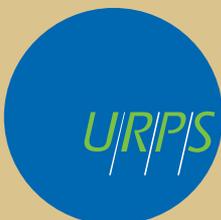




AdaptWest

Assets, Infrastructure and Economy
Research Paper
28 November 2014



URPS in collaboration with SEED consulting and AECOM



AdaptWest Research Paper

Assets, Infrastructure and Economy

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28 November 2014

Prepared for City of Port Adelaide Enfield
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1.0 Introduction

1.1. About AdaptWest

AdaptWest is a partner project between the Cities of Port Adelaide Enfield, Charles Sturt and West Torrens, the South Australian Government and the Australian Government to develop a Regional Climate Change Action Plan for Western Adelaide.

In 2013, an initial stage of work was completed comprising a social, economic and environmental profile of the Western Adelaide region, and collation of historical climate observations and future climate projections.¹

The current stage of AdaptWest builds upon this previous work and is being delivered through three main tasks:

- **Preparing the evidence base** - Identifying regional values and key decisions with potential to be impacted by climate change, and gathering information to better understand these values, decisions and impacts;
- **Undertaking the Integrated Vulnerability Assessment (IVA)** – Assessing the exposure, sensitivity, and adaptive capacity of the region to understand vulnerabilities and opportunities presented by climate change; and
- **Preparing the Adaptation Plan** – Identifying priority areas of focus and adaptation options, developing adaptation pathway maps, and determining key actions, roles and responsibilities, and implementation costs.

AdaptWest has adopted five themes through which to consider the region and its vulnerability to climate change. These themes are:

- Assets, infrastructure and economy;
- Coastal management;
- Environment and open space;
- Social and community resilience and health; and
- Urban planning and development.

The project's methodology embeds the active participation of key stakeholders from the Western Adelaide region associated with each of the five themes. Specifically, this involves interactive stakeholder workshops associated with each project task, and direct stakeholder input to key project decisions relating to the focus of the project, the assessment of vulnerability, and preferred adaptation responses.

¹ SKM (2013) *Western Adelaide Region Climate Change Adaptation Plan – Stage 1*

1.2. Values and key decisions

Two important aspects of the AdaptWest project's approach to vulnerability assessment and adaptation planning are the consideration of regional values, and key decision lifetimes.

Stakeholder input has driven the development of seven AdaptWest regional values which will be used to focus the project toward those features or aspects of particular importance to the region, namely:

- Amenity and quality of life;
- A strong and connected community;
- Coastal and riverine water quality;
- Coastal environment;
- Infrastructure and essential services;
- Management and use of stormwater; and
- Regional productivity and economic contribution to the state.

These values and the process of their development are described further in Section 2.4, and the values provide a point of reference throughout this research paper.

An important aspect of planning for regional adaptation is to understand the relationship over time between key decisions the region's stakeholders will make, and climate change impacts. In this context, a decision lifetime is the time taken to make a decision (lead time) plus the duration of that decision's implications (consequence time).²

Some decisions made by individuals or organisations have lifetimes that are shorter than the timeframes over which the major effects of climate change will occur (e.g. < 10 years). In contrast, there are decisions made today that have longer lifetimes (e.g. > 70-80 years) that will converge with the expected timing of some of the more significant projected impacts of climate change.

Early stakeholder input to the AdaptWest project has led to development of Figure 1.1, which summarises key decisions to be made amongst various stakeholder organisations and the region as a whole, and their lifetimes. Several of these decisions will be relevant across multiple project themes and regional values.

Consideration of key decision lifetimes will occur throughout the AdaptWest project, particularly in development of the **Adaptation Plan**.

² Stafford Smith et al. (2011) *Rethinking adaptation for a 4°C world* in Philosophical Transactions of the Royal Society A, p. 197

Figure 1.1: Western Adelaide key decision and decision lifetimes identified by stakeholders



1.3. Purpose of the research papers

A research paper has been prepared for each of the five AdaptWest themes as part of the task of **preparing the evidence base**.

The papers are intended to be a resource to support completion of the **IVA** and development of the **Adaptation Plan**.

Each paper provides **targeted** information about the region in relation to the theme topic and regional values and responds to the following IVA considerations:

- The current state of the region, in the context of regional values (Section 2.0);
- Exposure to climate hazards (Section 3.0);
- Sensitivity to climate hazards (Section 4.0); and
- The region's adaptive capacity (Section 5.0).

Development of the research papers has drawn upon the *Western Adelaide Region Climate Change Adaptation Plan – Stage 1*, additional relevant literature, and interviews with key informants associated with the research paper theme.

2.0 Assets, infrastructure and economy in the Western Adelaide region

2.1. Overview

Private and public assets and infrastructure are the backbone of the community and the economy. They are fundamental to the provision of essential services such as utilities, and contribute significantly to the creation of jobs, facilitation of commerce and the provision of community facilities, commercial buildings and residential housing.

2.2. Key stakeholders in assets, infrastructure and economy

An important aspect of the AdaptWest project is the involvement of stakeholders to help identify, assess and prioritise the region's vulnerabilities to climate change and options for adaptation. Key stakeholders identified in the assets, infrastructure and economy theme are:

- **Local governments** that own, operate and provide significant public services, assets and infrastructure such as community centres, public open space and recreation facilities, roads and bridges. Local governments also have responsibility for local planning and approvals, which relates to the development, maintenance and use of both private and public assets and infrastructure in the region. Local governments support economic development through the provision of infrastructure and services for local businesses. Local government also plays a valuable supporting role in emergency management and preparedness in the region, which looks to protect life, property and livelihoods during a disaster.
- **State government agencies** that own, operate and provide assets, infrastructure and facilities important to the region, including hospitals and schools, and arterial roads. The State Government oversees state-wide economic policy development and initiatives, is responsible for setting strategic directions in relation to critical infrastructure, and contributes to the development and implementation of planning policies. It is also responsible for a wide range of planned development projects in the region including new industrial precincts, essential services infrastructure, transport developments and major land divisions. The State also has primary responsibility for emergency management and preparedness across the region and beyond.
- **Commonwealth government and agencies** that set strategic policies in relation to critical infrastructure protection and are also providers of funding and investment in infrastructure programs.
- **Community groups and clubs agencies** that develop, own and operate assets, infrastructure and facilities and moreover, use those facilities provided by local

and state governments, for example residents associations, local environmental groups and sports clubs.

- **Households and individuals**, who are members of the community, own private assets, utilise essential services such as utilities, are consumers of goods and services produced by local business and industry and use local and state government owned infrastructure and facilities.
- **Business and Industry**, who own and operate infrastructure and facilities, particularly major transport infrastructure in the region which was once public owned. These include Adelaide Airport and port facilities. Local business and industry are also the backbone of the region's economy, providing jobs and services. Business and industry are also users of public infrastructure and services, and consumers of local goods and services.

2.3. Existing conditions

To better understand potential impacts to assets, infrastructure and the economy, a brief consideration below is given to the public assets, private assets and economic composition of the region. Unless indicated otherwise, all information in these sections is drawn from *Western Adelaide Region Climate Change Adaptation Plan – Stage 1*.³

2.3.1. Public assets and infrastructure

Public infrastructure provides valuable services, which are central to the functioning of the community. These include important community facilities such as:

- The Queen Elizabeth Hospital in Woodville South in the City of Charles Sturt;
- Police stations at Henley Beach, Holden Hill, Netley, Ottoway and Port Adelaide;
- 94 public primary and secondary schools and 3 special schools;
- 33 waste facilities;
- Techport – a master planned, key naval industry precinct which provides space for Air Warfare Destroyers and services to other maritime industries; and
- South Australian Aquatic Sciences Centre – a key marine and freshwater research laboratory development which supports aquaculture and recreational and commercial fishing industries.

For recreational purposes, jetties and boat ramps are also located throughout the region, along the coasts of Gulf St Vincent and Barker Inlet.

Additionally, major public assets and infrastructure owned by the State Government in the region include:

³ SKM (2013)

- 10,544 public housing dwellings;
- 97 schools;
- 143 kilometres of roads;
- 1,695 kilometres of water supply pipe;
- 1,976 kilometres of sewerage pipes; and
- \$817 million worth of stormwater and Water Sensitive Urban Design (WSUD) infrastructure.

WSUD is an approach to urban planning and design that integrates management of the total water cycle (e.g. groundwater, runoff, drinking water, waste water etc.) into the urban development process. WSUD infrastructure consists of features such as pervious pavements, rain gardens, green roofs and infiltration systems, gross pollutant traps, and bio retention swales.⁴

Infrastructure owned and operated by local councils in the region includes:

- \$2.8 billion worth of buildings, structures and roads (1,588 kilometres of roads);
- \$817 million worth of stormwater infrastructure;
- 16 community centres and 10 libraries as shown in Table 2.1;
- A number of parks and reserves: the region has over 122 playgrounds occurring in the City of Port Adelaide Enfield alone⁵, 72 parks and 1 memorial garden identified for the City of West Torrens⁶ and 103 parks and reserves identified for the City of Charles Sturt (e.g. Point Malcolm Reserve);⁷
- Linear parks, including the River Torrens Linear Park along the West Torrens/Charles Sturt boundary and the Westside Bikeway;⁸ and
- Sporting grounds and ovals, including 24 ovals listed for the City of Port Adelaide Enfield⁹ and 14 recreation/sports grounds listed within the City of West Torrens.¹⁰ The City of Charles Sturt has many sporting facilities such as AFL goals, cricket pitches and clubhouses present at some of its parks and reserves, such as Flinders Park Oval and Fawk Reserve.¹¹

⁴ Government of South Australia (2014a) *Water Sensitive Urban Design*

⁵ City of Port Adelaide Enfield (2014a), *Playgrounds, Parks and Gardens*

⁶ City of West Torrens (2009a), *Community Land Management Plans: Memorial Gardens*; City of West Torrens (2009b), *Community Land Management Plans: Parks*

⁷ City of Charles Sturt (2014), *Parks and their Features*

⁸ SKM (2013)

⁹ City of Port Adelaide Enfield (2014b), *Parks & Reserves Listing*

¹⁰ City of West Torrens (2009c), *Community Land Management Plans: Recreation/Sports Grounds*

¹¹ City of Charles Sturt (2014)

Table 2.1: Community centres and libraries in Western Adelaide

	Charles Sturt	West Torrens	Port Adelaide Enfield
Community centres	Bower Cottages Cheltenham Findon Henley & Grange Seaton North West Lakes Youth Central	Camden Western Youth Reedbeds Hamra Centre Plympton Glandore Thebarton Hub	Enfield Hillcrest Holden Hill Kilburn Lefevre North East The Junction Wandana
Libraries	Civic Library Woodville Findon Library Henley Beach Library Hindmarsh Library West Lakes Library	Hamra Centre Library	Enfield Library Greenacres Library Port Adelaide Library Semaphore Library

Federal assets in the region encompass 42 kilometres of road.

2.3.2. Private assets and infrastructure

Many of the private assets and infrastructure in the Western Adelaide region were once publicly owned. The major private sector assets in the region comprise various sectors and industries, including:

- Energy infrastructure (power stations and transmission lines owned by SA Power Networks and Electranet respectively);
- Transport facilities and infrastructure including:
 - Maritime (Flinders Ports infrastructure, including the Port of Adelaide and 19 other wharves along Inner and Outer Harbor);
 - Rail; and
 - Aviation (Adelaide Airport).

Energy infrastructure in the Western Adelaide region consists of 5 power stations, 31 zone substations, 3,470 kilometres of distribution lines and 87 kilometres of transmission lines. Distribution power stations and substations are primarily owned and operated by SA Power Networks (some substations owned by ElectraNet) and transmission lines are owned and operated by ElectraNet. The Western Adelaide region consists of five main power stations located along and within the vicinity of the northern coastline in

the City of Port Adelaide Enfield, and numerous substations inland. Power stations in the region include:

- Pelican Point power station, located at the tip of Outer Harbor;
- Osborne Cogeneration plant, located on the western side of Port River;
- Torrens Island power station, located on Torrens Island;
- Wingfield landfill gas station, located near North Arm Creek; and
- Synergen Dry Creek power plant, located near the Barker Inlet wetlands.

The largest of these power stations, Pelican Point, is a 480MW combined cycle power plant, and meets around a quarter of South Australian electricity demand. Osborne Cogeneration plant, albeit a smaller power plant, is 50% more efficient than conventional gas or coal-fired plants. It provides 10% of South Australia's electricity requirements.

Flinders Ports privately owns and operates the majority of ports throughout South Australia, and conducts crucial exporting activities for South Australia. There are 20 wharves within the Inner and Outer Harbor of Port Adelaide which are operated by Flinders Ports, the main port being the Port of Adelaide. The Port of Adelaide is the core service point for shipping in the State. During 2012/2013, there were over 15.17 million tonnes of cargo movements through the port, with 10.37 million tonnes imported and exported to overseas markets¹². Major commodities such as grains, limestone and petroleum products are exported through Flinders Ports facilities.

The Australian Rail Track Corporation (ARTC) is a former Commonwealth entity (now corporatised) that manages South Australia's 8,500 kilometres of standard gauge interstate track. The Adelaide to Wolseley and Adelaide to Port Augusta lines congregate within the Western Adelaide region, and connect the Outer Harbor, Dry Creek, Port Adelaide and Mile End suburbs. Lines managed by the ARTC are predominantly used for freight purposes, such as the Pacific National, and to a lesser extent, passenger services such as the Great Southern Rail.

The Adelaide Airport forms a significant part of Western Adelaide's economy, as well as the South Australia economy. Being the centre of aviation in South Australia, it services 7.5 million passengers a year, and contributes around 2.1% of Gross State Product (around \$1.9 billion). A centre for trade and channel for tourism, there are numerous businesses, both retail and industrial, that are indirectly or directly linked to the Adelaide Airport.

The region also houses important industries including:

- Adelaide Brighton Cement Limited, a cement and lime product manufacturer;
- Shell Bitumen Plant, a global bitumen manufacturer and supplier; and
- Owen Illinois (OI), a glass product manufacturer.

¹² Flinders Ports (2014), *Port Adelaide*

2.3.3. Economic composition and employment

As of June 2011, there are approximately 21,442 businesses in the Western Adelaide region, comprising of a mix of small and large firms. The majority of businesses are located in the Cities of Charles Sturt and Port Adelaide Enfield, comprising 75% of the total number of businesses in the region.

Gross Regional Product (GRP) for the region in 2011/12 was approximately \$16,084 million. The largest contributing sector to GRP was manufacturing, contributing 15.6 per cent, followed by Transport Postal Warehousing contributing about 12 per cent, then Construction and Wholesale Trade with 8.9 per cent and 8.7 per cent, respectively.¹³

With the exception of a much smaller share of employment in primary industries such as agriculture, forestry and fishing and a comparatively larger manufacturing workforce, the employment structure of Western Adelaide is largely reflective of the employment structure by industry of South Australia, and has been highly diversified over the past 18 years.¹⁴

At a State-wide level, a recent study by the Australian Bureau of Statistics found that the South Australian industries with the largest employment over the past decade were Health Care and Social Assistance, Retail Trade and Manufacturing. Together they accounted for over one third of the state's average annual employment.¹⁵ In the period from 2006-07 to the present, Health Care and Social Assistance has replaced manufacturing as the industry with the largest employment in South Australia.

This trend is reflected in Western Adelaide. While the region still contains more than 30 per cent of the State's manufacturing businesses, which still employs the largest percentage of workers (18.1 per cent in 2011/12), this sector has undergone significant change in recent times. There has been a significant increase in employment in health and community services, which now employs the second highest percentage of people in the region. The region has also seen significant growth in the freight transport, defence, warehousing and logistics industries. Employment in sectors such as road transport, services to finance investment, insurance and government administration has also increased.¹⁶ Falls in employment were seen in textiles, wholesale trade and other machinery and equipment sectors, which is reflective of the downturn in manufacturing seen more broadly within the State.

Recent studies¹⁷ have identified the following trends in relation to the changing industry and employment base in the region:

¹³ South Australia Government Data Directory (2014) Regional Profile Western Adelaide 2011-12

¹⁴ Campbell Pages (2014) State of Our Community

¹⁵ City of Charles Sturt (2013), *Quantitative assessment of Charles Sturt and Economic Models of Engagement and Delivery Report*

¹⁶ Department of Further Education, Employment Science and Technology (2014) *Strategic Plan to Guide Resource Allocation for Participation and Equity Programs 2011-2013m Western Adelaide Region*

¹⁷ City of Charles Sturt (2013)

- Small and medium enterprises are likely to drive future economic growth;
- Population growth is likely to be a key driver of regional economic activity;
- Mining, as well as defence, health and bioscience are the fastest growing employment sectors. For mining, this is likely in the form of ‘fly in/fly out’ employment, with the number of people participating in this type of employment in Western Adelaide currently exceeding the rate of South Australia as a whole;
- Diversification into employment growth areas outlined above will likely find a ready supply of workers who are residents of the area, reducing commuting and pressure on commuting infrastructure;
- Physical and social infrastructure investment and renewal is needed to underpin growth (e.g. roads, broadband and workforce development); and
- New and revitalised employment areas will require improved urban amenity and better services and infrastructure.

2.4. AdaptWest regional values, features and aspects

An important aspect of the AdaptWest project is the involvement of stakeholders to help identify, assess and prioritise the region’s vulnerabilities to climate change and options to adapt.

The initial stage of stakeholder involvement in the AdaptWest project was a workshop where representatives of the key stakeholder organisations identified the features of Western Adelaide that are important to their objectives and core functions and contribute to the vitality and functioning of the region and beyond. Stakeholders at this workshop identified the key decisions for the region summarised in Figure 1.1 (refer Section 1.2).

Additionally, the AdaptWest project team developed stakeholder input into a list of regional values, features and aspects that will form the basis of the Integrated Vulnerability Assessment.

Table 2.2 provides an overview of the regional values, features and aspects, identified by stakeholders at the Values and Key Decisions Workshop to be of importance and the relationship between these values and assets, infrastructure and the economy in Western Adelaide.

Table 2.2 AdaptWest values, features and aspects relating to assets, infrastructure and economy:

What we value in the Western Region	Features or aspects that relate to this value	Relationship to assets, infrastructure and economy in Western Adelaide
Coastal environment	Environmental values Community and recreation Tourism Assets and infrastructure	Significant community assets and both public and private infrastructure in the region are also located by the coast. This includes manufacturing facilities and ports and schools and community centres.
Coastal and riverine water quality	Port River River Torrens Gulf St Vincent WSUD Stormwater capture and reuse	Coast and riverine/estuarine areas are important environmental assets in the region. These include the Barker Inlet, the Torrens Estuary and aquatic reserves. Coastal and riverine environments in the region are managed to minimize impacts to water quality by public infrastructure for stormwater and flood management.
Management and use of stormwater	Protection of homes Protection of infrastructure WSUD Stormwater capture and reuse	Effective management of stormwater is fundamental to the protection of public and private assets as well as natural environments. There are four major catchments in the region, Port Adelaide, Dry Creek, River Torrens and Patawalonga. These catchments comprise urbanised and rural settings with engineered and natural formats. Several stormwater/flood items are of significance in the area, including the tidal wetlands of Gillman for ecological purposes, Breakout Creek Weir for storm surge protection, aquifer recharge schemes, gauging stations, and storm water reuse projects.
Infrastructure and essential services	Port facilities Adelaide Airport Water and wastewater treatment Power generation Transport Open space Defence industries Community facilities	Various key infrastructure assets and essential services lie within the Western Adelaide region. Adelaide Airport lies within the City of West Torrens, adjacent to West Beach. Numerous water supply and sewerage pipelines owned by SA Water also extend across the Western Adelaide region, including the Waste Water Treatment Plant at West Beach, with sewage pumped to Bolivar for treatment (eastern coast of Barker

Assets, infrastructure and economy in the Western Adelaide region

What we value in the Western Region	Features or aspects that relate to this value	Relationship to assets, infrastructure and economy in Western Adelaide
		<p>Inlet). Wetlands, both constructed and natural, are also present along watercourses discharging into coastal environments, e.g. Gillman wetlands and Apex Park wetlands. Infrastructure along the coast includes jetties (e.g. Henley Jetty) and Flinders Ports assets (e.g. Adelaide Container Terminal). Power stations and networks managed by SA Power and ElectraNet are also present along coastlines on Torrens Island and Outer Harbor.</p>
<p>Regional productivity and economic contribution to the state</p>	<p>Infrastructure and industries of State significance</p> <ul style="list-style-type: none"> - Port facilities - Adelaide Airport - Defence industries - Gillman industrial area - Tourism infrastructure e.g. Adelaide Shores <p>Adelaide Entertainment Centre</p>	<p>The Western Adelaide region houses significant industrial and commercial areas. As a result, economic drivers include: manufacturing, wholesale trade, transport, postal and warehousing, financial and insurance services, professional and technical services and health care and social assistance. As these sectors have the potential to grow faster than local demand, they are considered the primary avenue for the region's economic growth.</p> <p>In 2011/12, the region's GRP was approximately \$16,084 million. The largest contributing sector to GRP was manufacturing, contributing 15.6 per cent, followed by transport postal warehousing contributing about 12 per cent, then construction and wholesale trade with 8.9 per cent and 8.7 per cent respectively. Despite having the largest share in the region's economy, manufacturing in the region is in decline. This is reflective of broader trends throughout the State. As such, it is important for the prevention of economic decline in the region that the decline in activity in manufacturing sector be offset by growth in other sectors such as freight transport, defence, and warehousing and logistics industries. For example, Western Adelaide is characterised by</p>

Assets, infrastructure and economy in the Western Adelaide region

What we value in the Western Region	Features or aspects that relate to this value	Relationship to assets, infrastructure and economy in Western Adelaide
		<p>relatively low labour force participation for males between 45 and 64. This is likely to be related to difficulties faced by displaced workers following the closure of major manufacturing operations in the region such as Electrolux.</p> <p>The region contributes significantly to the freight transport, defence, warehousing and logistics and construction industries of the State. Economic benefits to the region and broader areas are also likely to stem from labour demand related to economic expansion from a number of major projects underway in the region.</p> <p>For example the \$264 million Bowden Urban Village project is expected to generate \$1 billion worth of investment, including 2200 high-density homes.¹⁸ Associated infrastructure includes plans for a \$418 million train tunnel and underground station as part of the Bowden Urban Village project. No timeframe has been set, and the project is dependent on Commonwealth funding.</p> <p>Construction of the \$812 million South Rd Superway will also contribute to labour force demand. Additionally, defence is now a major industry in Western Adelaide. Defence industry activities such as expansions to the Australian Submarine Corporation and the Commonwealth Government's \$36 billion submarine building project are likely to continue to generate jobs in the region.¹⁹ However, continued growth in this sector is highly dependent on continued Commonwealth Government funding and support.</p> <p>The dominance of manufacturing, transport postal warehousing and</p>

¹⁸ Department of Further Education, Employment, Science and Technology (2014)

¹⁹ Department of Further Education, Employment, Science and Technology (2014)

Assets, infrastructure and economy in the Western Adelaide region

What we value in the Western Region	Features or aspects that relate to this value	Relationship to assets, infrastructure and economy in Western Adelaide
		<p>Defence industries in the Western Adelaide region along with the Port of Adelaide means that transport infrastructure within this region is of critical importance to the State. This includes the Port and Adelaide Airport, as well as the city's arterial road and freight rail network, which service the region's industrial areas, sea and airports, and connects them to surrounding regions. Given the cross regional benefits associated with growth areas in the Western Adelaide region, enhancing cross suburban connectivity is central to the State Government's Transport Plan.²⁰</p>
<p>A strong and connected community</p>	<p>Diversity Equity and social justice Vulnerable members of the community</p>	<p>The region is extremely diverse, both culturally and linguistically. It is more culturally diverse than Adelaide as a whole with 26 per cent of the population born overseas. The region also has a higher number of Aboriginal people than the Adelaide average. Such diversity results in a varied regional workforce. In general, diversity in economic output and jobs lessen dependence on a single industry/sector and means available jobs are more likely to match the skill set of an increasingly diverse community (and thus labour force).</p> <p>Western Adelaide shows below average labor force participation rate (59.9 percent by comparison to 62.7 per cent in the State in 2010) and fluctuating levels of unemployment.²¹ In particular, the labor force participation rate in Port Adelaide Enfield – Park Statistical Local Area (SLA) and Charles Sturt – Inner West SLA are well below that of the rest of</p>

²⁰ Government of South Australia (2013) Building a Stronger South Australia: The Integrated Transport and Land Use Plan Technical Document

²¹ Department of Further Education, Employment, Science and Technology (2014)

Assets, infrastructure and economy in the Western Adelaide region

What we value in the Western Region	Features or aspects that relate to this value	Relationship to assets, infrastructure and economy in Western Adelaide
		<p>Western Adelaide (43.9 per cent and 53.4 per cent, respectively).²²</p> <p>Given these statistics, a number of variables must be considered to capitalise on diversity in economic activity and available jobs, These include: slowing the current decline of male labor force participation, improving the skill of people currently on the margins of the workforce and increasing the participation of groups who experience significant barriers to employment.²³</p> <p>With a number of major projects underway in the region, such as the Bowden Urban Project and associated infrastructure, and projected growth in a number of industries, bringing jobs and people within key rail and road corridors is a central component of the South Australian Government's Transport Plan.²⁴ This will allow for a more compact city in the long term, with more services to be accessed locally and help to reduce transport disadvantage in the future.²⁵ Growth in a number of industries in Western Adelaide is likely to have cross regional benefit. As such, enhancing cross suburban connectivity will still be important. An emphasis on encouraging greater public transport use will help to reduce car dependence, which is more pronounced in the outer areas of Adelaide, including the west.</p> <p>Public infrastructure plays a major role in community life, and educational assets and facilities also contribute to future economic capacity within the region. Western Adelaide has 94 public primary and</p>

²² Department of Further Education, Employment, Science and Technology (2014)

²³ Department of Further Education, Employment Science and Technology (2014)

²⁴ Government of South Australia (2013)

²⁵ Government of South Australia (2013)

What we value in the Western Region	Features or aspects that relate to this value	Relationship to assets, infrastructure and economy in Western Adelaide
		<p>secondary schools and 3 special schools. Port Adelaide Enfield contains the majority of the region’s tertiary campuses, with a TAFE campus. Tertiary qualifications in the region are more likely to be at the Certificate III or IV level, although bachelor degree rates are average, with no regional variations evident.²⁶</p>
<p>Amenity and quality of life</p>	<p>Safety and health Sport, recreation, entertainment and tourism facilities Coastal /water based recreation Open and green spaces Natural and historical environments</p>	<p>Public and private recreational facilities, open spaces and natural environments are central to the quality of life for the Western Adelaide region. Sporting fields, stadiums, beaches, tourist attractions, parks and community buildings are assets that contribute to the region’s amenity and quality of life. Character and amenity of the built environment and building safety and soundness also form a vital part of the overall quality of life of the Western Adelaide region.</p> <p>Given the community and economic assets within the region and the planned growth in urban and commercial development, emergency management is critically important to ensure the safety and security of the community. Building safety is regulated through the development assessment process with building rules consent along with planning consent required for new development.</p> <p>South Australia is largely divided into Emergency Management Zones based on the Government Reform Commission Uniform Regional Boundaries. As such, the western Adelaide region is entirely located within one Emergency Management Zone.²⁷ The State Emergency Management Plan requires each zone to have its own Zone</p>

²⁶ Campbell Pages (2014)

²⁷ SKM (2013)

What we value in the Western Region	Features or aspects that relate to this value	Relationship to assets, infrastructure and economy in Western Adelaide
		Emergency Management Committee, which is responsible for local planning to take account of local issues, the nature and level of risk, and local resources available in the region. Increasing engagement of local communities in emergency management is a central component of the State’s approach to Emergency Management. Local government and their communities therefore have a critically important role in disaster risk reduction and mitigation. ²⁸

2.5. Key decisions

Consideration of the relationship between climate impacts and key decision lifetimes is another focus of the AdaptWest project (refer Section 1.2).

At the same workshop described in Section 2.4, stakeholders identified the key decisions for the region relating to the assets, infrastructure and economy theme. These theme-specific key decisions are set out in Table 2.5, and contributed to the broader regional key decisions summarised in Figure 1.1 (refer Section 1.2).

Table 2.3 Key decisions relating to assets, infrastructure and economy

Decision lifetime	Key decision
Short lifetime decisions (0-10 years)	<ul style="list-style-type: none"> • Coastal path • Sand drift fencing/access ways • Political objectives/election cycle (state and local) • Customer request management • Repair and maintenance • Waste management – general maintenance • Resources (labour) • Recreational activities (trends and fads) • Stormwater/flood mitigation (maintenance)

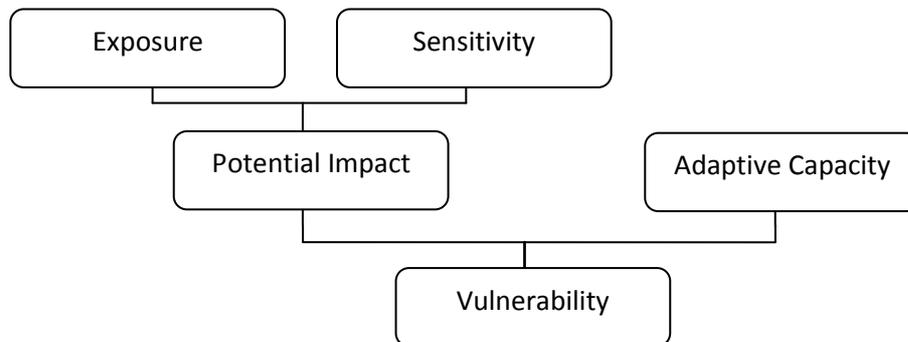
²⁸ Government of South Australia (2014b) South Australian fire and Emergency Service Commission, Local Emergency Management Arrangements

Decision lifetime	Key decision
Medium lifetime decisions (10-30 years)	<ul style="list-style-type: none"> • Waste management – operational management • Industrial variations • Infrastructure management • Wetlands and bio filters • Stormwater/flood mitigation (localised) • Property (buying, maintaining, disposing of) • Road/footpath stability/resealing • Coastline – ramps, protection walls, groynes • Long lived asset intervention
Long lifetime decisions (30+ years)	<ul style="list-style-type: none"> • Waste management/landfill (strategic) • Stormwater/flood mitigation (strategic and long-term assets) • Land use cycle • Open space planning • Transport planning • Coastal strategy (reinforcement or abandonment)

2.6. Preliminary identification of IVA indicators

The AdaptWest research papers are a resource to support completion of an IVA for the region. The IVA will assign scores against a range of indicators in relation to their exposure and sensitivity to climate variables, as well as the region’s adaptive capacity (adaptive capacity is further discussed in Section 5.0). An IVA is a tool that helps to identify areas of vulnerability to the impacts of climate change and assists with prioritising or identifying areas for focusing adaptation action.

Figure 2.1: Assessment of vulnerability in the IVA



Based on the existing conditions in the region and their relationship to values, a list of suggested indicators that could be used to assess the vulnerability of assets, infrastructure and the economy in Western Adelaide has been developed, and is included in Appendix A.

These suggested indicators will be considered further by the AdaptWest project team in development of a list of regional indicators that will assist to identify vulnerabilities across the project themes and regional values.

3.0 Exposure factors

This section outlines the climate hazards that the region may be exposed to as a result of changing climatic conditions. The exposure of Western Adelaide to climate hazards is summarised in Table 3.1.

Table 3.1: Exposure of Western Adelaide to potential climate hazards

Climate hazard	Exposure of Western Adelaide
Increasing average temperature	Entire region exposed
Increasing frequency, intensity and duration of heatwaves	Entire region exposed
Declining average annual rainfall	Entire region exposed
Increasing rainfall intensity	Entire region exposed
Coastal inundation caused by sea level rise /storm surge	Marine and coastal areas of the region exposed
Increased coastal recession due to accelerated erosion	Marine and coastal areas of the region exposed
Increasing temperature of Gulf waters	Marine and coastal areas of the region exposed
Increasing acidity of Gulf waters	Marine and coastal areas of the region exposed

Unless otherwise stated, the discussion of projected changes in climate below is based on a medium emissions scenario and median model outputs (often referred to as the “best estimate”). Baseline conditions refer to the period 1980-1999, which is the standard reference period identified by CSIRO and Bureau of Meteorology (BoM).²⁹

3.1. Increasing average temperature

Temperatures in southern Australia have been increasing by about 0.2°C per decade since 1950³⁰ and are expected to rise further over the coming decades. By 2030, average annual temperatures are projected to rise by 0.6-1°C and by 2070 by 1.5-2°C compared with baseline conditions (ranging from 1-3°C under low to high emissions).³¹ Mean maximum temperatures are expected to increase greatly,

²⁹ CSIRO and BOM (2007-2014) *Climate Change in Australia*. www.climatechangeinaustralia.com.au

³⁰ CSIRO and BOM (2007-2014)

³¹ CSIRO and BOM (2007-2014)

particularly during summer months.³² For example, average maximum February temperatures could increase from 28.2 °C to 32.7 °C.

3.2. Increasing frequency, intensity and duration of heatwaves

Heatwave typically describes a prolonged period of excessive heat, with common measures being the number of consecutive days over 35°C or 40°C. Three or more consecutive days where the average of daily maximum and minimum temperatures is greater than 32°C is a trigger used by the State Emergency Service for preparation of Extreme Heat Plans to mitigate the impact of extreme heat events on the community.³³

The frequency of heatwaves with an average of the daily maximum and minimum temperatures of more than 32°C for 3 or more days is projected to increase from 1 in 20 years under current conditions to 1 in every 1 to 5 years (under high emissions or low emissions, respectively) by 2070. The duration of heatwaves will also increase by 2070, with projections suggesting that the region could experience periods of 5 to 6 days where an average of the daily maximum and minimum temperatures exceeds 32°C (1 in every 20 years).

With regard to intensity across each year, the number of days with maximum temperatures of 35°C or more is projected to increase from less than 15 to over 17 per year by 2030 and to over 35 by 2070 (high emissions, 50th percentile). Days with temperatures over 40°C are projected to increase from less than 2 per year to 2.5 per year by 2030 and over 10 per year by 2070 (high emissions, 50th percentile).

3.3. Declining average annual rainfall

Average annual rainfall is expected to decrease across the Western Adelaide region in the coming decades. Median projections are for rainfall to decline by 2-5% by 2030 and between 5-20% by 2070 throughout South Australia.³⁴

Using information from meteorological stations in Western Adelaide, the most likely outcome under a medium and high emissions scenario is for average annual rainfall to decline by about 60 to 75 millimetres per year by 2070.³⁵

Seasonally, a greater decline in rainfall has been predicted for spring than for autumn, however observations imply that autumn to winter rainfall patterns have changed and may be attributed to climate change impacts on atmospheric circulation patterns.³⁶

³² SKM (2013) p.36

³³ SKM (2013) p.37

³⁴ CSIRO and BOM (2007-2014)

³⁵ SKM (2013) p.42

³⁶ SKM (2013) p.42

3.4. Increasing rainfall intensity

Extreme rainfall events are forecast to become more intense by 2070, particularly during spring and summer. Historically, the total daily rainfall that is exceeded only once per year on average (i.e. a 1 year average recurrence interval (ARI)) is 27 millimetres. Under a medium emissions scenario, the daily rainfall totals exceeded for 10 year and 100 year ARIs are 50 millimetres and 75 millimetres, respectively.

Under a high emissions scenario there is an increase in rainfall intensity with the 10 year and 100 year ARI events anticipated to rise from 50 millimetres and 75 millimetres, to 58 millimetres and 90 millimetres (respectively) by 2070.³⁷

3.5. Coastal inundation caused by sea level rise /storm surge

Global mean sea level rise for 2081–2100 relative to 1986–2005 will likely be in the range of 0.3 to 0.6 m for RCP4.5 and RCP6.0³⁸ (equivalent to a low to medium emissions scenario).³⁹ Tide gauging in the Western Adelaide region has found sea levels to be rising at a rate of 2.06 millimetres per year and 2.08 millimetres per year at the Inner Harbour and Outer Harbour areas respectively.⁴⁰

Sea level rise could exacerbate exposure to non-climate specific threats such as land subsidence from natural causes and anthropogenic activities (e.g. landfill developments and large-scale groundwater extraction), and saline intrusion of aquifers.⁴¹

Sea level rise is also expected to intensify storm surge events. These are events where sea levels rise significantly above normal tide levels for a temporary period of time. Presently, the mean sea level at Outer Harbor is 0.13 m below the Australian Height Datum (AHD). However, the 100 year ARI water level for Outer Harbor based on current mean sea levels is 2.4 metres above AHD. This means that under a high sea level rise scenario, storm surge events could cause tides to reach areas that are presently 2.4 metres above AHD.⁴²

3.6. Increasing coastal recession due to accelerated erosion

Coastal recession is defined as the landward retreat of a coastline. Coasts which are composed of erodible sediments (such as sand or mud) may retreat in response to sea level rise. The rate of change of coastal recession is dependent on many factors such as the rate of sea level rise, the resistance of the coast to erosion, effectiveness of any coast protective infrastructure, and longshore sediment movement.⁴³

³⁷ SKM (2013), p.42

³⁸ RCP = Representative Concentration Pathway, as referred to in: IPCC (2013) *Summary for Policymakers*, Cambridge University Press

³⁹ IPCC (2000) *Summary for policymakers: Emissions Scenarios*, IPCC

⁴⁰ DEH (2005) *Adelaide's Living Beaches: A Strategy for 2005-2025*, Department of Environment and Heritage, p.54

⁴¹ SKM (2013) p.60; DEH (2005), p.55

⁴² DEH (2005) p.101

⁴³ SKM (2013), p.61

Most of the coast in the Western Adelaide region is highly erodible as it is comprised mainly of sand and mud. Areas along the coast of St Vincent's Gulf are unprotected and are therefore more susceptible to wave action. Coastal recession in the Western Adelaide region could be between 50m and 100m in a high sea level rise scenario (i.e. 1m) if no control measures are implemented.⁴⁴

3.7. Increasing temperature of gulf waters

The best estimate of changing sea surface temperatures are for a 1.5 to 2°C warming of oceans off South Australia by 2070.⁴⁵ How this translates to changes in the shallower Gulf waters is yet to be seen. Past work found approximately equal rates of warming in the deep ocean waters of the Great Australian Bight compared with the mouth of Spencer Gulf (i.e. 0.11°C and 0.12°C per decade since 1950, respectively).⁴⁶

3.8. Increasing acidity of gulf waters

The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report suggests that the earth's oceans will become more acidic under all scenarios assessed. Projections for decreasing pH range from 0.06 to 0.32 by 2100, with a best estimate more likely to be in the order of a 0.2 pH unit decrease.⁴⁷ This compares with a 0.1 pH unit decrease that has already been experienced since the beginning of the industrial era 250 years ago.

⁴⁴ South Australian Coast Protection Board (1992), *Coastal Erosion, Flooding and Sea Level Rise Standards and Protection Policy*, Coastline, p.6

⁴⁵ CSIRO and BOM (2007-2014)

⁴⁶ Suppiah *et al.* (2006) *Climate Change Under Enhanced Greenhouse Conditions in South Australia*, CSIRO Marine and Atmospheric Research, p.5-6

⁴⁷ IPCC (2013) *Summary for policymakers*, University Press, p.25

4.0 Sensitivity factors

This section describes the potential sensitivities of AdaptWest assets, infrastructure and economy values to climate hazards. Table 4.1 below outlines the asset, infrastructure and economy aspects of identified to be of value to stakeholders and the climate hazards which they are exposed to.

Table 4.1: Potential sensitivities of assets, infrastructure and economy values to climate hazards

HAZARD	Increased temperatures	Increased heatwaves (IFD)	Increased temperature of Gulf waters	Increased rainfall intensity	Reduced average annual rainfall	Coastal inundation	Coastal recession
Coastal environment	-	-	x	x	-	x	x
Coastal and riverine water quality	-	-	x	x	-	x	x
Stormwater management and use	x	x	-	x	x	x	x
Infrastructure and essential services	x	x	x	x	x	x	x
Regional productivity and economic contribution	x	x	x	x	x	x	x
Strong and connected community	x	x	-	x	x	x	x
Amenity and quality of life	x	x	-	x	x	x	x

4.1. A strong and connected community

The features and aspects of Western Adelaide relating to this value include diversity, equity and social justice, and vulnerable members of the community.

Increased heatwaves and extreme heat situations also place added strain on health services. As the primary healthcare provider in the Western Adelaide region, Queen Elizabeth Hospital may come under greater strain due to increased illness, fatigue and possible death and associated with climate change induced heatwaves. This places greater pressure on the capabilities of hospitals, which help strengthen

communities and their wellbeing. To accommodate future demand, added infrastructure may be required, which will likely be at an increased cost.

Climate change hazards may impact the availability of public assets such as recreational and open space areas within the Western Adelaide region (either directly or indirectly) which will have subsequent flow-on effects to community strength and connectedness. Coastal inundation may damage popularly used open space areas and associated infrastructure, which may result in increasing lengths of closures of affected open spaces to the public (e.g. parks and playgrounds). Indirect losses of availability of open spaces and recreational infrastructure may occur through increasing maintenance costs associated with minimising climate change hazards which may be required to be passed on to local residents and users of open spaces. This may potentially inhibit use by residents in lower income brackets.

4.2. Amenity and quality of life

The features and aspects related to this value are safety and health, sport, recreation, entertainment and tourism facilities, coastal and water based recreation, open and green spaces, and natural historical environment.

Community recreation and tourism assets such as jetties and boat ramps could be affected directly through sea level rise and indirectly through longer periods of beach inundation. This could lead to reduced beach access and use, inadvertently preventing access to jetties and boat ramps at beaches. Access to and quality of recreational assets may also be lost through increased rainfall intensity, as playing fields and open spaces often serve as retention areas for flood mitigation.

Increasing temperatures and decreasing rainfall may cause vegetation die back, which presents hazards to residents (e.g. falling trees) and reduces the aesthetics of the region. Degradation and loss of vegetation, particularly along streets, pavements and open space areas, decreases the quality of public assets which provide locals with spaces for leisure, exercise and social interaction. Increased maintenance efforts and operational costs would be required by local governments to conserve the amenity of streets, pavements and open spaces.

Heatwaves and extreme heat events under climate change scenarios may reduce opportunities for outdoor recreation. Sporting events or formal recreational activities may be cancelled, postponed or relocated indoors, placing additional pressure on indoor facilities. Infrastructure upgrades to sport and recreation facilities such as playing fields, recreation centres and walking paths may be required to maintain their ability to operate in hot and dry conditions. This not only adds to costs for infrastructure upgrades and maintenance, but also decreases the quality of life for residents in the region. Extreme heat events and heatwaves also have the potential to impact on the buildings in which community programs and services are delivered, and limit the access of residents to these services in the region.

4.3. Coastal and riverine water quality

The features and aspects relating to coastal and riverine water quality in the Western Adelaide region include the Port River, the River Torrens and the Gulf St Vincent. Additionally, the application of WSUD and the capture and reuse of stormwater are equally important aspects.

The primary threat to coastal water quality in the Western Adelaide region is the activation of coastal acid sulfate soils (CASS). These soils are present over 2.5 square kilometres of the Gillman area, which encompasses parts of the Port River coastline, Port River estuary and Barker Inlet. Disturbances of the CASS from drainage and infrastructure development have previously caused the production of sulphides. The release of acid and metal ions in surrounding bodies of water deteriorates coastal water quality. Any drainage areas within or downstream of the Gillman area would be subject to increased treatment costs to ensure water quality standards are met. This inadvertently adds to the economic costs of water treatment.⁴⁸

Water sensitive urban design (WSUD) and stormwater capture and reuse features are present across various parts of the Western Adelaide region. For example, wetlands were constructed around the Port River (Gillman Wetlands) and the River Torrens (Breakout Creek wetlands, Apex Park wetland) for the purpose of improving riverine water quality. They are, however, at risk from inundation due to rising sea levels, as they would be damaged and their functionality would diminish, leading to higher maintenance and treatment costs.⁴⁹

4.4. Coastal environment

The features and aspects relating to the value of the coastal environment in the Western Adelaide region include environmental values, community and recreation, tourism, and assets and infrastructure.

Assets and infrastructure along the coastal environment in the Western Adelaide region primarily comprises:

- Jetties (Largs Bay, Semaphore, Grange, Henley Beach);
- Boat ramps (Adelaide Shores); and
- Surf lifesaving clubs (North Haven, West Beach, Semaphore, Grange, Henley).⁵⁰

Infrastructure along the coastal environment is susceptible to flooding, which may damage or prevent use of jetties and boat ramps. Increased rainfall intensity, coastal inundation and recession may also damage assets and infrastructure of National and State importance (e.g. airport and port facilities), increasing potential damage from the 100 year ARI storm tide to over \$180 million by 2100. Residential zones are also present within low lying areas such as Outer Harbor, West Lakes and Henley Beach (i.e. along the Gulf St Vincent coastline) and require protection from seawater inundation through the installation of mitigation infrastructure. These may

⁴⁸ SKM (2013) p. 177

⁴⁹ SKM (2013) p. 114

⁵⁰ SKM (2013) p. 158-179

include sea walls, stormwater detention basins and stormwater pump stations.⁵⁴ Many public, recreational and tourism infrastructure assets are located along the coastal environment as well, such as surf lifesaving clubs and stormwater infrastructure, and are susceptible to coastal inundation from sea level rise and coastal recession from accelerated erosion. Sections 4.5, 4.6 and 4.7 detail the impact of climate hazards on some of these assets along the coast.

4.5. Infrastructure and essential services

The features and aspects relating to this value include port facilities, Adelaide airport, water and wastewater treatment, power generation, transport, open space, defence industries and community facilities.

A variety of assets and infrastructure are present within the Western Adelaide region, including homes, schools, roads, bridges, and community and public infrastructure, utilities and industry. Higher operational costs for energy, water and maintenance, increased fallibility of power supply and utilities, loss of property from coastal erosion, and the accelerated deterioration of buildings, marine infrastructure, roads and bridges from storms, heat, flooding and inundation are some of the main climate change impacts facing the Western Adelaide region.

The Western Adelaide region also contains some of South Australia's most vital infrastructure – the Adelaide Airport and the Port of Adelaide. Located within the City of West Torrens near the coastline of Gulf St Vincent, Adelaide Airport infrastructure is highly susceptible to flooding risks from intense storm events due to low lying areas adjacent to the Airport. Economically, potential disturbances to aircraft movements from increased wind and storm intensity and frequencies and seawater incursions can affect output and growth of the Airport, with flow-on effects to the rest of the region.⁵¹

Extreme weather events and sea level rise may lead to disruptions to the operation of the Port of Adelaide, including transportation and supply chains⁵². Climate hazards can also impact on infrastructure within the port area, such as Techport Australia and the South Australian Aquatic Sciences Centre (SAASC). These facilities could be affected by surface flooding from increased storm intensity and sea water incursions as a result of projected sea level rise. Both could lead to increased corrosion of physical assets and cause disruption and delays to operations.

In addition to coastal inundation and potential associated infrastructure destruction from storm surges and erosion, extreme heat will also place additional pressure on electricity transmission and distribution infrastructure in the Western Adelaide region, such as Torrens Island and Pelican Power Stations. These stations are also both vulnerable to impacts such as sea level rise and salt water corrosion due to their location adjacent in Port Adelaide and adjacent to Port River respectively. Both stations and transmissions lines may also be susceptible to destructive winds associated with projected increases in storm intensity and to increased demand from more frequent heatwaves. These factors could lead to accelerated corrosion

⁵¹ SKM (2013), p.194

⁵² AECOM (2013) p.28

of the power station's physical assets, as well interrupting operations and interfering with supply⁵³.

4.6. Management and use of stormwater

The features and aspects relating to the management and use of stormwater in the Western Adelaide region include the protection of homes and infrastructure, Water Sensitive Urban Design (WSUD) and stormwater capture and reuse.

Four catchments make up the Western Adelaide region. These are:

- Port Adelaide – a highly urbanised catchment and water course, containing an artificial lake;
- Dry Creek Catchment – a large mixed use catchment
- River Torrens – a mix of urban and rural catchments with a water course partly lined with concrete, an artificial lake created by a weir and an artificial outlet to the sea; and
- Patawalonga Creek - a mix of urban and rural catchments with primarily natural watercourses.⁵⁴

Stormwater infrastructure in the Western Adelaide region comprises assets such as pipes, culverts, local and main drains, pits, open channels, junction boxes, pumping stations, wetlands and trunk drains. These infrastructure elements provide protection to homes and infrastructure from major flooding and storm events. However, these features are at risk of direct seawater and/or subsequent stormwater inundation due to rising sea levels and increased rainfall intensity. For example, the existing stormwater network in the Port Adelaide catchment, of which a significant area of the catchment has been prone to frequent flood inundation, is at risk of losing its ability to transfer stormwater out to sea efficiently due to high downstream runoff levels. Being a highly urbanised area at a relatively low elevation, this suggests homes and infrastructure alike are at an increased level of risk from damage.⁵⁴

Parts of the Outer Harbor and Patawalonga Creek catchment are also at risk of seawater and stormwater inundation respectively. However, studies have suggested that existing WSUD and stormwater reuse infrastructure, such as the Apex Park wetlands, play a dual role in that they also act as a buffer to prevent seawater from inundating surrounding residential areas. The Breakout Creek Weir, in addition to management stormwater along the Torrens, River provides protection from storm surge⁵⁴

4.7. Regional productivity and economic contribution to the State

The features and aspects relating to this value include infrastructure and industries of state significance, such as port facilities, the Adelaide Airport, and defence

⁵³ SKM (2013) p. 194

⁵⁴ SKM (2013) p. 200-207

industries, Gillman industrial area, tourism infrastructure and the Adelaide entertainment centre.

Many of the region's industrial tracts and privately operated economic infrastructure is situated in or around the coastal area. These include major private assets and infrastructure, such as electrical power stations (owned by SA Power Network and Electranet), ports and wharves (e.g. the Adelaide container terminal), rail infrastructure and Adelaide Airport. Key businesses and industries are also located along the coast, such as Adelaide Brighton Limited and OI. These assets involve significant capital investments and play an essential economic role for the region and the State, and are at risk of coastal hazards such as coastal inundation caused by sea level rise and coastal recession caused by accelerated erosion. .

Likely impacts on assets and infrastructure associated with the regional productivity include flooding and seawater inundation, damage to buildings and structures, and shut down periods during flooding or extreme heat events. A number of flow-on impacts may result from this, including higher operating costs associated with power usage and insurance excesses, increased capital costs associated with retrofitting and additional maintenance, disruptions to supply chains, disruptions and delays to asset function (e.g. power outages, increased stormwater detention), reduced safety of energy infrastructure and the accelerated depreciation of assets.

Although climate change risks affecting private sector assets and infrastructure are the responsibility of the owner and operator, some costs (e.g. from insurance or adaptation measures) are likely to be transferred to consumers and the community through availability, pricing and quality of services.

5.0 Adaptive capacity factors

Adaptation is the process of adjustment to actual or expected climate and its effects, and in the case of human systems, seeks to moderate harm or exploit beneficial opportunities. Adaptive capacity is the ability to adjust to potential damage, take advantage of opportunities, or respond to consequences.⁵⁵

In determining adaptive capacity, consideration is given to what extent a feature or function in its current form, with current practices in place, could continue to function and respond to the consequences and opportunities presented by expected future climate conditions (in the case of AdaptWest the projected climate in 2070).

In a regional context, adaptive capacity is complex and made up of a range of factors associated with systems, institutions, humans and other organisms. These factors can include natural attributes, physical infrastructure, technology, management plans and practices, funding, and governance arrangements. Social and cultural factors such as social capital, social networks, values, customs and perceptions also impact upon adaptive capacity, in for example the functionality of stakeholder relationships within governance arrangements, and whether barriers exist to implementing management practices on the ground.

A differentiation can be made between autonomous adaptation – occurring in response to changes to systems, but not as a conscious response to climate stimuli, and planned adaptation – occurring in response to an awareness that conditions have or will change⁵⁶. Adaptive capacity can be considered in a similar way, occurring ‘naturally’, or being deliberately developed to increase resilience to known challenges.

The following discussion provides a brief overview of current features and conditions that contribute to Western Adelaide’s adaptive capacity in relation to assets, infrastructure and the economy. Those living, working, providing services and doing business in the region are considered to be most knowledgeable about the region, and as such it is intended that this summary be tested, refined and built upon by the region’s stakeholders as part of the collaborative IVA that will be undertaken in the next stage of the project.

The Western Adelaide region contains some of South Australia’s most significant assets and infrastructure, such as the Queen Elizabeth Hospital, Techport Australia, South Australian Aquatic Sciences Centre (SAASC), SA Water stormwater and wastewater infrastructure, SA Power Networks and Electranet power stations and electricity transmission and distribution networks, and the Adelaide Airport. Adaptive capacity of the assets and infrastructure in the region is highly variable due to the nature of how public and private assets and infrastructure are managed in the

⁵⁵ IPCC (2013), *Climate Change 2013: Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change: Impacts, Adaptation and Vulnerability – Glossary*

⁵⁶ IPCC (2007) *Climate Change 2007: Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change – Glossary*

region. Technical and governance challenges exist for both public and private sectors.

Adaptation planning for public infrastructure is evident for assets owned by SA Water, through their Strategic Plan 2012-16. This plan outlines the integrated water planning and asset stewardship strategies through which SA Water intends to optimise asset functionality and reliability and the capacity of the stormwater system in the region. Actions such as asset lifecycle planning and system capacity adaptation are to be implemented by SA Water, while collaborating with the Essential Services Commission of South Australia (ESCOSA).⁵⁷ SA Water actions will be a primary influence in the adaptive capacity of the region due to the vulnerability of the Western Adelaide region to flooding. Effective management of stormwater systems will be essential to maintain resilience to climate change impacts.

Alternatively, there are many significant public infrastructure assets that do not have a specific plan for adaptive capacity, such as the Queen Elizabeth Hospital and Techport Australia, even though they have been identified as vulnerable to climate risks such as flooding, or in the case of the Queen Elizabeth Hospital, significant increases in future demand (potentially outstripping capabilities).⁵⁸ This is primarily attributed to knowledge gaps (e.g. in insurance levels and asset valuation) and information barriers at local levels.⁵⁹ Studies are being conducted by external organisations such as the National Climate Change Adaptation Research Facility (NCCARF) to tackle these knowledge gaps. An example of this is a study by Balston et al. which discusses tools that allow local governments to quantify costs of climate change.⁶⁰

The adaptive capacity of key private assets and infrastructure, such as the Adelaide Airport, is largely influenced through their strategic planning activities. Adelaide Airport has outlined in their Adelaide Airport Master Plan 2014 (Preliminary Draft) that to mitigate climate risk, they will aim to achieve the following objectives over the next five years:

- Complete a climate vulnerability and adaptation study;
- Prepare an in-depth review of infrastructure against the outcomes of the adaptation study;
- Accommodate extreme weather events into the Airport Emergency Plan where required; and
- Integrate new pavement and building standards into development and construction guidelines where required.⁶¹

Additionally, Adelaide Airport has undertaken efforts as part of their strategic plan to minimise flooding risk. These include:

⁵⁷ SA Water (2012) *SA Water Strategic Plan 2012-16*

⁵⁸ SKM (2013) pp. 170-174

⁵⁹ SKM (2013) pp. 178-179

⁶⁰ Balston et al. (2013) *Quantifying the cost of climate change impacts on local government assets*

⁶¹ Adelaide Airport (2014) *Adelaide Airport Preliminary Draft Master Plan 2014*, p.202

- 2013 Flood modelling assessments;
- SA Water Adelaide Airport Stormwater Scheme – which involved the construction of a ‘managed aquifer recharge scheme’. This will harvest and store up to 270 million litres of treated stormwater annually from Brownhill-Keswick Creek when operational; and
- 2013 Stormwater Detention Basin Project, West Beach, which involved the facilitation of a major flood detention basin in West Beach to minimise flooding impacts to residents in the area.⁶²

Adaptive capacity for private asset owners is impeded by several factors. First, there is insufficient information and/or evidence of large scale climate change adaptation planning from most private asset owners.⁶³ While Adelaide Airport and SA Power Networks have begun to include some strategic planning for climate change adaptation, there is still detailed information missing from the results of some of their initiatives; for example, the 2013 flood modelling assessments of Adelaide Airport.

Consultation with private asset owners indicates that, while general climate change information is made available by state and federal governments, there is a lack of specific guidance or support for active adaptation planning.

Secondly, broader uncertainty in policy and information regarding climate change adaptation limits the adaptive capacity of private infrastructure, as private owners are left unaware of the nuances of the legal frameworks in place and what this means for them in terms of legal risk.⁶⁴

Finally, there is a lack of market incentives for private asset owners to facilitate private adaptation measures.⁶⁵ There are very few incentives for climate change adaptation measures to be implemented by private asset owners, with most incentives revolving around reduction in energy and greenhouse gas emissions⁶⁶. Some market mechanisms actually act as a barrier to adaptation, such as the network pricing approach of the Australian Energy Regulator (AER). Consultation with network operators identified that the current approach of the AER, which sets 5 year pricing determinations that effectively dictate how networks are operated and developed, does not actively consider the impacts of climate change and so provides no market incentive for adaptation. One financial incentive offered by DEWNR is the ‘Prospering in a changing climate grant program’, which provides funding to sectors for the support of projects that demonstrate innovation and leadership in climate change adaptation.⁶⁷

Appendix B identifies and summarises existing management and policy measures that are in place to undertake climate change mitigation, both explicitly and implicitly. These policies would be expected to mitigate some of the potential

⁶² Adelaide Airport (2014) pp.184-209

⁶³ SKM (2013) p.5

⁶⁴ Johnston et al. (2013) *Climate change adaptation in the boardroom*, p.11

⁶⁵ Johnston et al. (2013) *Climate change adaptation in the boardroom*, p.16

⁶⁶ Government of South Australia (2014) *What organisations, business and industry can do*

⁶⁷ DEWNR (2014) *Prospering in a changing climate grant program*

climate change impacts so as to enable the region to continue to function, cope or adjust to future climate conditions.

6.0 Summary of conclusions

The Western Adelaide region contains a range of public and private assets and infrastructure which are essential to the functioning of the community and the regional economy, and also contribute to the economy of the State. These range from community infrastructure such as the Queen Elizabeth Hospital to commercial and industrial assets that are vital to the region's economic prosperity. Among these are Adelaide Airport and the Port of Adelaide, along with assets associated with freight, warehousing, logistics, transport and manufacturing businesses.

The region's primary economic divers include manufacturing, wholesale trade, transport, postal and warehousing, financial and insurance services, professional and technical services and health care and social assistance. While manufacturing still employs the highest number of people and remains is the largest contributing sector to the region's economy (the region contains 30 per cent of the State's manufacturing businesses), the sector has undergone significant change in recent times. Freight, transport, defence, warehousing, logistics, health care and social assistance are likely to play a much larger role in the region's economy in the future. A pipeline of major urban development and transport projects is also likely to contribute to continued labour demand, which may also have cross-regional benefits.

To take advantage of such benefits and ensure economic viability, appropriate transport infrastructure is of critical importance, both to ensure commercial viability of freight, logistics and warehousing businesses, and also to ensure residents are able to access jobs and other social infrastructure such as schools.

Given the concentration of important community and economic assets located in the region such as Techport Australia, SA Power Networks, Electranet power station, the Port of Adelaide and Adelaide Airport, emergency management and appropriate continuity planning is critically important to ensure the safety and security of the community.

Adaptive capacity of public assets not necessarily consistent despite public ownership and regulation. While some assets such as those owned by SA Water, include adaptation planning as part of their strategic plan, others have no specific plans for adaptation. Additionally, Councils that own and operate a large number of community assets are facing increasing resource constraints which may impede their ability to implement adaptation planning.

There is little information available about what climate change adaptation planning if any is underway amongst private asset owners. Broader policy uncertainty regarding climate change adaptation limits the adaptive capacity of private infrastructure, as private owners are left unaware of the nuances of the legal frameworks in place and what this means for them in terms of legal risk. There is also a lack of market incentives for private asset owners to facilitate private adaptation measures.

The exposure, sensitivity and adaptive capacity of Western Adelaide, including in relation to assets, infrastructure and economy, will be further explored in collaboration with regional stakeholders through the IVA process.

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8.0 Appendices

Appendix A: Suggested IVA indicators

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Buildings	Condition of built cultural heritage (e.g. heritage buildings, bridges, monuments, public art)		✓					
Buildings	Condition of public realm (street scapes, street trees, paving, drinking fountains, public art)		✓					
Buildings	Increased urban density impact on individual wellbeing		✓					
Buildings	Condition of public buildings (incl. Schools, libraries, hospitals)					✓		

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Buildings	Demand for emergency evacuation centres and facilities					✓		
Buildings	Demand for heat refuges					✓		
Communications networks	Percentage of down time for telecommunications infrastructure					✓		
Community planning and development	Quality of cycling and walking infrastructure (e.g. footpaths etc.)					✓		
Community planning and development	Frequency of public transport service interruptions					✓		
Education	School attendance		✓					

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Education	Ability to access educational and lifelong learning facilities					✓		
Education	Internet access					✓		
Emergency management	Demand for emergency services					✓		
Existing social capital	Rates of volunteerism	✓						
Existing social capital	Participation in organised sport, church or community group in local area	✓						
Existing social capital	Level of support from family, friends and neighbours	✓						

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Land assets	Condition of natural cultural heritage (e.g. scar trees, heritage vineyard, springs, rivers, burial grounds)		✓					
Land assets	Quality of active recreation and sporting sites (outdoor - ovals, courts, pools, lawn bowls)		✓					
Land assets	Quality of open space (predominantly green space)		✓					
Land assets	Productivity of farmland (pasture)							✓
Land condition	Beach erosion				✓			
Land condition	Cliff erosion				✓			

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Land condition	Condition of the Barker Inlet				✓			
Land condition	Dune erosion				✓			
Land condition	Inland area affected by soil erosion				✓			
Local government services	Property values							✓
Local government services	Property values					✓		
Mental health	Impact on children < 12 years of age		✓					
Mental health	Impact on people aged over 65 years and at risk		✓					

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Mental health	Impact on people who require assistance for core activities		✓					
Physical health	Impact on children < 12 years of age		✓					
Physical health	Impact on people aged over 65 years and at risk		✓					
Physical health	Impact on people who require assistance for core activities		✓					
Public safety	Levels of anti-social behaviour		✓					
Quaternary sector	GRP from education and training							✓

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Quaternary sector	Impact on people choosing to live and work in the region							✓
Recreation	Participation in organised sport, church or community group in local area		✓					
Secondary industries	Costs of waste management							✓
Secondary industries	GRP from manufacturing							✓
Service networks	Condition of wastewater management assets					✓		
Service networks	Delivery of potable water (condition of pipes and water quality)					✓		

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Service networks	Frequency of electricity supply disruption					✓		
Social inclusion/exclusion	Impact on children < 12 years of age	✓						
Social inclusion/exclusion	Impact on people aged over 65 years and at risk	✓						
Social inclusion/exclusion	Impact on people who require assistance for core activities	✓						
Social inclusion/exclusion	Levels of anti-social behaviour	✓						
Social inclusion/exclusion	Impact on people geographically isolated from transport services	✓						

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Social inclusion/exclusion	Impact on people under financial stress	✓						
Social inclusion/exclusion	Number of outdoor civic events held by Councils	✓						
Sporting facilities	Quality of active recreation and sporting sites (indoor)		✓					
Tertiary industries	GRP from health care and social assistance							✓
Tertiary industries	GRP from retail trade							✓
Tertiary industries	GRP from tourism (accommodation and food service)							✓
Tertiary industries	Tourist accommodation occupancy rates							✓

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Transport networks	Condition of jetties and boat ramps					✓		
Transport networks	Condition of rail					✓		
Transport networks	Condition of roads					✓		
Water	Groundwater quantity and quality (salinity) – local GMA			✓				
Water	Surface water quantity and quality – Coastal/estuaries			✓				
Water	Surface water quantity and quality - Rivers			✓				
Water	Condition of stormwater management infrastructure						✓	

Primary indicator	Secondary indicator	Assets, infrastructure and economy values						
		A strong and connected community	Amenity and quality of life	Coastal and riverine water quality	Coastal environment	Infrastructure and essential services	Management and use of stormwater	Regional productivity and economic contribution
Water	Quantity of recycled water (treated wastewater and stormwater)						✓	
Water	Quantity of stormwater generated						✓	

Appendix B: Policies and plans contributing to adaptive capacity

Appendix B: Policies and plans contributing to adaptive capacity

Plans, policies and strategies contributing to adaptive capacity

Plans, policies and strategies	Commonwealth Government	Government of South Australia	City of Port Adelaide Enfield	City of West Torrens	City of Charles Sturt
National Urban Policy	x				
Securing a Clean Energy Future – The Australian Government's Climate Change Plan 2011	x				
National Climate Change Adaptation Framework 2007	x				
Decision tools - Local Adaptation Pathways Program	x				
Adapting to Climate Change in Australia Position Paper 2010	x				
South Australia's Strategic Plan		x			
SA Planning Strategy - 30 Year Plan for Greater Adelaide		x			
Tackling Climate Change: SA's Greenhouse Strategy 2007-2020		x			
Coast Protection Board Strategic Plan 2009 – 2014		x			
State/Regional NRM Plans (under <i>NRM Act 2004</i>)		x			
Adelaide and Mt Lofty Regional NRM Plan (under <i>NRM Act 2004</i>)		x			
Adelaide's Living Beaches Strategy 2005 – 2025		x			
Prospering in a Changing Climate: A Climate Change Adaptation Framework for South Australia, 2012		x			
Water for Good Plan 2010		x			

Appendix B: Policies and plans contributing to adaptive capacity

Plans, policies and strategies	Commonwealth Government	Government of South Australia	City of Port Adelaide Enfield	City of West Torrens	City of Charles Sturt
Flood Inundation and Hazard Mapping Study for Brown Hill and Keswick Creeks, 2003		X		X	X
Economic Statement 2013		X			
South Australian Building Code		X			
Strategic Infrastructure Plan for South Australia, 2004/05 – 2014/15		X			
RDA Adelaide Metropolitan Road Map First Edition 2012-2015		X			
LGA SA Climate Change Strategy 2008-2012		X	X	X	X
SA Local Government Sector Agreement – Climate Change		X	X	X	X
City of Port Adelaide Enfield (PAE) City Plan 2010-2016			X		
PAE Environment Strategy for a Sustainable City 2009-2014			X		
PAE Development Plan			X		
City of Charles Sturt (CS) Community Plan 2027					X
CS Towards One Planet Living: Greening the Western Suburbs Plan 2008-2013					X
CS Development Plan					X
City of West Torrens (WT) Towards 2025 Community Plan November 2011				X	
WT Climate Change Action Plan 2009-2014				X	
WT Development Plan				X	