;
- standard headworks charges apply per sewer connection;
- to accommodate for mixed use multi storey buildings, connections will utilise a 150mm diameter PVC pipe with valve and meter.
- no provision has been made for the extraction and replacement of peat, ASS treatment, or any other soil remediation;
- no allowance has been made for the reinstatement of crossovers, based on the assumption that all existing lots will be demolished before or during the time of sewer construction; and
- all private networks that are not shown in the maps will not be reused in the new fit out and will be made redundant.

Various studies have indicated that ASS soils, peat deposits, and various pollutants are present on the site. Depending on the level of ASS / unideal soil conditions that is encountered on site, the treatment of soils can become a significant cost.

### 3.4.2 Upgrades Required

The Water Corporation has completed a preliminary review of options available to serve the SCC and surrounding areas. This review found that:

- WWPSs that are within the catchment of the Subiaco WWTP:- the SCC development will have negligible impact on long term flows (revised flow estimates similar to those assumed in current long term wastewater conveyance planning); and
- WWPSs that are within the catchment of the Beenyup WWTP:- the SCC development will have a significant impact on long term flows (revised peak flow estimates significantly greater that those assumed in current long term wastewater conveyance planning).

The Water Corporation has presented two options that may be implemented to upgrade the wastewater headworks to accommodate for the projected yield. Both options have been projected to have similar cost implications on the project. For the purposes of this report, GHD has assumed that Option One provided by the Water Corporation will apply, and accordingly the following upgrades will be required:

- Upgrade of the gravity line between the Twyford Place Pump Station (PS10) and the Sheldrake Street Pump Station (PS2) from 300mm / 450mm diameter pipes to 600mm / 750mm diameter pipes;
- Reroute flows from the Civic Place Pump Station (PS11), through a 150mm diameter pressure main, to the gravity main feeding the Sheldrake Street Pump Station (PS2);
- Upgrade of the Sheldrake Street Pump Station (PS2), increasing its pump rate to approximately 245 L/s; and
- Increasing the pump rate of the Civic Place Pump Station (PS11) to achieve a design flow of 77 L/s.

Ultimately the new combined flow rate flowing into the Hamersley Main Sewer will be 322 L/s. This flow rate is approximately 150L/s greater than the current flow rate. A diagram of the current pressure and gravity main system is shown in Figure 3.1, and the proposed upgrade in Figure 3.2.

In respect of servicing the Stage 1 development it has been assumed that the following upgrades will be required:

- Upgrade of the gravity line between the Twyford Place Pump Station (PS10) and the Sheldrake Street Pump Station (PS2) from 300mm / 450mm diameter pipes to 600mm / 750mm diameter pipes; and
- Upgrade of the Sheldrake Street Pump Station (PS2), increasing its pump rate to approximately 245 L/s (its eventual required capacity under full development).

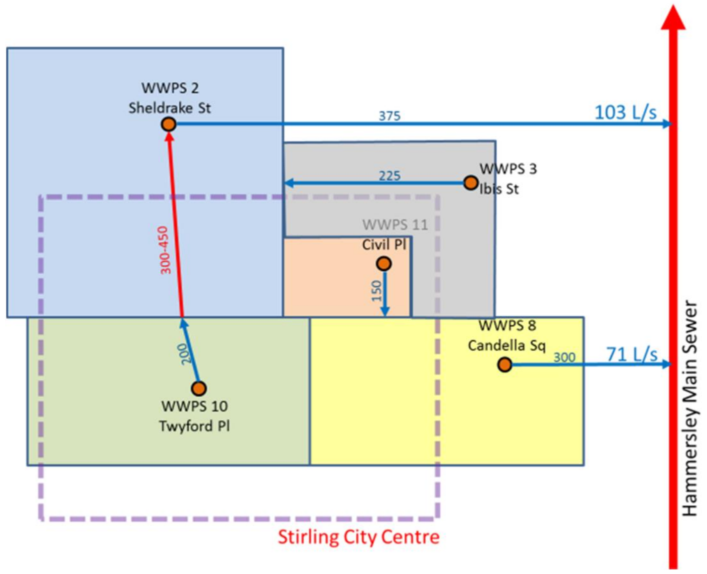



Figure 3.1 Current Hamersley MS Pressure and Gravity Main Layout

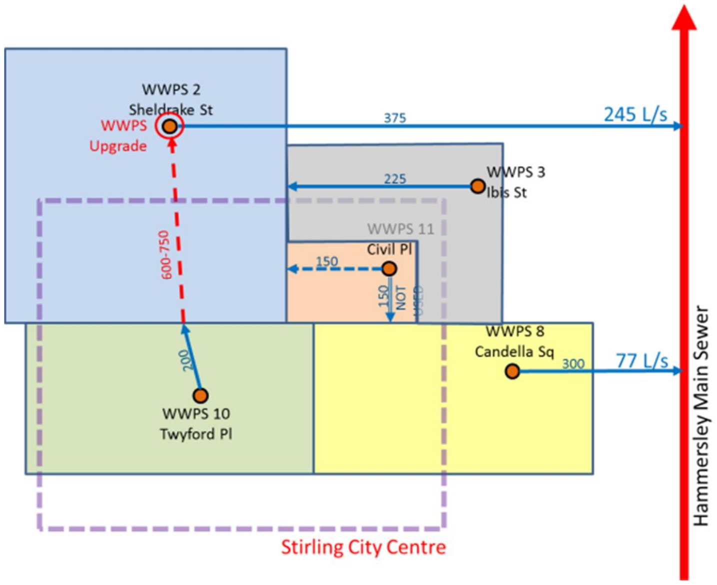



Figure 3.2 Proposed Hamersley MS Pressure and Gravity Main Layout for BaU Case

This increased flow has provided indication that the Main Sewer itself will require upgrading for ultimate development. It has been assumed here that this upgrade is not triggered by Stage 1.

The sewer reticulation has been estimated to predominantly consist of 150mm diameter PVC sewers, with selected lengths of 225mm diameter PVC sewer. By projecting the flows using Water Corporation Design Standard No. DS50, the indication is that 300mm diameter sewers may be required in the Station Precinct to accommodate for flows equivalent to CBD flows. Further, detailed analysis will be required to confirm the actual pipe sizes required to service each precinct.

### 3.4.3 Costs

**Cost Breakdown**

**Headworks:** All sewer gravity mains (pipes of diameter 300mm or greater) will be initially funded by the Water Corporation, who will be reimbursed through headworks charges, paid for by developers. Further investigation and consultation with the Water Corporation will be required to accurately project the final headworks costs attributable to the SSC as standardised headworks fees are not applicable to mixed use and multi storey developments.

The cost of WWTP upgrades related to Stage 1 has been estimated at $6m per ML/day (i.e. $7.6m) for the Beenyup plant, with operating costs of $0.2 / kL.

The cost of the proposed sewer headworks is estimated as follows.

| Item | Capital cost |
|---|---:|
| Pump stations | $5.9 m |
| Sewer upgrade | $1.9 m |
| Main sewer upgrade | Not required |
| Total | $7.8 m |

**Reticulation:** All sewer reticulation pipes (pipes of diameter smaller than 300mm) and lot connections are usually funded by the developer. In situations such as the precincts of Stirling where redevelopment may occur on a lot-by-lot basis over many years an alternative arrangement may need to be established to fund the works usually undertaken at the cost of developers.

The cost of the new sewer reticulation is estimated at $6.0m.

## 3.5 Drainage

### 3.5.1 Approach and Assumptions

It is assumed that the current site utilises two drainage systems:

- An underground pit and pipe system that accommodates for minor storm events; and
- An overland flow path governed by the grades in the road reserve.

It is further assumed that these two systems currently utilise the Water Corporation main open drain, with the exception to areas in the north of the SCC.

For estimation purposes, assumptions include:

- these two systems will continue to be utilised within all new road reserve, and will tie into the existing systems. A pit and pipe system will be assumed to be laid for the whole length of new road;
- the majority of the site will be serviced by the Water Corporation main open drain and only a small northern portion of the site will be serviced by the local government via the existing basins located north in the Birralee Reserve and Yuluma Park;
- the Water Corporation main open drain, basin located in the Jackadder Reserve, and basins serving the northern portion of the site have sufficient capacity to accommodate future increased stormwater flows (caused by an increase in impermeable road pavement area);
- no allowance has been made for the reinstatement of crossovers, based on the assumption that all existing lots will be demolished before or during the time of drainage construction;
- upgrades to existing stormwater drainage infrastructure, in existing road reserve, will not be required; and
- all new roads will be a dual cambered road, requiring a drainage pits on both sides.

### 3.5.2 Upgrades Required

All new road reserves will require a pit and pipe system to keep water off the road pavement, maximising the effective and safe utilisation of roads during storm events. All piping is likely to be made from reinforced concrete. The minimum pipe size used in new road reserve will be 300mm in diameter, with the pipe size increasing as flows within the pipes accumulate from storm water captured upstream.

The pipe sizes required will need to be determined in the future by a Local Water Management Strategy, Urban Water Management Plan, and stormwater modelling.

It has been proposed that a swale be constructed in new road reserves to supplement the pit and pipe system. This will help reduce the pipe sizes needed and will add an aesthetic element to the new roads.

### 3.5.3 Costs

**Cost Breakdown**

All new drainage infrastructure is assumed to be funded by the developer.

The cost of the new drainage infrastructure is estimated at $2.5m.

## 3.6 Waste

### 3.6.1 Approach and assumptions

If the SCC development went ahead without any changes to the waste collection and processing system, Council would continue to collect kerbside waste from residential dwellings. Council, and other commercial contractors, would also continue to collect waste from businesses, offices and other commercial premises in the SCC area.

For the Stage 1 area the greatest effect of this will be felt in the Station (southern section) and Southern Precincts where more waste will mean more collection vehicle movements.

A number of measures would have to be put in place in these Precincts to ensure that waste collection by conventional business as usual means, (bins and trucks and delivery to the Balcatta Transfer Station or other disposal or processing sites). The measures would need to ensure waste removal could be undertaken efficiently and without disrupting vehicular and pedestrian traffic, retail and office activities and without causing significant visual impact.

These measures might include:

- implementing strict and enforceable planning approval conditions dealing with:-
  - waste management capacity and storage;
  - waste minimisation programs and practices;
  - physical access for waste collection vehicles;
  - restricted and/or scheduled access times for waste collection vehicles;
- surrendering Council's obligations to collect waste from residential dwellings to commercial operators or licencing or contracting of residential waste collection to a single operator;
- ensuring streets are wide enough and rated for heavy vehicles. Certain streets could be designated for waste collection vehicles and access to other streets prevented;
- retaining the one bin system. This simplifies on-site storage and collection systems with no need for separate recycling storage, no issues with recycling contamination and no need for additional collection vehicles;

- allowing domestic and commercial waste to be stored and collected together;
- providing a smaller waste capacity allowance per dwelling;
- implementing innovative accounting systems for residential and commercial waste to ensure commercial waste does not migrate to domestic system, i.e Bar codes, RFIDs, swipe cards, locking bins;
- council acquiring and operating more collection vehicles and using of more staff; and
- expanding or redevelopment of the Balcatta Transfer Station.

### 3.6.2 Costs

The City of Stirling's 2012 waste collection totalled 175,300 tonnes. Based on the projected increases set out in Section 2.8, this will escalate to some 250,000 tonnes ultimately, of which 11,270 tonnes can be attributed to the SCC Stage 1 area. Assuming similar costs per tonne to that presently met by the City, the additional cost of servicing the SCC Stage 1 will be around $2.1m per annum (in 2013 dollar value).

## 3.7 Telecommunications

The upgrades to telecommunications infrastructure are fully described in Volume 1 in respect of:

- fibre technology;
- wireless technology;
- mobile cellular; and
- VOIP technology.

The costs of development include:

- the provision of fibre optic cable (NBN cost not included here);
- the provision of conduit including trenching and backfill at $155$/m; and
- pits for access to pipework every 40m at $1,500 each.

These costs total $3.9m, with an assumed operating cost of around $100k per annum.

## 3.8 Building Costs

As the alternatives to business as usual involve the substitution of thermal energy from the building scale to the precinct scale, it is appropriate to include the cost of boilers and chillers in the BaU cost build-up.

A very approximate assessment has been made on the following basis:

- Boilers and chillers represent some 5.6% of total building capital costs, or $128.50 per m$^2$; and
- Operations and maintenance costs for this plant are around 2.5% of capital costs.

The total cost of this equipment is $50m with annual operating costs of $1.3m.

## 3.9 Summary of Upgrades

The total cost of the items set out above is summarised below in Table 3.2.

### Table 3.2 Summary of Upgrade Costs

| Service | Description | Capex | Opex |
|---|---|---|---|
| **Water** | | | |
| Potable | Upgrade source / treatment / conveyance | | 0.928 |
| | Upgrade storage | | |
| | Upgrade distribution mains | 5.000 | 0.183 |
| | New & upgraded reticulation | 5.700 | |
| | New meters | | |
| Wastewater | Upgrade WWTP | 7.644 | 0.093 |
| | Upgrade main sewer - SCC component | | |
| | Upgrade pump stations | 5.900 | |
| | Local trunk sewers and rising mains | 1.900 | |
| | Upgrade local reticulation | 6.000 | |
| Drainage | New road drainage | 2.500 | |
| **Energy** | | | |
| Electricity | Substation upgrades | 7.000 | 0.245 |
| | New distribution feeders | 1.000 | 0.035 |
| | LV transformers & switchgear | 4.400 | 0.154 |
| | Undergrounding and line removal | 4.268 | |
| SWIS Generation | Additional 15 MW required | 31.000 | |
| | FOM | | 1.000 |
| | Fuel | | 4.800 |
| | Carbon price | | 11.500 |
| Gas | Distribution upgrades | 1.240 | 0.043 |
| | Reticulation upgrades | 0.563 | 0.020 |
| | Gas consumption | | 0.940 |
| **Waste** | Additional operating costs | | 2.100 |
| **Telecoms** | Upgrades / NBN | 3.900 | 0.098 |
| | **Total Infrastructure** | **88.035** | |
| **Building costs** | Boilers / Chillers | 50.400 | 1.260 |
| | **Total** | **138.435** | |

(1) This figure is an annualised cost based on the current LRMC of water determined by the Water Corporation and agreed with the Economic Regulatory Authority. This per kL figure incorporates both capital and operating costs.

# 4. Description of Preferred Servicing Concept

The preferred BAT servicing concept is described in detail in Volume 1 of this report. The following sections outline the application of this strategy to the Stage 1 area. The BaU and BAT sub-options are depicted in Figure 4.2, Figure 4.3 and Figure 4.4 respectively.

## 4.1 Energy supply – Trigeneration / Solar option

### 4.1.1 Description

A full description of this option is included in Volume 1 of this report. At ultimate this consists of six energy hubs which provide electricity to the entire SCC development, and heating and cooling to the distributed services zone of the SCC. Each hub consists of a number of gas engines, absorption chillers, electric chillers and a thermal storage tank. Each hub will be connected by a primary hot and cold water loop. For Stage 1 it has been determined that 2 of the eventual 6 hubs would be required.

The attractiveness of a precinct scale trigeneration system is the avoidance of the need to install chillers and boilers at the building level. This equipment is replaced by simple heat exchangers.

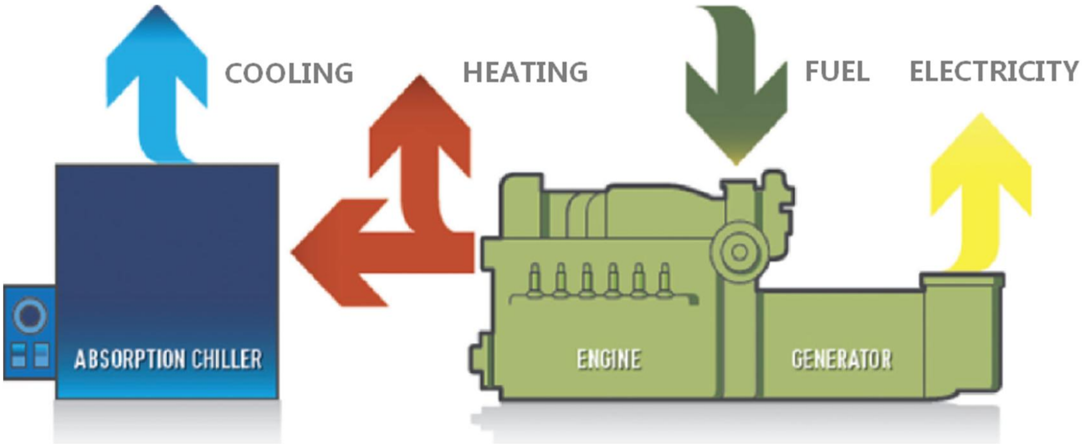



Figure 4.1 Trigeneration Schematic

The trigeneration equipment has been sized to meet a baseload of approximately 75% of the winter thermal loads in the distributed services zone. The balance of the thermal loads will be met by electric chillers, supplemented with chilled water storage.

Under this scenario additional electricity supply will be required to meet the demands within the Stage 1 distributed services zone. This shortfall will be met though grid connected solar PV systems constructed at a building level and aggregated across the development. Installations of 1-2 MW may be possible on buildings with large roof areas (such as the IKEA building). Conventional rooftop systems are envisaged. The estimated capacity of the solar PV systems for Stage 1 is 10.4 MW, requiring around 52,000m2 of PV panels.

Solar energy will not be available to meet the summer evening peak demands of the development. Accordingly it has been assumed that electrical storage of about 4 hours will be required. As the system is grid-connected, any short term shortfall in solar electricity production at night or during cloudy weather would be met by the grid.

### 4.1.2 Infrastructure Requirements

The plant has been sized from the demand profiles generated from the modelling reported in Section 2.5. The gas engines have been sized to cover the electrical demand for the entire development, including the recycled water plant, waste treatment facilities, street lighting and the energy infrastructure. During the day the engines will operated at full load, providing electricity and hot water to the district water loop and thermal energy to the absorption chillers. The chillers will operate at full load during the summer months. To service the full peak load in the summer months, chilled water storage is charged over night to supplement the chillers during the day. These will be capable of 40 MWh total storage with a peak discharge of 7.5 MWth.

The table below shows the sizing of all equipment for the development.

Table 4.1 Trigeneration Equipment

| Equipment | Stage 1 Size | Energy Hub Size | Units |
|---|---|---|---|
| Gas Engines | 3.8 | 1.9 | MWe |
| Absorption Chillers | 4 | 2 | MWth |
| Electrical Chillers | 6.6 | 3.3 | MWth |
| Central Heating Loop | 6,450 | NA | m |
| Central Cooling Loop | 6,450 | NA | m |
| Chilled Water Storage | 40 | 20 | MWh |

A map of the proposed trigeneration network is depicted in Figure 4.5.

### 4.1.3 Building design and performance implications

The demand profiles reported here are based on assumptions about the performance of buildings within the development. High energy and thermal performance buildings are critical to the feasibility of the district energy scheme. Reducing and avoiding energy consumption from design, through construction and maintaining efficient operation is significantly more economical than installing energy infrastructure to service the building. The energy scheme is designed on the assumption that all buildings will achieve the applicable 5 star National Australian Built Environment Rating Scheme (NABERS) Energy Office, Residential or Shopping Centre performance.

A 5 star NABERS office building is becoming the standard benchmark for commercial buildings with 41 buildings in Australia achieving 5 stars or higher. NABERS for residential and shopping centre buildings is a newer scheme and slightly more difficult to achieve, however 2 shopping centres have achieved 6 star NABERS energy ratings.

During the time that the SCC development is being constructed, 5 Star or higher NABERS Energy across all buildings should become the benchmark, although cannot be assumed.

The cost of improving the thermal performance of buildings to this level of efficiency (in comparison to business as usual) has been estimated at about 1.5% of building costs, or $13.5m for Stage 1.

### 4.1.4 Network implications – electricity / gas

As noted in Section 3.1, power infrastructure upgrades will be necessary in the development area. GHD has estimated that the lower electrical demand arising from adoption of the preferred concept and energy efficient buildings would reduce the peak electrical demand from 15 MVA to 7.4 MVA (50%).

GHD has estimated that this scenario would reduce the necessary upgrades to 3no. 66MVA transformers and 16 additional distribution feeders. This is less than the upgrade assessed in Volume 1 for the entire development, and Stage 1 in isolation would likely defer 1no. 66MVA transformers from 2029 to 2033.

The Western Power cost for this upgrade alone (Stage 1) would be around $57m of which the SCC share is estimated to be $3m based on load share.

The use of natural gas a source for trigeneration in the Stage 1 area increases the consumption by around 158,000 GJ pa incurring additional costs of $1.9m per annum. Carbon costs associated with this generation are estimated at $2.5m per annum in 2065. It has been assumed that the upgrade of the gas network required under BaU will be sufficient to deliver the additional gas required for the trigeneration scheme for Stage 1 (two stations only). Expansion beyond that will invoke the additional upgrades set out in Volume 1 of the report.

#### 4.1.5 Trigeneration / Solar Costs

The estimated costs for the trigeneration / solar option for Stage 1 are set out in Table 4.2.

Table 4.2 Trigeneration / Solar Costs

| **Option 1 – Trigen / Solar system** | | Capital Costs ($) | | |
|---|---|---|---|---|
| Item | Size | Unit | Cost per unit | Total cost |
| Trigen Plant | 3.8 | MW | 2,000,000 | 7,600,000 |
| Absorption chillers | 4 | MW | 500,000 | 2,000,000 |
| Solar PV | 10.4 | MW | 1,760,000 | 18,304,000 |
| Electrical storage | 3.5 | MW | 700,000 | 2,450,000 |
| Electrical chillers | 6.6 | MW | 260,000 | 1,716,000 |
| Heating Loop | 6,450 | m | 1,700 | 10,965,000 |
| Cooling Loop | 6,450 | m | 2,000 | 12,900,000 |
| Pits | 40 | | 3,000 | 120,000 |
| Pumps | 3 | | 50,000 | 150,000 |
| Chilled Water Storage | 40 | MWh | 71,800 | 2,872,000 |
| Heat rejection system | | | | 2,500,000 |
| | | | Total | 61,577,000 |

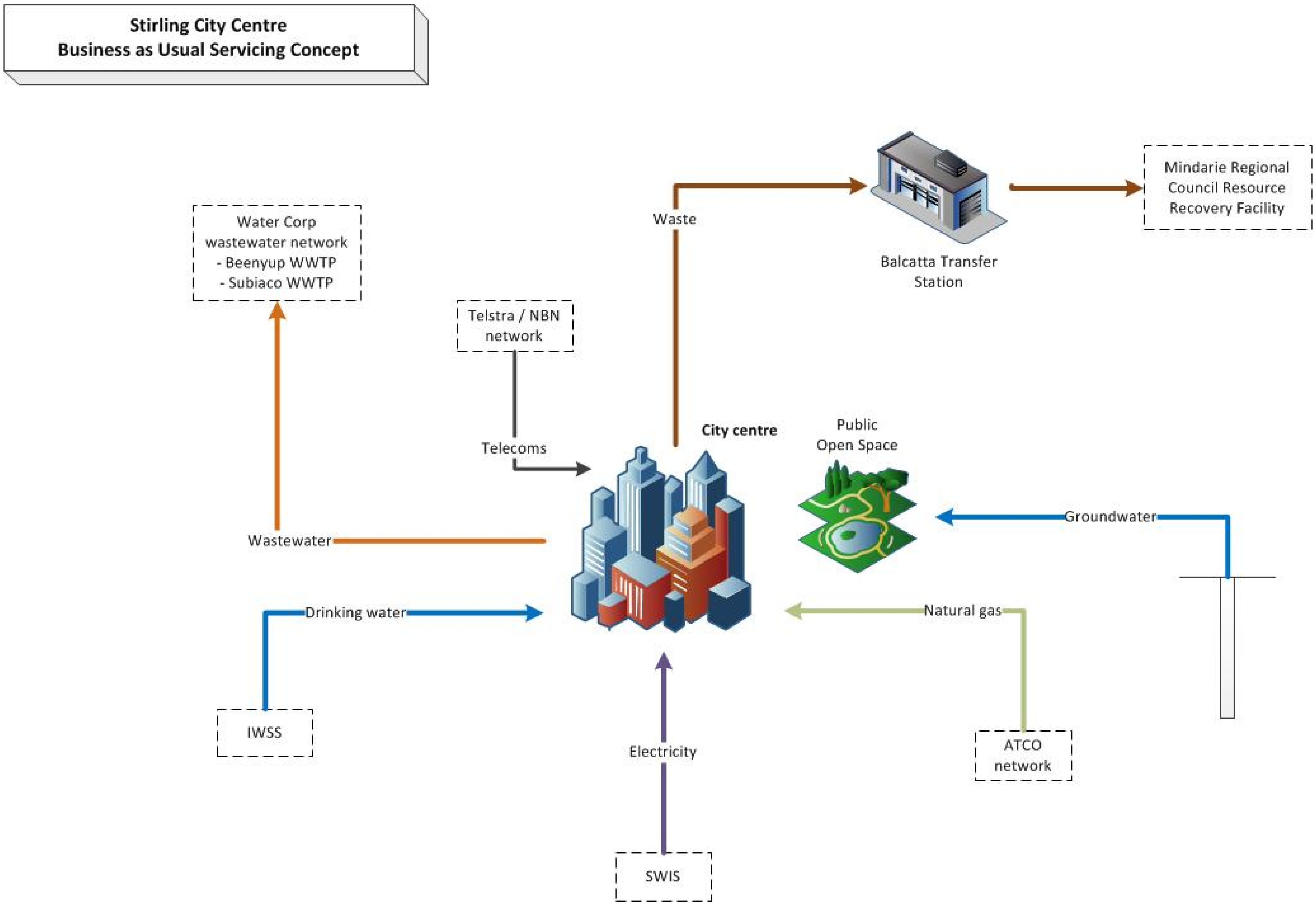



Figure 4.2 Business as Usual Scenario

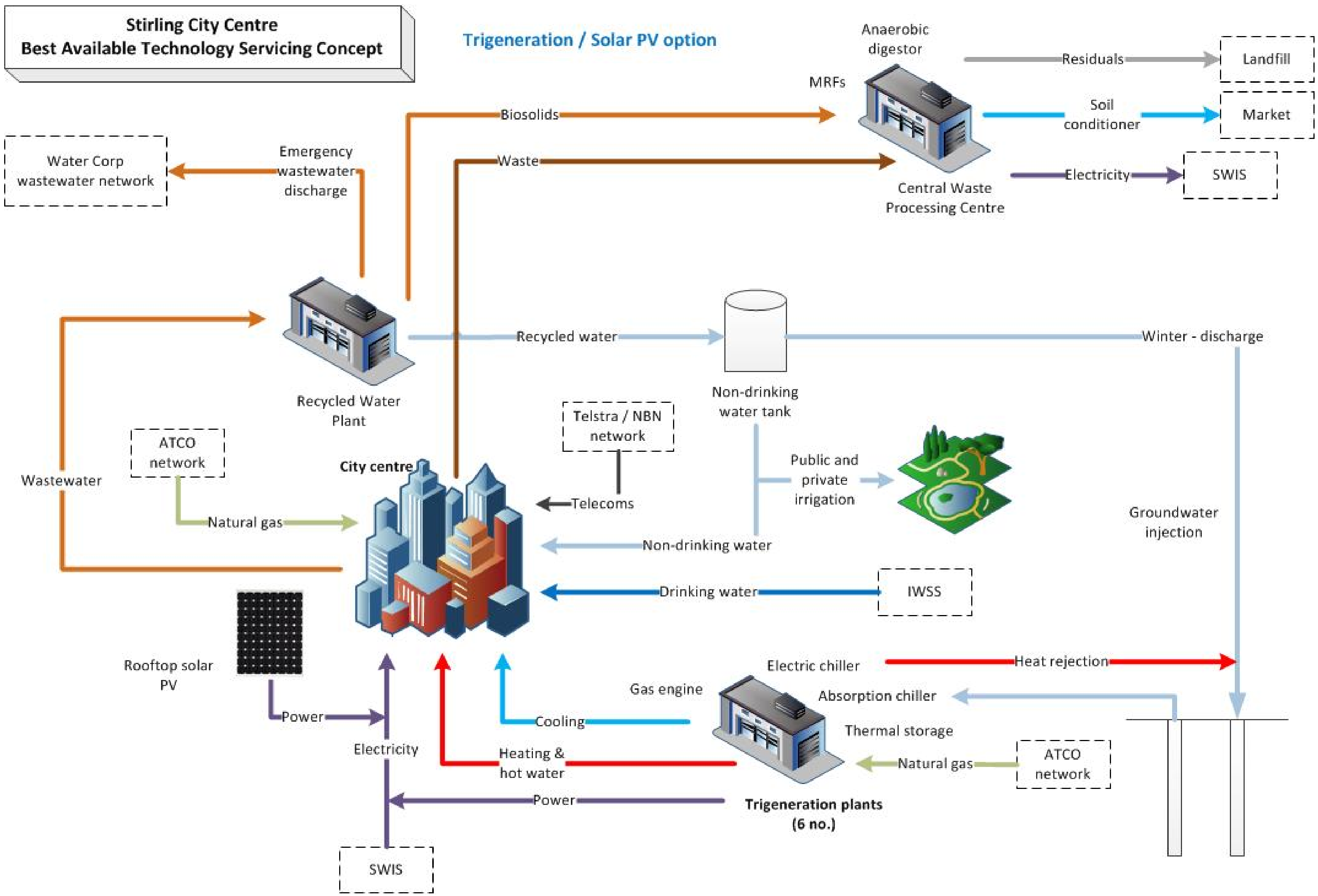



Figure 4.3 Preferred Concept - Trigeneration / Solar PV Scenario

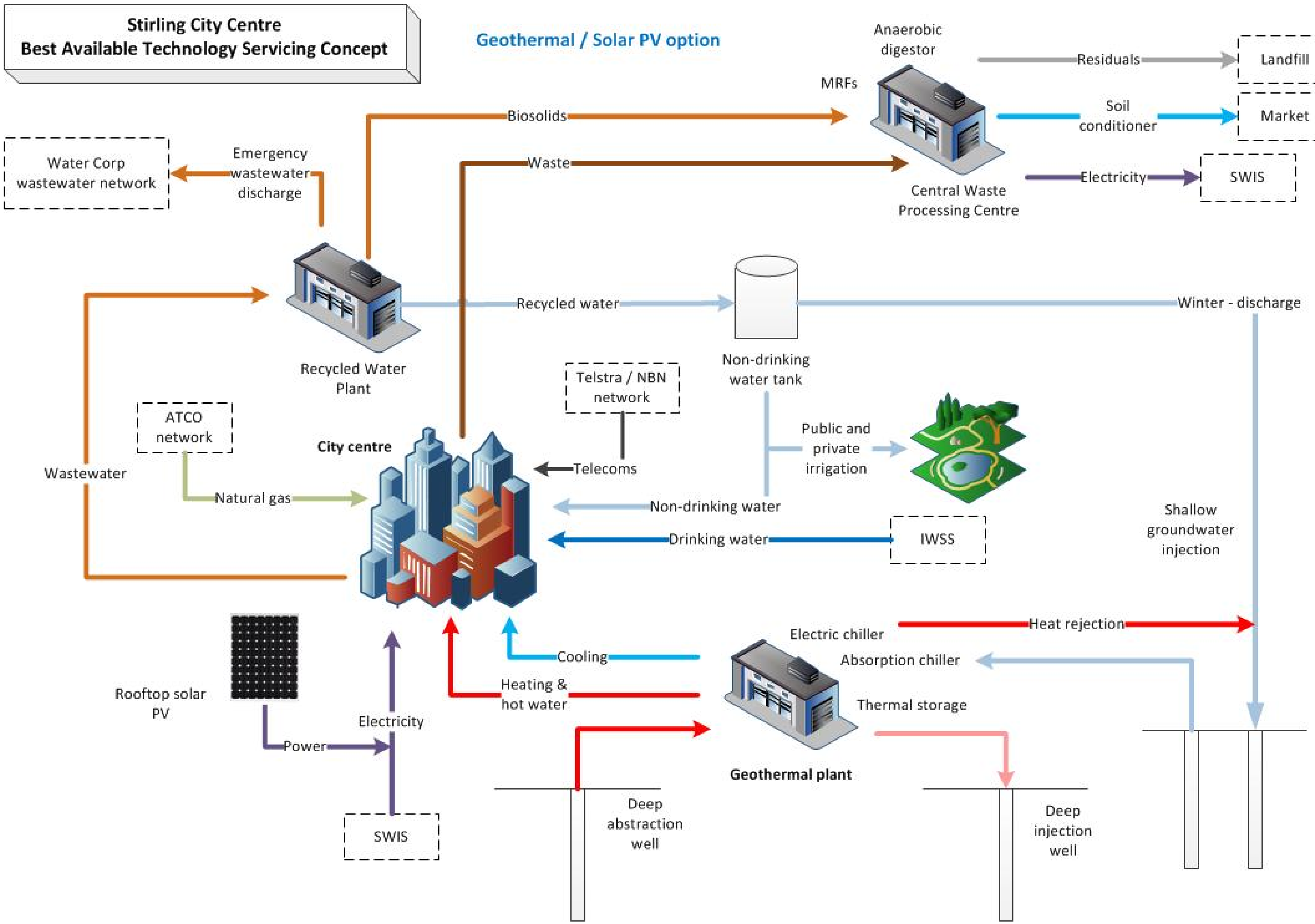



Figure 4.4 Preferred Concept – Solar / Geothermal Scenario

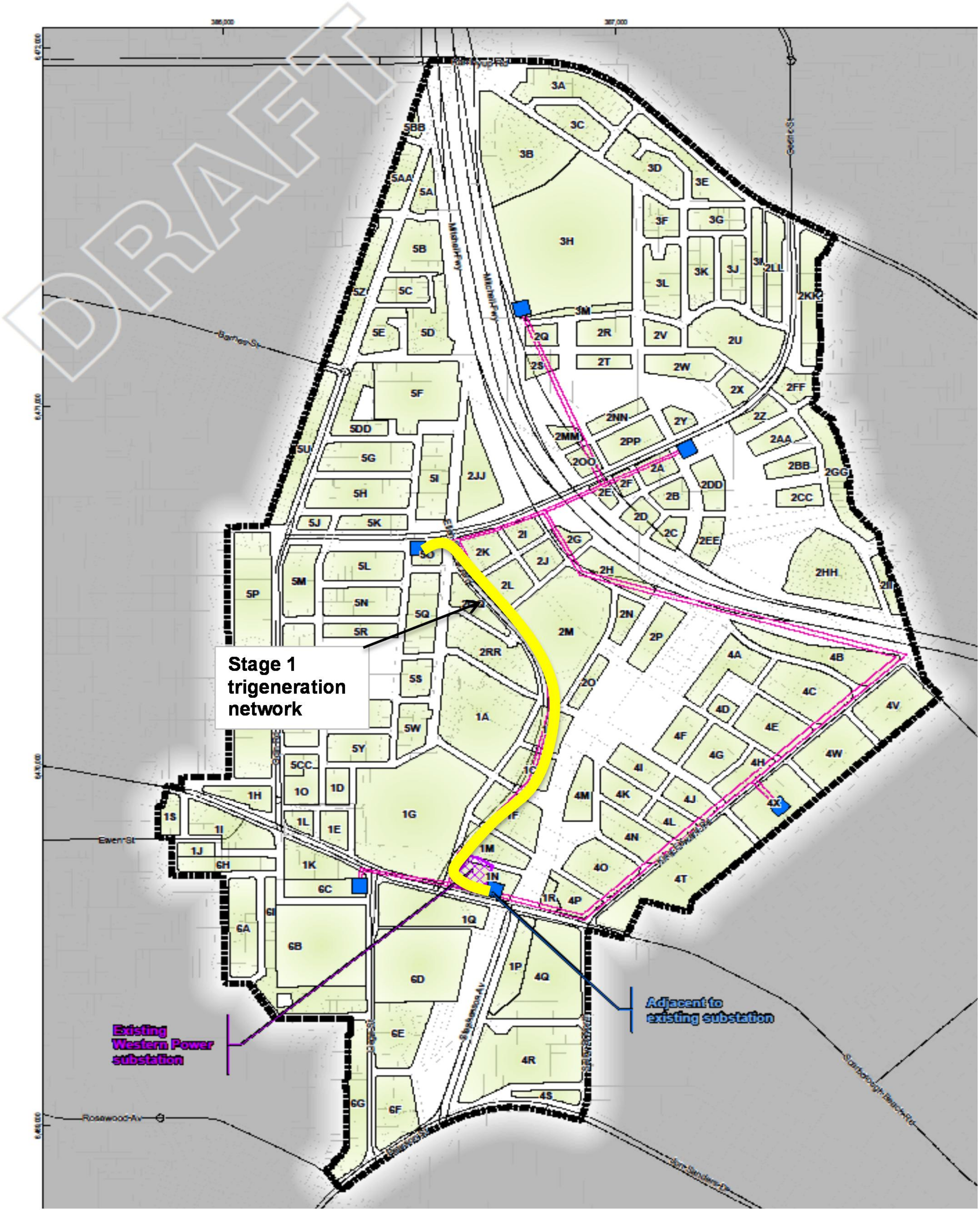



Figure 4.5 Trigeneration Network

## 4.2 Energy supply – Solar PV / Geothermal option

### 4.2.1 Electricity

In this scenario the primary electricity supply will be provided via the SWIS through grid connected solar PV systems constructed at a building level and aggregated across the development. Installations of 1-2 MW may be possible on buildings with large roof areas (such as the IKEA building). Conventional rooftop systems are also envisaged.

Assuming a solar PV array of 14.5 MW for Stage 1, some 72,500 m2 of solar panels would be required for Stage 1. Noting that the IKEA site is some 15,000 m2, the required capacity to meet peak power could be obtained from the roofs of 5 equivalent sized buildings. It is envisaged that the local utility would secure rights to roofs within the development for solar PV installations through the planning scheme, and negotiate leasing arrangements with building owners. Appropriate buildings would include the IKEA building, the Westfield shopping centre, energy stations and other buildings within the development, and light industrial buildings in the adjacent Osborne Park area.

Solar energy may not be available to meet the summer evening peak demands of the development. Accordingly it has been assumed that electrical storage of about 4 hours will be required.

Previous concerns about the impact of local solar on the grid have been alleviated by the recently completed Solar Cities project. However, close coordination with Western Power will be required in the grid integration design process.

### 4.2.2 Thermal Energy

The thermal network under this scenario would be supplied by geothermal energy. Although geothermal energy can potentially be used to generate electricity, in the context of this project it is being considered as a heat source for the proposed thermal network.

As described in detail in Volume 1 of the report, the groundwater temperature may reach well in excess of 100°C at 3000 m depth. This temperature is suitable to drive an absorption chiller for thermal energy (mainly air-conditioning), given a suitably productive geothermal resource. It is also possible to operate absorption chillers at the lower temperature of 80°C with accompanying lower coefficients of performance.

### 4.2.3 Network implications – electricity / gas

The use of geothermal as a thermal energy source removes the need for natural gas as a feedstock and hence upgrades for the gas distribution network for this purpose will not be necessary.

### 4.2.4 Solar PV / Geothermal Costs

The cost of solar PV has declined significantly in recent years and this is forecast to continue. A recent survey[3] identifies a Perth cost range of $1.38 - $2.93 (average $1.63) per watt for systems in the range of 1-5kW. The average across Australia is $1.76. Costs include the installed costs of panels, inverters and grid connections but not meters. The $1.76 figure has been used here, although this may be conservative in that real costs will continue to fall, and large scale purchases would likely achieve better prices than small scale systems. These costs include the value of small-scale technology certificates (STCs) a tradeable commodity attached

[3] http://www.businessspectator.com.au/article/2013/7/4/solar-energy/solar-pv-price-check-july?utm_source=exact&utm_medium=email&utm_content=342241&utm_campaign=cs_daily&modapt=

to eligible installations of renewable energy systems[4]. STCs accounted for an effective discount of around 68c per watt in Perth at the time of the survey.

Solar PV will not achieve the same output as the trigeneration option at the time of peak power, particular the evening peak. Accordingly it is likely to be necessary to incorporate electrical storage sufficient to provide around 4 hours of storage. The costs of electrical storage have been very high but are dropping rapidly with the take up of renewable energy[5]. A figure of $700 per kW has been adopted here. A specific storage technology solution has not been determined at this stage, although several are reviewed in a recent report prepared for the Clean Energy Council including flow and lithium ion batteries and compressed air.

For the purposes of this study, it is assumed that a suitable geothermal resource is available at a depth of 1500 – 3000m. As cost variables for a drilling program include rig availability and delays in the drilling itself, which can add proportionately considerable cost increases, together with other considerations such at target depth and planned well development. Therefore it is appropriate to consider a cost estimate for a well doublet in the range of $15-25m. The upper bound figure has been used here.

Table 4.3 Solar PV / Geothermal costs

| Option 2 – Solar PV / Geothermal system | | Capital Costs | | |
|---|---|---|---|---|
| Item | Size | Unit | Cost per unit | Total cost |
| Solar PV | 14.5 | MW | 1,760,000 | 25,520,000 |
| Electricity storage | 4.85 | MW | 700,000 | 3,395,000 |
| Geothermal bore completion | 1 | Doublet | 25,000,000 | 25,000,000 |
| Absorption chillers | 12 | MW | 500,000 | 6,000,000 |
| Electrical chillers | 6.6 | MW | 260,000 | 1,716,000 |
| Heating Loop | 6,450 | m | 1,700 | 10,965,000 |
| Cooling Loop | 6,450 | m | 2,000 | 12,900,000 |
| Pits | 40 | | 3,000 | 120,000 |
| Pumps | 3 | | 50,000 | 150,000 |
| Chilled Water Storage | 40 | MWh | 71,800 | 2,872,000 |
| Heat rejection system | | | | 2,500,000 |
| | | | Total | 91,138,000 |

## 4.3 Water, Wastewater and Drainage

### 4.3.1 Scheme Water

The proposed water recycling scheme is expected to reduce potable demands by around 50% in the Stage 1 area. If it is assumed that the peak instant demand on the potable network reduces in proportion to this, larger potable water mains within the area would be able to be downsized.

Over the size range relevant here (approx DN100 to DN600), mains would generally only be able to be downsized to the next standard WC main size.

### 4.3.2 Water Recycling

The water recycling scheme proposed for the SCC is based on the following assumptions.

[4] http://ret.cleanenergyregulator.gov.au/Certificates/Small-scale-Technology-Certificates/what-is-stc
[5] http://reneweconomy.com.au/2013/energy-storage-costs-to-halve-market-set-to-boom-study-52851

- wastewater collected from residential and commercial properties will be treated at a Recycled Water Plant (RWP). Recycled water from the RWP will be used to meet all non-potable water demands within the SCC including residential in-house non-potable uses (toilet flushing and cold washing machine tap), commercial toilet flushing, 'new' POS irrigation (POS that doesn't currently exist and is established within the SCC), and road verge irrigation for areas established within the SCC; and.
- new POS irrigation and verge irrigation water will be sourced from recycled water created within the SCC while the existing POS irrigation source will remain local groundwater using current groundwater licences.

### 4.3.3 Wastewater Conveyance

The required wastewater upgrades for BaU are described in Section 3.4.2.

The required upgrades for the BAT strategy are described in detail in Volume 1 of the report and briefly summarised below.

- construct a Recycled Water Plant (RWP); and
- reconfigure WWPSs and associated pressure mains to pump all wastewater from WWPSs 10 (Twyford Place) and 11 (Civic Place) to the WRP.

It is proposed to progressively transfer these pump stations to the WRP as the SCC area is developed and recycled water demands within the area increase. Initial transfer of the Twyford Place pump station to the WRP will provide approximately 1.0 ML/d of recycled water to meet early recycled water demands within the area.

### 4.3.4 Recycled Water Plant

A RWP is proposed to be built to treat wastewater from a number of the Water Corporation's WWPSs with catchments within or extending into the SCC area. The plant will provide high quality recycled water which will be used to meet non-drinking water demands within the area. A secondary benefit is that it will reduce the volume of wastewater that needs to be conveyed to the Beenyup WWTP, and subsequently treated at this plant and discharged via ocean outfall.

A full description of the RWP is included in Volume 1.

It is envisaged that Stage 1 will require a capacity of around 1.5 ML/day which will grow to 3.5 ML/day at ultimate.

### 4.3.5 Recycled Water Distribution System

It is proposed to supply NDW from centralised NDW storage tanks located at the RWP site, via an adjacent booster pump station designed to meet the minimum pressure requirement over the full range of potential NDW demands. The key design criteria for the recycled water distribution system are detailed in Volume 1.

Hydraulic modelling has not been undertaken as part of this study to size NDW distribution and reticulation pipe networks. Rather, for the purpose of the preliminary cost estimate included in the report, it has been assumed that:

- the distribution network will comprise a DN300 ring main and a DN375 main to supply NDW from the delivery pump station to the ring main; and
- reticulation mains connected into the ring main will supply NDW through the served area. For the purpose of the cost estimate it has been assumed that 10%, 15% and 75% of the total length of reticulation mains are DN200, DN150 and DN100 reticulation mains, respectively.

### 4.3.6 Aquifer Storage and Recovery

ASR is being considered as a means of storing excess recycled water in the winter months, to be abstracted in the summer months if / when there is a shortfall of recycled water. The abstracted recycled water from the groundwater will then be added to the non-potable network within the SCC.

If the excess recycled water produced is not required for the non-drinking water scheme it will remain in the superficial aquifer. The quality of the water being injected into the superficial aquifer will be that which is produced by the recycled water treatment plant. The disinfection arrangements for the RWP would be configured such that surplus water would not be disinfected prior to injection.

The concept for ASR is to inject excess recycled water when it is produced into bores in the superficial aquifer in the road reserve along King Edward Rd. Further modelling is required to determine the feasibility of this disposal option. It is estimated that an area of 20x20m is required for a superficial ASR bore.

### 4.3.7 Groundwater as an Alternative Source

An alternative to ASR would be using groundwater as a top-up resource if / when there is a shortfall of recycled water. In such a case the water quality of the superficial groundwater is important in terms of meeting the quality required for the non-potable network. The water quality of the ambient groundwater in the superficial aquifer may be problematic, particularly to meet aesthetic water quality targets. Iron concentrations in the groundwater are of particular concern as they exceed water quality targets. Shandying the abstracted groundwater with the recycled water may not be enough to lower iron concentrations to within the aesthetic water quality targets. Treatment will be needed for the abstracted groundwater water prior to addition to the non-potable network if it proves to be necessary to meet demand (not costed here).

Groundwater quality data is included in Volume 1.

***Water quantity summary***

During winter the daily recycled water injection required is estimated to be 0.37 ML/day. This is for five months from May to September and is based on conventional water use. This is equivalent to 3.6 L/s for injection in the winter months. During the summer months (December to February), the daily recycled water injection required is around 0.1 ML/day.

At full development, the aquifer storage scheme will be required to inject an estimated 490 ML/year. Preliminary modelling suggests that this will have some impact on the groundwater levels – preliminary estimations suggest that the groundwater level will increase by less than 1m during injection. The Stage 1 volume is around 100 ML/year, and so the impact will be significantly less than this.

There may be some minimal losses to the stream (previously Osborne Park Branch Drain). However, more detailed modelling will be required to further interpret the interaction between injection, abstraction, groundwater levels and losses to the stream. The results of this modelling will be included in the Total Water Cycle Options Report (GHD 2013).

### 4.3.8 Drainage

The draft District Water Management Strategy (Essential Environmental Services 2010) requires best practice water sensitive urban design (WSUD) features for the development. Where possible, all stormwater from frequent events will be collected / treated on lots, and street drainage will incorporate rain gardens, swales and other management devices. Less frequent, higher rainfall events will utilise the street drainage system to convey water through the existing stormwater system. Stormwater within the relevant catchment will be discharged into the urban stream corridor where it will be naturally treated and conveyed into the steam channel.

Design of the streetscape WSUD features and of the urban stream are the subject of separate commissions, and accordingly are not addressed here.

#### 4.3.9 Building design and performance implications

The delivery of the proposed water cycle and recycled water network has implications for building design.

Waterwise demands have been assumed meaning that water efficiency practices will need to be mandated for buildings, including water efficient fixtures and fittings internally, and water efficient irrigation practices.

The recycled water network will require additional plumbing in buildings to accommodate a second water supply. For present purposes it has been assumed that the cost of this is incorporated in the increased building costs to achieve 5 star building performance (see Section 4.1.3).

#### 4.3.10 Network implications

The proposed recycled water system will have significant implications for the Water Corporation's potable water supply and wastewater networks, and also affect the quantity and quality of groundwater entering the urban stream. A brief summary of these implications, which are similar for Stage 1, is provided in Volume 1.

#### 4.3.11 Costs

**Scheme Water Headworks:** The capital cost of the proposed ultimate headworks upgrades is estimated at $2.5m for the mains upgrades (a saving of $0.5m on BaU). A provisional amount of $1m has been assumed for additional distribution upgrades (a saving of $1m on BaU). It is anticipated that these upgrades will be necessary for Stage 1.

The cost of additional source has been estimated at the value of the LRMC of water, taken as $1.75 / kL (2012/13 figure plus inflation) – see Section 3.3.3. This amount effectively recovers the capital and operating costs of new sources of water on the IWSS. This rate leads to a cost of $0.35m pa for the 0.2 GL pa drinking water demand from Stage 1.

**Scheme Water Reticulation:** The cost of scheme water reticulation is assumed to be the same as in the BaU case, i.e. $5.7 m including contingency and preliminaries.

**Sewer Headworks:** The cost of WWTP upgrades is avoided with this option. The costs of upgrades to the local wastewater system are estimated as follows.

| Item | Capital cost |
|---|---:|
| Pump Stations | $1.8 m |
| Sewer upgrade | $0 |
| RWP collection | $0.95m |
| Main sewer upgrade | $0 |
| **Total** | $ 2.75m |

**Sewer reticulation:** is assumed to be the same as the BaU scenario, i.e. $6.0 m.

**Recycled Water Plant:** The cost of providing the first stage (1.5 ML/day) of a recycled water plant with an ultimate capacity of 3.5 ML/day is $13m including contingency and preliminaries. Operating costs are estimated at $0.85/kL.

**Non Drinking Water distribution / reticulation:** The cost of the distribution and reticulation (third pipe) network for Stage 1 is $7.1m. Operating costs are estimated at $0.15/kL.

**Non Drinking Water disposal:** The cost of the groundwater disposal system is estimated at $1.1m with operating costs of $0.04/kL.

## 4.4 Waste

The proposed waste concept described in Volume 1 assumes that waste is collected across the entire City of Stirling and processed centrally in waste-to-energy facilities at Balcatta. Under this scenario the SCC only contributes some 25% of the total waste at ultimate development. The Stage 1 development area will contribute less than half of the ultimate SCC area. Accordingly the generation of waste at Stage 1 will not significantly influence overall waste quantities.

It has been assumed in the following sections that the strategy would still be implemented across the City of Stirling, but the demands from the SCC for waste and for energy are scaled down.

### 4.4.1 Waste Collection

The proposed waste collection arrangements for the ultimate development are described in detail in Volume 1. The following commentary relates to the application of this strategy in the Stage 1 area.

Normal mixed bagged waste from multi-unit dwellings in the more densely populated Stage 1 areas will be placed by residents in chutes in their buildings which will be connected to a vacuum waste collection system. No system for the separate collection of recyclables will be provided within residential buildings. Bagged waste from multi-unit dwellings will include all recyclables.

Commercial premises generating mixed bagged waste will also place this into the vacuum waste system through separate entry points. A system for the collection of separated recyclables will be available for commercial premises and in public areas, although it is expected that some recyclables will remain in the mixed waste system.

Waste placed in the vacuum system will be transported through the systems pipes to a central terminal in the SCC area. From here it will be collected by Council (using vehicles running on biogas generated from the anaerobic digestion plant), or a contractor, and taken by road to the CWPF.

Bulk bins, either in-ground or above ground, will be provided for recyclables in public areas for commercial premises and the public to use. The bins will allow commercial businesses and the public to separate and dispose of recyclable containers and recyclable paper and cardboard. These bins will be collected by Council (using vehicles running on biogas generated from the anaerobic digestion plant), or a contractor, and taken by road to the CWPF.

### 4.4.2 Waste Separation

At the CWPF, bagged waste collected from the vacuum terminal, as well as bulky waste collected in the occasional bulky waste skips, will be processed through a ‘dirty MRF’. This will separate the different components using a series of plant and equipment that takes advantage of the physical characteristics of the waste. Typical elements include rotating trommels, vibrating and rotating screens, magnets and eddy currents, air classifiers and possibly some sorting by hand.

Materials likely to be separated include organics, glass, ferrous and non-ferrous metals, hazardous materials, recyclable and non-recyclable paper and cardboard, timber, textiles, organics and recyclable and non-recyclable plastics. Waste from the transfer station will also be processed through the dirty MRF.

The recyclable containers, paper and cardboard collected from the bulk bins will be processed through a clean MRF using similar technology as the dirty MRF. Residual materials from this MRF will be transferred for processing through the dirty MRF. Materials likely to be separated include glass, ferrous and non-ferrous metals, hazardous materials, recyclable paper and cardboard and plastics, non-recyclable paper and cardboard. Residual material will be sent to the dirty MRF.

Depending on the quality, recyclables recovered from the dirty MRF will be aggregated with recyclables recovered from the clean MRF. Hazardous materials will be sent for suitable disposal or recovery.

### 4.4.3 Waste Processing

The processing of waste at the CWPF is described in detail in the Volume 1 report. This involves anaerobic digestion of separated organics and biosolids from the recycled water plant.

The AD process produces biogas and solid digestate. The biogas has several potential uses as fuel in the SCC including as a feedstock for electricity production or a fuel for Council vehicles.

GHD’s projections indicate that the capacity of the dirty MRF required by the time of the ultimate development would be about 180,000 tonnes per year of which about 73,000 tonnes would be separated for AD feedstock. This would generate about 8.1 million m3 of biogas, 14,500 tonnes of digestate, 16,700 tonnes of leachate and 8,700 tonne of water vapour.

The Stage 1 area is likely to contribute some 11,270 tonnes of total waste per annum, representing only about 22% of the total ultimate SCC volumes.

#### *Waste to Energy*

Separated non-recyclable material (non-recyclable paper, plastics and other high-calorific materials such as timber and textiles) could be used as a fuel in an off-site waste-to-energy facility using a gasification process (e.g. East Rockingham proposed plant). Gasification is the combustion of feedstock in a low oxygen environment. The process generates a syngas and a solid ash. The syngas can be used as a fuel which could feed into electricity production while the ash would be landfilled.

It is not proposed that gasification is adopted as a component of this strategy but is a possible option for the future.

### 4.4.4 Waste Facilities

A full discussion of the options for facilities is included in Volume 1.

The City of Stirling owns and operates a transfer station at Balcatta several kilometres north of the SCC area. For the purposes of this report it is assumed that all waste facilities will be housed at that location.

The proposed waste facilities will only produce a minor quantum of the electricity supply, and so are not an integral component of the servicing strategy for the development area, either in the Stage 1 area or the total development. Accordingly the early construction of the facilities is not critical to servicing Stage 1. However for the purposes of this report it has been assumed that this element of the strategy would proceed as part of Stage 1, noting that these facilities service the whole of the City of Stirling, not just the SCC.

### 4.4.5 Implications for the City of Stirling waste management

It is apparent from the figures calculated by GHD that a separate waste processing system of the type proposed (mechanical separation, anaerobic digestion and gasification) is not viable for the low tonnages likely to be generated from the SCC area. Only processing all of the waste generated in the City of Stirling would provide the volumes that would make the proposed process viable. It is considered that the City of Stirling is large enough to consider a waste management solution of this size.

The City of Stirling currently uses a one bin system across all residential areas, all waste generated from each household is placed in a single bin. There is no separation of recyclables or organics at the source, separation is undertaken mechanically at a processing facility. If the processing system detailed above was adopted, the one bin system would remain and the majority of residents would notice no change in their waste collection service.

Regardless of the technology chosen, a system like that proposed would provide Council with significant independence for its waste system. Council would not depend on external operators or organisations, such as Mindarie Regional Council, to process its waste. With this independence however, comes considerable expense and risk.

While the anaerobic digestion technology is well developed for processing specific single stream waste types, few successfully process municipal and mixed waste. The capital costs are high and should the technologies fail, Council could be severely compromised logistically and financially. The risk model for ownership and operation of the facility will have to be carefully considered.

Odour and noise control will also be major issues for Council to consider and significant community engagement over these issues and health risk perceptions will be required.

### 4.4.6 Building design and performance implications

The major implication for buildings arising from the strategy is revised collection facilities. It is proposed that a vacuum waste system operates in the SCC, including the Stage 1 area. The vacuum pipe system will need to be integrated into the building design, but it has been assumed at this stage that this can be readily accommodated within conventional building service cores.

Conventional waste storage will not be necessary, which will reduce space requirements and costs at the building scale.

### 4.4.7 Costs

The costs of the new technologies described above and in more detail in Volume 1 are summarised below.

| | Capex ($m) | Opex ($m) |
|---|---|---|
| Additional operating costs | | 1.100 |
| Vacuum waste system | 22.50 | 0.338 |
| Dirty MRF | 15.00 | 7.000 |
| Clean MRF | 10.00 | 1.400 |
| Anaerobic digestor | 50.00 | 4.000 |
| Biogas treatment | 1.25 | 0.019 |
| | 98.75 | |

## 4.5 Telecommunications

A modern telecommunications system as described in Section 3.7 is independent of other technologies and is common to both the BaU and BAT concepts.

## 4.6 Cost Summary – BAT Options

Capital and estimated operating costs are presented below for both BAT options (Table 4.4 and Table 4.5 and summarised in Table 4.6 together with BaU. All costs are in 2013$m. This information does not readily facilitate a life cycle cost comparison between the options as the timing of capital and operating spend is different for the options. In particular the BaU option involves costs which are difficult to forecast, including the future mix of generation on the SWIS, fuel costs and carbon costs. A full life cycle cost comparison is the subject of a separate parallel report. The figures include contingencies and preliminaries.

Table 4.4 Summary of estimated capital and operating costs – Trigeneration / Solar Option

| Service | Description | Capex ($m) | Opex ($m) |
|---|---|---|---|
| **Water** | | | |
| Potable | Upgrade source / treatment / conveyance (1) | | 0.350 |
| | Upgrade storage | | |
| | Upgrade distribution mains | 3.500 | - |
| | New & upgraded reticulation | 5.700 | |
| | New meters | | |
| Wastewater | Upgrade WWTP | - | |
| | Upgrade main sewer | - | |
| | Upgrade pump stations | 1.800 | |
| | RWP collection | 0.945 | |
| | Upgrade local reticulation | 6.000 | |
| Drainage | New road drainage | 2.500 | |
| Non-drinking water | Recycled Water Plant | 13.000 | 0.457 |
| | RW distribution | 3.000 | 0.036 |
| | RW reticulation | 4.100 | |
| | RW disposal | 1.100 | 0.015 |
| **Energy** | | | |
| Electricity | Substation upgrades | 2.700 | 0.095 |
| | New distribution feeders | 0.6 | 0.021 |
| | LV transformers & switchgear | 4.400 | 0.154 |
| | Undergrounding and line removal | 4.268 | |
| Local Generation | Gas engines | 7.600 | 0.266 |
| | Solar PV | 18.304 | 0.275 |
| | Electrical storage | 2.450 | 0.086 |
| Thermal Network | Absorption chillers | 2.000 | 0.070 |
| | Electric chillers | 1.716 | 0.060 |
| | Chilled water storage | 2.872 | 0.101 |
| | Hot water network | 10.965 | 0.384 |
| | Chilled water network | 12.900 | 0.452 |
| | Pits and pumps | 0.270 | 0.009 |
| | Heat rejection system | 2.500 | 0.088 |
| Gas | Distribution upgrades | 1.240 | 0.043 |
| | Reticulation upgrades | 0.563 | 0.020 |
| | Gas consumption | | 0.940 |
| | Additional fuel for trigeneration | | 1.940 |

| | | | |
|---|---|---|---|
| | Carbon costs for additional fuel | | 2.500 |
| **Waste** | Additional operating costs | | 1.100 |
| | Vacuum waste system | 22.500 | 0.338 |
| | Dirty MRF | 15.000 | 7.000 |
| | Clean MRF | 10.000 | 1.400 |
| | Anaerobic digestor | 50.000 | 4.000 |
| | Biogas treatment | 1.250 | 0.019 |
| **Telecoms** | Upgrades / NBN | 3.900 | 0.098 |
| | **Total Infrastructure** | **219.643** | |
| **Building costs** | | | |
| | Improved thermal efficiency | 13.500 | |
| | **Total** | **233.143** | |

Table 4.5 Summary of estimated capital and operating costs – Solar / Geothermal Option

| Service | Description | Capex ($m) | Opex ($m) |
|---|---|---|---|
| **Water** | | | |
| Potable | Upgrade source / treatment / conveyance (1) | | 0.350 |
| | Upgrade storage | | |
| | Upgrade distribution mains | 3.500 | |
| | New & upgraded reticulation | 5.700 | |
| | New meters | | |
| Wastewater | Upgrade WWTP | - | |
| | Upgrade main sewer - SCC component | - | |
| | Upgrade pump stations | 1.800 | |
| | Local trunk sewers and rising mains | 0.945 | |
| | Upgrade local reticulation | 6.000 | |
| Drainage | New road drainage | 2.500 | |
| Non-drinking water | Recycled Water Plant | 13.000 | 0.457 |
| | RW distribution | 3.000 | 0.036 |
| | RW reticulation | 4.100 | |
| | RW disposal | 1.100 | 0.015 |
| **Energy** | | | |
| Electricity | Substation upgrades | 2.700 | 0.095 |
| | New distribution feeders | 0.600 | 0.021 |
| | LV transformers & switchgear | 4.400 | 0.154 |
| | Undergrounding and line removal | 4.268 | |
| Local Generation | Solar PV | 25.520 | 0.383 |
| | Electrical storage | 3.395 | 0.119 |
| Thermal Network | Geothermal bore - doublet | 25.000 | 0.750 |
| | Absorption chillers | 6.000 | 0.070 |
| | Electric chillers | 1.716 | 0.060 |
| | Chilled water storage | 2.872 | 0.101 |
| | Hot water network | 10.965 | 0.384 |
| | Chilled water network | 12.900 | 0.452 |
| | Pits and pumps | 0.270 | 0.009 |

| | | | |
|---|---|---|---|
| | Heat rejection system | 2.500 | 0.088 |
| Gas | Distribution upgrades | 1.240 | 0.043 |
| | Reticulation upgrades | 0.563 | 0.020 |
| | Gas consumption | | 0.940 |
| **Waste** | Additional operating costs | | 1.100 |
| | Vacuum waste system | 22.500 | 0.338 |
| | Dirty MRF | 15.000 | 7.000 |
| | Clean MRF | 10.000 | 1.400 |
| | Anaerobic digestor | 50.000 | 4.000 |
| | Gasification plant | | |
| | Biogas treatment | 1.250 | 0.019 |
| | Syngas treatment | | - |
| **Telecoms** | Upgrades / NBN | 3.900 | 0.098 |
| | **Total Infrastructure** | **249.204** | |
| **Building costs** | | | |
| | Improved thermal efficiency | 13.5 | |
| | **Total** | **262.704** | |

(1) This figure is an annualised cost based on the current long run marginal cost of water (LRMC) determined by the Water Corporation and agreed with the Economic Regulatory Authority. This per kL figure incorporates both capital and operating costs.

Table 4.6 Summary of estimated capital and operating costs – BaU vs BAT ($m)

| | | BaU | | Trigen / Solar | | Solar / Geothermal | |
|---|---|---|---|---|---|---|---|
| | | Capex | Opex | Capex | Opex | Capex | Opex |
| Water | | | | | | | |
| | Potable (1) | 10.700 | 1.111 | 9.200 | 0.350 | 9.200 | 0.350 |
| | Wastewater | 21.444 | 0.093 | 8.745 | - | 8.745 | - |
| | Drainage | 2.500 | | 2.500 | | 2.500 | |
| | Non-drinking water | | | 21.200 | 0.508 | 21.200 | 0.508 |
| | | 34.644 | | 41.645 | | 41.645 | |
| Energy | | | | | | | |
| | Electricity | 16.688 | 0.434 | 11.968 | 0.270 | 11.968 | 0.270 |
| | SWIS generation | 31.000 | 17.300 | | | | |
| | Local Generation | | | 28.354 | 0.627 | 23.405 | 0.419 |
| | Thermal Network | | | 33.223 | 1.164 | 63.123 | 1.914 |
| | Gas | 1.803 | 1.003 | 1.803 | 5.433 | 1.803 | 1.003 |
| | | 49.471 | | 75.348 | | 104.909 | |
| Waste | | - | 2.100 | 98.750 | 13.857 | 98.750 | 13.857 |
| Telecoms | | 3.900 | 0.098 | 3.900 | 0.098 | 3.900 | 0.098 |
| | **Ttl infrastructure** | **88.015** | | **219.643** | | **249.204** | |
| Building costs | | 50.400 | 1.260 | 13.500 | - | 13.500 | - |
| | **Total** | **138.415** | | **233.143** | | **262.704** | |

(1) The Opex figures represent annualised costs for IWSS upgrades based on the current long run marginal cost of water (LRMC) determined by the Water Corporation and agreed with the Economic Regulatory Authority. This per kL figure incorporates both capital and operating costs.

These figures show significantly higher capital costs for the BAT infrastructure options, reflecting the initial cost of establishing the local energy, water and waste technologies.

## 4.7 Land Requirements

A preliminary estimate of the required land for the facilities described above is set out in the table below. Assumptions are:

- waste facilities at existing Balcatta site;
- trigeneration plants to be distributed across development and 2 of the ultimately required 6 hubs will be built within Stage 1;
- recycled water plant needs to be as central as possible but assumed to be in the Osborne Park Industrial Area – entire site required for Stage 1;
- existing Western Power site is necessary to retain; and
- a new site should not be required under the BAT solution if the existing sub-station can be expanded. If not 0.25 – 0.35 ha will be required for such a site, probably located adjacent to or in the nearby industrial area.

### Table 4.7 Land requirements

| Plant | Hectares |
|---|---|
| **Waste** | |
| Clean MRF | 0.50 |
| Dirty MRF | 0.96 |
| Anaerobic digestion plant | 0.50 |
| Storage and loading | 0.25 |
| | 2.21 |
| **Energy** | |
| Power plant (2no. X 1600m2) | 0.32 |
| Second substation | 0.35 |
| | 0.67 |
| **Water** | |
| Recycled water plant | 0.45 |
| NDW storage | 0.30 |
| Abstraction / discharge plant | 0.20 |
| | 0.95 |
| **Total land take** | **3.83** |

A very preliminary concept has been identified for the service corridor and this is described in Volume 1.

GHD

GHD House, 239 Adelaide Tce. Perth, WA 6004
P.O. Box 3106, Perth WA 6832
T: 61 8 6222 8222 F: 61 8 6222 8555 E: permail@ghd.com.au



G:\61\28902\WP\136863.docx

Document Status

| Rev No. | Author | Reviewer | | Approved for Issue | | |
|---|---|---|---|---|---|---|
| | | Name | Signature | Name | Signature | Date |
| 0 | W. Grace | T. Eldridge | [signature] | P. Tilley | [signature] | 3 Dec 2013 |
| | | | | | | |
| | | | | | | |

www.ghd.com