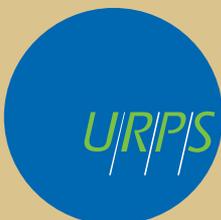




AdaptWest

Urban Planning and Development
Research Paper
28 November 2014



URPS in collaboration with SEED consulting and AECOM



AdaptWest Research Paper

Urban Planning and Development

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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 is 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, M, Horrocks, L, Harvey, A, and Hamilton, C (2011) *Rethinking adaptation for a 4°C world* in Philosophical Transactions of the Royal Society A, 369, pp.196-216, 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 primarily upon the *Western Adelaide Region Climate Change Adaptation Plan – Stage 1* and additional relevant literature and interviews with key informants associated with the research paper theme where appropriate.

2.0 Urban planning and development in the Western Adelaide region

2.1. Overview

The urban planning and development theme within the AdaptWest project relates to land use, and the policy, legislation and standards that guide new development in the region.

In South Australia planning legislation and policy seek to regulate the nature and form of development and the use and management of land and buildings in the public interest.

Policies are contained in local Development Plans for each Council that divide land into zones that outline the types of land uses and structures (defined as 'development' in the *Development Act 1993*) that are envisaged in particular areas.

The scope, form and implementation of policies is governed by the *Development Act 1993* and *Development Regulations 2008*. Some regulation of development occurs directly through implementation of the *Development Regulations*.

Building standards are in place to achieve and maintain acceptable standards of structural adequacy, safety, health, sustainability and amenity for the benefit of the community.

National standards apply through the Building Code of Australia (BCA), and Minister's Specifications relate to specific building issues that require attention in South Australia. Minister's Specifications are referenced in the *Development Regulations 2008* or in South Australian variations to the BCA.

Since September 2010, under the *Development Act 1993*, new homes and extensions built in South Australia need to achieve a 6-star level of energy efficiency using an approved computer-based energy rating program (though there are defined exceptions).

Section 2.3 provides an overview of the following aspects of urban development and planning in relation to Western Adelaide:

- Land use;
- Planning policy; and
- Building standards.

Unless indicated otherwise, all information in these sections is drawn from *Western Adelaide Region Climate Change Adaptation Plan – Stage 1*.³

³ SKM (2013)

2.2. Key stakeholders

Key stakeholders in Western Adelaide’s urban planning and development are:

- **Local governments** that develop, implement and enforce local planning policies, implement and enforce state planning policies, and implement and enforce state and national building standards;
- **Minister and Department for Planning, Transport and Infrastructure** that are responsible for strategic planning for Greater Adelaide (inclusive of Western Adelaide), development of planning policies comprising the South Australian Planning Policy Library (SAPPL), approval of local planning policies, and implementation of planning policies in some circumstances;
- **State government bodies and agencies** that:
 - Contribute to the development and implementation of planning policies (for example the Coast Protection Board and the Environment Protection Authority); and
 - Are 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;
- **Australian Building Codes Board** that produces and maintains the BCA;
- **Private certifiers** who can implement state and national building standards and some planning policies;
- **Developers** who propose and undertake development; and
- **Members of the community** whose environment is affected by planning decisions and development outcomes, and who have opportunity to provide input to planning and development processes at points defined in legislation.

2.3. Existing conditions

2.3.1. Land use

Residential land uses are the most common land use across Western Adelaide. The only significant areas where residential is not the primary land use are the Adelaide Airport, north and eastern LeFevre Peninsula, and north of Grand Junction Road.

Industry is the second most prominent land use in Western Adelaide, with the major uses in this sector being Transport, Postal and Warehousing (1236 ha), Manufacturing (831 ha), and Electricity, Gas, Water and Waste Services (461ha).

The State Government’s *30-Year Plan for Greater Adelaide* sets out directions for future urban development, population growth, and employment lands. A key focus of the Plan is an emphasis on increased population densities and urban infill along key public transport corridors. Western Adelaide is slated for a significant proportion

of this growth, with targets in place for an additional 42,560 dwellings and 83,000 net additional population by 2040.

This means that there may be increased densification of built form in Western Adelaide’s residential areas in the future, as well as along key transit corridors such as the Outer Harbor and Grange rail lines, and at significant brownfield redevelopment sites at Bowden (former Clipsal and Origin sites), Woodville (to complement the Cheltenham St-Clair development), Woodville West and Port Adelaide (state land).

Increased densification of population has impacts not only for non residential areas but for the usage and demand for non residential land uses including those associated with employment, services, community uses and open space.

2.3.2. Planning policy

Zones in each Development Plan outline the types of land uses, activities and structures envisaged in particular areas, with zone policy written to facilitate envisaged forms of development and discourage inappropriate development.

Western Adelaide contains more than 10,000 ha of Residential zoning, covering 59% of the region. There is a total of 3,931 ha of Industrial zoning, accounting for approximately 23% of the region. Open Space, Recreation and Community zoning covers around 8% of the region, with Commercial and Centre and Airfield zones each accounting for approximately 5% of zones.⁴

Table 2.1: Development Plan Zones in Western Adelaide

Zone type	Zones		
	Charles Sturt	West Torrens	Port Adelaide Enfield
Airfield	-	Airfield	-
Commercial and Centre	Local Centre Neighborhood Centre District Centre	Commercial Local Centre Neighbourhood Centre District Centre	Commercial Local Centre Neighbourhood Centre District Centre Regional Centre
Conservation	-	-	Conservation

⁴ This information is drawn from SKM (2013). Amendment record tables of each Council’s Development Plan have been reviewed in September 2014. Amendments since March 2013 have had a negligible impact on the overall zoning profile of the region.

Zone type	Zones		
	Charles Sturt	West Torrens	Port Adelaide Enfield
Industry	Industry Home Industry Special Use	Industry	Industry Light Industry Home Industry Industry/Business(Gepps Cross Gateway) Bulk Handling
Open Space, Recreation and Community	Coastal Open Space Metropolitan Open Space System Recreation Stadium	Coastal Open Space Community	Coastal Open Space Metropolitan Open Space System Recreation Community
Residential	Residential Residential Character	Residential	Residential Residential Character

Port Adelaide Enfield has a proportionally smaller area of Residential Zones but much more extensive Industry Zones, which cover an area of 3,050 hectares, or nearly 40% of the Council area. Port Adelaide Enfield also has a proportionally larger area covered by Commercial and Centre zoning (519 ha or 6.6%), while Open Space, Recreation, Community and Conservation zoning covers a very small area.

Residential is the predominant zoning in Charles Sturt, covering 80% of the Council and an area of 4,108 hectares. Industry and similar zoning is proportionally smaller with 518 hectares covering 10% of the Council area. Charles Sturt contains significant Open Space, Recreation, Community and Conservation zoning, with 282 hectares covering 6% of the Council area.

Residential Zones cover nearly 2,000 hectares in West Torrens, accounting for approximately 53% of the Council area. Industry in the Council area covers 362 hectares, or 9.7% of all zones. The Airfield zone which contains Adelaide Airport covers 804 hectares, or more than 20% of the Council area. Open Space, Recreational and Community zones are also significant in West Torrens, covering 372 hectares or 10% of the Council area.

The Development Plans of all three Western Adelaide Councils are in the South Australian Planning Policy Library (SAPPL) format. This means the Western Adelaide Development Plans are in a generally consistent format and include similar policies considered by the State Government to be best practice.

Each of the Development Plans contains policies that apply across all zones relating to climate change-related considerations, as shown in Table 2.2.

Table 2.2: Climate change related policies in Western Adelaide Development Plans

Development Plan General Section: Climate change related policies	Charles Sturt	Port Adelaide Enfield	West Torrens
Hazards			
General	X	X	X
Flooding	X	X	X
Bushfire		X	
Salinity	X	X	X
Acid Sulfate Soils	X	X	X
Landslip	X	X	
Coastal Areas			
General	X	X	X
Environmental protection	X	X	X
Maintenance of public access	X	X	X
Hazard risk minimisation	X	X	X
Erosion buffers	X	X	X
Land division	X	X	X
Protection of economic resources	X	X	X
Development in appropriate locations	X	X	X
Natural Resources			
Water Sensitive Design	X	X	X

Key policies relating to climate hazards that are consistent across the three Development Plans include:

- Development should not be undertaken where it will create or aggravate coastal erosion, or where it will require coast protection works which cause or aggravate coastal erosion.
- Development should be designed and sited so that it does not prevent natural landform and ecological adjustment to changing climatic conditions and sea levels and should allow for the following:
 - a) the unrestricted landward migration of coastal wetlands

- b) new areas to be colonised by mangroves, samphire and wetland species
 - c) sand dune drift where appropriate, the removal of embankments that interfere with the abovementioned processes.
- Development and its site should be protected against the standard sea-flood risk level which is defined as the 1 in 100 year average return interval flood extreme sea level (tide, stormwater and associated wave effects combined), plus an allowance for land subsidence for 50 years at that site.
- Commercial, industrial, tourism or residential development, and associated roads and parking areas should be protected from sea level rise by ensuring all of the following apply:
 - a) site levels are at least 0.3 metres above the standard sea-flood risk level
 - b) building floor levels are at least 0.55 metres above the standard sea-flood risk level
 - c) there are practical measures available to protect the development against a further sea level rise of 0.7 metres above the minimum site level required by part a).
- Buildings to be sited over tidal water or which are not capable of being raised or protected by flood protection measures in future, should have a floor level of at least 1.25 metres above the standard sea-flood risk level.
- Development that requires protection measures against coastal erosion, sea or stormwater flooding, sand drift or the management of other coastal processes at the time of development, or in the future, should only be undertaken if all of the following apply:
 - a) the measures themselves will not have an adverse effect on coastal ecology, processes, conservation, public access and amenity.
 - b) the measures do not nor will not require community resources, including land, to be committed.
 - c) the risk of failure of measures such as sand management, levee banks, flood gates, valves or stormwater pumping, is acceptable relative to the potential hazard resulting from their failure.
 - d) binding agreements are in place to cover future construction, operation, maintenance and management of the protection measures.
- Development should be set back a sufficient distance from the coast to provide an erosion buffer (in addition to a public reserve) which will allow for at least 100 years of coastal retreat for single buildings or small scale developments, or 200 years of coastal retreat for large scale developments (ie new townships) unless either of the following applies:

- a) the development incorporates appropriate private coastal protection measures to protect the development and public reserve from the anticipated erosion
 - b) the council is committed to protecting the public reserve and development from the anticipated coastal erosion.
- Where a coastal reserve exists or is to be provided it should be increased in width by the amount of any required erosion buffer. The width of an erosion buffer should be based on the following:
 - a) the susceptibility of the coast to erosion
 - b) local coastal processes
 - c) the effect of severe storm events
 - d) the effect of a 0.3 metres sea level rise over the next 50 years on coastal processes and storms
 - e) the availability of practical measures to protect the development from erosion caused by a further sea level rise of 0.7 metres per 50 years thereafter.
- Development should not occur where essential services cannot be economically provided and maintained having regard to flood risk and sea level rise, or where emergency vehicle access would be prevented by a 1-in-100 year average return interval flood event, adjusted for 100 years of sea level rise.
- Development should not be undertaken in areas liable to inundation by tidal, drainage or flood waters unless the development can achieve all of the following:
 - a) it is developed with a public stormwater system capable of catering for a 1-in-100 year average return interval flood event
 - b) buildings are designed and constructed to prevent the entry of floodwaters in a 1-in-100 year average return interval flood event.

While hazard policies apply across the Council areas, hazard overlay maps are not contained within any of the Development Plans. Development Constraints maps are included in all three Development Plans, through West Torrens's Plan is the only one in which Development Constraints mapping shows a climate related hazard (see *Flooding* below).

The SAPPL Development Plan format allows for 'local additions', meaning the inclusion by Councils of policies that do not form part of the standard state-wide policies subject to the approval of the Minister for Planning. Table 2.3 summarises where local additions have been made to the climate change related policies in the region's Development Plans.

Table 2.3: Local additions to climate change related policies in Western Adelaide Development Plans

General Section policy	Climate change related local additions		
	Charles Sturt	Port Adelaide Enfield	West Torrens
Hazards			
General	Buildings should be erected on stable land (Principle 4)	-	-
Flooding	-	Refer <i>Flooding</i> section below	Refer <i>Flooding</i> section below
Acid Sulfate Soils	-	Development, including excavation and filling of land, that may lead to the disturbance of acid sulfate soils should be managed in a way that minimises the potential for harm to the marine, estuarine and coastal environment, public health or damage to buildings, structures or infrastructure (Principle 22)	-
Coastal Areas			
Environmental protection	-	The coast should be protected from adverse impacts of develop including measures for flood, erosion and wave protection (Principle 2) Standards for development setbacks and public reserves applying other than in specified areas within the Newport Quays development (Principles 11 and 13)	-
Erosion buffers	-	Development should not occur where essential services cannot be economically provided and maintained having regard to flood risk and sea level rise, or where emergency vehicle access would be prevented by a 1-in-100 year average return interval flood event, adjusted for 100 years of sea level rise other than in specified areas within the Newport Quays development (Principle 27)	-

General Section policy	Climate change related local additions		
	Charles Sturt	Port Adelaide Enfield	West Torrens
Hazard risk minimisation	Unavoidable stormwater and effluent outfalls should be designed and located so as not to conflict with the objectives for coastal areas and if discharging across a beach do so at beach level from properly constructed pipes or channels (Principle 21)	-	-
Natural Resources			
Water Sensitive Design	Site drainage should not discharge into or onto a service lane unless adequately designed and engineered for such function (Principle 17)	Stormwater management systems should not create conditions conducive to the breeding of vectors of disease and nuisance pests (Principle 14) Additional detail around objectives for stormwater management systems including that rainwater tanks be designed in accordance with the average rainfall for the area and not the roof size (Principle 16) Major drainage systems should be designed to accommodate existing upstream flows (Principle 17) Design guidelines for permanent stormwater retention basins and artificial wetland systems (Principles 19 and 20) All land and development should be capable of being properly drained to a legal point of discharge (Principle 21) Performance criteria for vehicle washing and cleaning areas (Principles 22 and 23)	On site detention and retention of stormwater should be sited away from areas where site contamination has occurred. (Principle 16)

Flooding

Development Constraints mapping in the West Torrens Development Plan shows land subject to a 1-in-100 year average return interval flood event across the Council area as a flood hazard. These areas are subject to additional policies requiring that:

- Development should not occur unless it is sited, designed and undertaken with appropriate precautions being taken against the relevant hazards (General Section, Hazards, Principle 2);
- Ground floor levels of all development should be located above a design flood level which provides an acceptable level of risk to persons and property. minimises the impact of floodwaters onto adjoining properties, ensures development will not adversely affect the level of floodwaters on adjoining properties (General Section, Hazards, Flooding, Principle 7); and
- Certain forms of development (consulting room, dwelling, office, recreation area, store and warehouse) be exempt from the complying assessment pathway and subject to the more rigorous on merit assessment process.

These additional policies are identified as 'local additions' to the SAPPL modules.

While the Charles Sturt and Port Adelaide Enfield Development Plans include Development Constraints Mapping, no climate related hazards are shown on these maps.

The Charles Sturt Development Plan adopts the SAPPL Hazard policies relating to flooding unamended, while the Port Adelaide Development Plan contains the following local additions to the flooding provisions:

- Poorly-drained land should be raised at least 1.3 metres above the highest winter watertable before development takes place (General Section, Hazards, Flooding, Principle 7);
- Where flood protection measures are provided (e.g. levees or pumping stations) they should be designed such that building sites are not lower than the estimated water level for rainfall or storm tide events, or a combination of these, with an annual probability exceedance of 1 per cent plus 0.3 metre allowance for sea level rise. Floor levels and sills around underground parking cellars or the like should be at least 0.25 metres above this minimum land level (General Section, Hazards, Flooding, Principle 8); and
- Where flood protection measures are not provided for development situated on low-lying land, building sites and development should be at least 0.25 metres above the minimum flood level (General Section, Hazards, Flooding, Principle 9).

Future planning policy change

Strategic Directions Reports (SDRs) for the Western Adelaide Councils identify the priority future Development Plan Amendments (DPAs) summarised in Table 2.4.

Table 2.4: Priority investigations and DPAs for Western Adelaide Councils

Proposed study/DPA and scope	Timing
City of Charles Sturt Strategic Directions Report (2014)	
Residential Yield Analysis - Spatial analysis of residential dwelling targets in 30 Year Plan for Greater Adelaide	2013
Residential City-Wide Policies DPA - Review residential policies with a focus on non-growth areas	2013/14
Residential Streetscape DPA - Review residential policies, with a focus on areas with consistent streetscapes and will promote more stringent controls on development	2013/14
Heritage DPA – Incorporate findings of heritage review	2013/14
Residential Regeneration and Arterial Road Transport Corridors DPA(s) - Investigate policy (and zoning) amendments to support and facilitate residential regeneration	2013/14
Henley Beach Precinct DPA – Implement ‘Henley Beach Precinct Master Plan’ (2006) and ‘Henley Transport and Parking Plan’ (2013)	2013/14
Urban Employment DPA - Investigate application of the ‘Urban Employment Zone’ policy module from the SAPPL to industrial precincts	2014/15
City of Port Adelaide Enfield Strategic Directions Report (2012)	
Port Adelaide Centre DPA – Implement new SAPPL modules to assist with Port Adelaide Centre’s revitalisation	2012/13
Prospect Road and Environs DPA – Capitalise on <i>The 30-Year Plan</i> proposal for a mass transit extension along Prospect Road	2012/13
Restricted Residential Policy Area DPA - Policy Area 14 in the Residential Zone, which spans the eastern Lefevre Peninsula. Existing boundary and policy analysis with a view to assessing accuracy and function.	2012/13
North West Corridor DPA – Land use design parameters around this major transit corridor under <i>The 30-Year Plan</i>	2013/14
Hanson Road DPA - Improving the function and appearance of Hanson Road, complementing the surrounding areas which are undergoing regeneration	2015/16
Centres Zones DPA - inventory of existing Centre zones in the Council area against community needs, rezoning requests from stakeholders, and the new activity centres typology referred to in the 30-Year Plan	2015/16
General Review DPA – Update SAPPL modules	2016

Proposed study/DPA and scope	Timing
West Torrens Strategic Directions Report (2008)	
Better Development Plan Conversion DPA – Adoption of SAPPL format and policy modules [Completed]	2009/10
Housing Diversity DPA - To provide an appropriate range of housing options to meet the future and contemporary expectations of the West Torrens community [Completed]	2008/09
Activity Centres Review DPA – Review of activity centres using retail and economic analysis	2008/09
Employment DPA - Provide an appropriate range of employment options for the needs of West Torrens residents	2011/12

The West Torrens SDR of 2008 lists an Urban Stormwater DPA and a Conservation DPA with a focus on protection of the River Torrens environment as additional DPAs to be considered should additional staff or budgetary resources be available. The priority of these DPAs may have increased with completion of high priority DPAs identified in the SDR.

2.3.3. Building standards

Development in the Western Adelaide region is subject to various building rules, regulations, standards and codes at both national and state levels. There are three underlying pieces of legislation and standards which affect building development in South Australia. These are:

- **Development Act 1993 (South Australia):** allows regulation of the use and management of land and buildings, and the design and construction of buildings. Establishes the requirement for development approvals. Administered by the Department of Planning, Transport and Infrastructure (DPTI).
- **Development Regulations 2008 (South Australia):** supporting regulations under the Development Act 1993 (South Australia). Outlines requirements and guidelines for acquiring development approvals. Administered by DPTI.⁵
- **Building Code of Australia (BCA) (Commonwealth):** Volumes 1 and 2 of the National Construction Code series. Outlines the standards set for building works in Australia. Goals of the BCA are to “achieve and maintain acceptable standards of structural adequacy, safety, health, sustainability and amenity for the benefit of the community”.⁶ Administered by the Australian Building Codes Board (Cwth).

⁵ Gibbs and Hill (2011), *Coastal Climate Change Risk – Legal and Policy Responses in Australia*, Department of Climate Change and Energy Efficiency (DCCEE), pp.76-79

⁶ Government of South Australia (2014a), *The Building Code of Australia*

This legislation and standards establish rules, policies and initiatives for buildings in the Western Adelaide region relating to hazard protection and environmental performance. South Australia's Strategic Plan also contains targets relating to energy efficiency, though these do not have regulatory effect. Table 2.3 below summarises South Australian building policies and initiatives.

Table 2.3: Building policies and initiatives⁷

Building policies/initiatives	Purpose	Relevant institution
T60: Energy efficiency - dwellings	From South Australia's Strategic Plan. A target to improve the energy efficiency of dwellings by 15% by 2020, with a milestone of 10% by 2014.	Department of Premier and Cabinet (DPC) (SA)
T61: Energy efficiency – government buildings	From South Australia's Strategic Plan. A target to improve the energy efficiency of government buildings by 30% by 2020, with a milestone of 25% by 2014.	Department of Premier and Cabinet (DPC) (SA)
Code of Practice for House Energy Rating Assessors	Helps ensure that house energy ratings for the energy efficiency potential of houses are verified in a credible and reliable manner and in compliance of the Development Act 1993	Department of Planning, Transport and Infrastructure (DPTI) (SA)
Residential energy efficiency scheme (REES)	Requires larger energy providers to assist households in energy saving activities, including energy auditing services, installing energy efficient light globes and power controllers	Department of State Development (DSD) (SA)
National Strategy on Energy Efficiency (NSEE)	Accelerate efforts for the uptake of energy efficiency measures in buildings, streamline roles and responsibilities across all levels of government, and help residents and businesses transition to a low-carbon future	Council of Australian Governments (COAG)
Government Buildings Energy Strategy	Strategy for managing energy use and improving energy efficiency in government buildings in South Australia	Government Buildings Energy Group (GBEG)
Six star energy efficiency requirements for new homes	From the <i>Development Act 1993</i> . From 2010, all new homes and extensions built in South Australia must meet a 6-star energy efficiency standard	Department of State Development (DSD) (SA)

⁷ Government of South Australia (2014b), *State Government energy efficiency initiatives*

Building policies/initiatives	Purpose	Relevant institution
Development Plans <ul style="list-style-type: none"> - Port Adelaide - Enfield - Charles Sturt - West Torrens 	Detailed criteria for assessment of development applications in each Council area. Outlines principles of development control criteria for building in coastal regions (including site and floor level criteria and hazard risk minimization) and flood prone regions.	City of Port Adelaide Enfield City of Charles Sturt City of West Torrens

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 this involvement was a workshop in which representatives of key stakeholder organisations identified those aspects of Western Adelaide that are important to their objectives and core functions and contribute to the vitality and functioning of the region and beyond.

The AdaptWest project team developed stakeholder input into a list of regional values with associated features and aspects that will form the basis of subsequent project tasks and in particular the IVA.

Table 2.4 describes the AdaptWest values, features and aspects that have a direct relationship to social and community resilience and health in the region.

Table 2.4: AdaptWest values, features and aspects relating to urban planning and development

What we value in the Western Region	Features or aspects that relate to this value	Relationship to urban planning and development in Western Adelaide
A strong and connected community	Diversity Equity and social justice Vulnerable members of the community	The location and form of community infrastructure that contributes to social inclusiveness such as hospitals, schools, and community centres is regulated by planning policies and building rules. Development Plans also contain policies to encourage provision of affordable housing in new residential development.

Urban planning and development in the Western Adelaide region

What we value in the Western Region	Features or aspects that relate to this value	Relationship to urban planning and development in Western Adelaide
Amenity and quality of life	<p>Safety and health</p> <p>Sport, recreation, entertainment and tourism facilities</p> <p>Coastal /water based recreation</p> <p>Open and green spaces</p> <p>Natural and historical environments</p>	<p>Around 8% of the region is zoned for open space and recreational and community facilities. These zones provide for development, enhancement and protection of public and private recreational facilities, open spaces and natural environments that are central to the quality of life for the Western Adelaide region. Sporting fields, stadiums, beaches, tourist attractions, nature reserves all provide essential community services.</p> <p>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>Amenity of the urban form is maintained through the planning system under the <i>Development Act 1993</i> and <i>Development Regulations 2008</i>, with new development subject to policies associated with visual impact including bulk, scale, and site coverage. Buildings and areas of historical significance are protected by heritage legislation and specific planning policies.</p> <p>Building safety is also regulated through the development assessment process with building rules consent along with planning consent required for new development.</p>
Coastal and riverine water quality	<p>Port River</p> <p>River Torrens</p> <p>Gulf St Vincent</p> <p>Water Sensitive Urban Design (WSUD)</p> <p>Stormwater capture and reuse</p>	<p>Planning policies and building rules require implementation of stormwater management strategies and techniques in new development.</p> <p>Development Plans contain policies that seek to protect water quality, for example through general provisions that seek to protect and enhance natural resources, and regulate specific activities such as horse keeping on the banks of the River Torrens.</p>

Urban planning and development in the Western Adelaide region

What we value in the Western Region	Features or aspects that relate to this value	Relationship to urban planning and development in Western Adelaide
Coastal environment	Environmental values Community and recreation Tourism Assets and infrastructure	<p>Planning policy has a key role in managing the coastal environment through regulation of land uses and application of performance standards for new development on the coast.</p> <p>Specific policies that apply to coastal areas relate to environmental protection, maintenance of public access, hazard risk minimisation, erosion buffers, land division, protection of economic resources, and development in appropriate locations.</p> <p>Key coastal land uses such as public open space and tourism development are also managed through planning policy.</p>
Infrastructure and essential services	Port facilities Adelaide Airport Water and wastewater treatment Power generation Transport Open space Defence industries Community facilities	<p>Planning policies seek to ensure that new development can be adequately serviced by infrastructure including roads and stormwater management.</p> <p>Policies are also in place to protect the operations of major assets such as Adelaide Airport, Flinders Ports assets (e.g. Adelaide Container Terminal), and electricity infrastructure at Torrens Island.</p> <p>The location and form of community infrastructure such as wetlands, parks and open space, and community buildings such as hospitals, schools, and community centres are regulated by planning policies and building rules.</p>

Urban planning and development in the Western Adelaide region

What we value in the Western Region	Features or aspects that relate to this value	Relationship to urban planning and development in Western Adelaide
Management and use of stormwater	Protection of homes Protection of infrastructure Water Sensitive Urban Design (WSUD) Stormwater capture and reuse	<p>Western Adelaide is a substantially developed area, with large areas of hard surface generating stormwater runoff.</p> <p>Increased residential densities in the region sought by <i>The 30-Year Plan for Greater Adelaide</i> have potential to further increase runoff, but also to contribute to stormwater management through incorporation of open space, WSUD and stormwater capture and reuse. Planning policies and building rules require implementation of stormwater management strategies and techniques in new development.</p> <p>Development Plans of each of the regional Councils contain policies relating to flood protection, stormwater management, and WSUD. Development generally must be protected from a 100 year ARI flood event.</p>
Regional productivity and economic contribution to the state	Infrastructure and industries of state significance: <ul style="list-style-type: none"> - Port facilities - Adelaide Airport - Defence industries - Gillman industrial area - Tourism infrastructure e.g. Adelaide Shores - Adelaide Entertainment Centre 	<p>About 23% of the region is within industrial zones. Much of the regional productivity in the region is sourced from the developments along the northern and north-western coast along Barker Inlet.</p> <p>Western Adelaide contains more than 30% of South Australia’s manufacturing businesses, and there has been significant growth in freight, defence, transport, warehousing and logistics. Ongoing availability of industrial land to meet demand, and ability to develop and operate industrial land uses are a vital component of regional productivity.</p> <p>Development Plan zoning and planning policies and building rules that apply to industrial and tourism areas and new industrial and tourist development impact on the ongoing viability of the regional economy and investment decisions.</p> <p>Industry trends in the region have indicated a shift in development patterns and occupant preferences, with some users seeking up to 60% office space and 40% warehouse space, and a desire for greater urban amenity.</p>

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 urban planning and development 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 2.4: AdaptWest key decision relating to urban planning and development

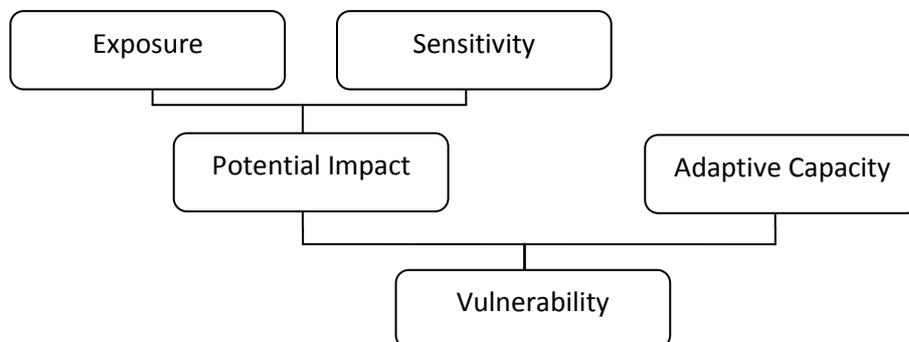
Decision lifetime	Key decision
Short lifetime decisions (0-10 years)	<ul style="list-style-type: none"> • Social infrastructure • Waste management • Emergency management, deployment of personnel • Coastal management and planning-erosion • Budget decisions for stormwater management - this transitions into medium/long term outcomes • Rates and local government revenue • Community Plan • Asset Management Plan • Environment Plan • Open Space Plan • Financial Plan • Community gardens and markets • Community events and activities
Medium lifetime decisions (10-30 years)	<ul style="list-style-type: none"> • Street upgrades (footpaths and physical infrastructure) • Defence industry (ASC, Shipyards) – jobs, employment, transportation • Conservation of built heritage, historic conservation area and State/local heritage • Review of Development Plan to influence built form generally • Review of planning system/legislation • Community education to influence behaviour change • Change of community attitude to built form (e.g. density vs open space)

Long lifetime decisions (30+ years)	<ul style="list-style-type: none"> • Determining location of residential development and concentration of new infill housing (density, brownfield) • Land use and rezoning – consequences over the long-term • Infrastructure decisions; transport, stormwater, electricity • Gillman industry – jobs creation, long-term industrial growth • Street plantings and natural asset management • Decisions about Pelican Point and electricity infrastructure • Decisions made arising from development assessment process (actual built form outcomes) • Stormwater infrastructure • Public open space planning (land acquisition) • Review of Development Plan to rezone industrial land • Improved cycle infrastructure • Regeneration of neighbourhoods • Provision of open space with recreational facilities
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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 (refer Figure 2.1; 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 focussing 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 urban planning

and development 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).⁸

3.1. Increasing average temperature

Temperatures in southern Australia have been increasing by about 0.2°C per decade since 1950⁹ 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).¹⁰ Mean maximum temperatures are expected to increase greatly,

⁸ CSIRO and BOM (2007-2014) *Climate Change in Australia*.
www.climatechangeinaustralia.com.au

⁹ CSIRO and BOM (2007-2014)

¹⁰ CSIRO and BOM (2007-2014)

particularly during summer months.¹¹ 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.¹²

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.¹³

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 2070.¹⁴

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.¹⁵

¹¹ SKM (2013) p.36

¹² SKM (2013) p.37

¹³ CSIRO and BOM (2007-2014)

¹⁴ SKM (2013) p.42

¹⁵ 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 2070.¹⁶

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 RCP6.0¹⁷ (equivalent to a low to medium emissions scenario).¹⁸ 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.¹⁹

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.²⁰

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.²¹

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.²²

¹⁶ SKM (2013), p.42

¹⁷ RCP = Representative Concentration Pathway, as referred to in: IPCC (2013) *Summary for Policymakers*, Cambridge University Press

¹⁸ IPCC (2000) *Summary for policymakers: Emissions Scenarios*, IPCC

¹⁹ DEH (2005) *Adelaide's Living Beaches: A Strategy for 2005-2025*, Department of Environment and Heritage, p.54

²⁰ SKM (2013) p.60; DEH (2005), p.55

²¹ DEH (2005) p.101

²² 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.²³

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 2070.²⁴ 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).²⁵

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.²⁶ This compares with a 0.1 pH unit decrease that has already been experienced since the beginning of the industrial era 250 years ago.

²³ South Australian Coast Protection Board (1992), *Coastal Erosion, Flooding and Sea Level Rise Standards and Protection Policy*, Coastline, p.6

²⁴ CSIRO and BOM (2007-2014)

²⁵ Suppiah *et al.* (2006) *Climate Change Under Enhanced Greenhouse Conditions in South Australia*, CSIRO Marine and Atmospheric Research, p.5-6

²⁶ IPCC (2013) *Summary for policymakers*, University Press, p.25

4.0 Sensitivity factors

This section describes the potential sensitivities of AdaptWest values relating to urban planning and development to climate hazards. Table 4.1 below summarises the values and climate hazards to which they are sensitive.

Table 4.1: Potential sensitivities of urban planning and development values to climate hazards

HAZARD VALUE	Increased temperatures	Increased heatwaves (FD)	Increased temperature of Gulf waters	Increased rainfall intensity	Reduced average annual rainfall	Coastal inundation	Coastal recession	Increased pH of Gulf waters
Amenity and quality of life	X	X		X	X	X	X	
A strong and connected community	X	X		X	X	X	X	
Coastal and riverine water quality	X	X	X	X	X	X	X	X
Coastal environment	X	X	X	X	X	X	X	X
Infrastructure and essential services	X	X		X	X	X	X	
Stormwater management and use	X	X		X	X	X	X	
Regional productivity and economic contribution	X	X	X	X	X	X	X	X

4.1. Amenity and quality of life

Higher temperatures and heatwaves will impact upon the amenity of residential areas, potentially affecting housing, roads, and public and private open spaces. Increasing temperatures may require energy efficiency and thermal comfort measures (passive and active) of existing buildings to be upgraded and adapt to changing conditions. Lower income households are likely to be disproportionately affected by this.

Preferences with regard to built form and housing assets (e.g. swimming pools, rainwater tanks, and shaded areas) may change in response to climate conditions, which require greater efforts from developers to meet demands. Some residential areas may be more restricted in their capacity to adapt to newer, more energy efficient building technologies due to policy conditions (e.g. heritage and character protection) or the existing built environment (e.g. land use interfaces, siting and appearance of structures).²⁷

²⁷ SKM (2013), p. 143

Community buildings are also likely to be impacted with rising temperatures impacting on the integrity of external surfaces and thermal performance of buildings. Infrastructure upgrades to sport and recreation facilities such as playing fields, recreation centres and walking paths may be required to maintain their usability in hot and dry conditions, for example lights to enable evening use, air conditioning of indoor facilities, heat tolerant playing surfaces, and shade structures in parks and playgrounds.

Effects of hot and dry conditions on trees and vegetation (drying, plant loss, introduction of disease) have flow on effects to amenity and people's quality of life. Urban heat island (UHI) effect may also exacerbate the intensity and impacts of heatwaves and extreme heat in built up areas, and particularly those at higher densities. UHI refers to the difference in air temperature between urban environments and surrounding rural environments, where urban environments experience warmer temperatures due to a larger impervious surface area as a result of urban development. Modelling recently undertaken in Adelaide shows that building height increases contribute to an increased UHI effect by trapping heat at night.²⁸

Flood risk as a result of increased rainfall intensity has potential to affect residential, industrial, and commercial land uses, with sea level rise, storm surge and coastal inundation similarly affecting the full range of land uses present along the region's coast. This has flow on effects for health, wellbeing and safety of the population, and the productivity of businesses and industry including retail and tourism. Impacts of coastal erosion would be more gradually experienced, but could similarly compromise homes, businesses and community facilities on the coast.

4.2. 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. Equity and social justice encompasses access for all members of the community to a high level of amenity and quality of life, and as such the sensitivities described in Section 4.1 are equally relevant to this value.

Vulnerable members of the community may rely more heavily on services provided in public buildings such as community centres and hospitals. These buildings and access to them may be compromised during extreme heat, heat waves, and periods of intense rainfall and/or coastal inundation.

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 Torrens River and the Gulf St Vincent. Additionally, the application of Water Sensitive Urban Design (WSUD) and the capture and reuse of stormwater are equally important aspects.

²⁸ Ewenz, C.M and Bennet, M.G (2013) *Increased Urban Heat Island Effect due to Building Height Increase*

WSUD and stormwater capture and reuse features are water quality improvement mechanisms present across various parts of the Western Adelaide region. For example, wetlands around the Port River (Gillman Wetlands) and the Torrens River (Breakout Creek wetlands, Apex Park wetland) were constructed for the purpose of improving riverine water quality.²⁹

Planners and developers face a challenge in ensuring WSUD technologies are located in areas where they are most effective and functional. Increasing rainfall intensity and reduced average annual rainfall affect the asset life and capabilities of WSUD technologies such as bio-retention systems and infiltration systems. Intense and infrequent rainfall events may uproot vegetation and damage infrastructure, while heatwaves may affect the health of filtration vegetation, rendering the actual treatment capabilities of WSUD technologies useless.³⁰

4.4. Coastal environment

The coastal environment in the Western Adelaide region comprises the following assets:

- Port River coastline;
- Estuaries, including the Barker Inlet and Port River Estuary;
- Aquatic reserves (e.g. Torrens Island Conservation Reserve);
- Coastal reserves, such as the Torrens River Estuary; and
- Remnant sand dunes along the Gulf St Vincent coastline and Tennyson and West Beach.³¹

A broad range of public and private assets and land uses along the coast could be impacted by sea level rise, coastal recession, and coastal inundation. These include environmental assets, homes, businesses, major industry (e.g. Adelaide Container Terminal), tourism infrastructure (e.g. Adelaide Shores), recreational beaches, walking paths, benches, and playgrounds, and community buildings (e.g. Surf Life Saving Clubs).

The environmental assets of the region's coast, and the associated habitats and ecosystems they provide, are vulnerable to the effects of sea level rise, with global mean sea levels projected to rise by between 18 and 140 centimetres by 2100. The impact of sea level rise on the coastal environment will first be apparent during storm surge events, accelerating coastal erosion above natural rates.³² This is particularly the case for sandy beaches, which compose 47 per cent of South Australia's beaches. Rising sea surface temperatures could also increase the risk of algal

²⁹ SKM (2013) p.114

³⁰ WSAA (2012) *Climate Change Adaptation and the Australian Urban Water Industry*, p.45

³¹ SKM (2013) p. 121-122

³² URPS (2014) *Defining the Sea Level Rise Problem in South Australia*, prepared for the Local Government Association of South Australia in partnership with the Climate Change Unit, Water and Climate Change Branch, Department for Environment, Water and Natural Resources, and the Coast Protection Board, p.21

blooms in exposed areas and coastal reserves such as Mutton Cove on the Lefevre Peninsula.³³ Additionally, sea level rise is likely to exacerbate issues with existing acid sulfate soils in the region, particularly through Gillman Industrial Area.

Foreshores are important places for social gatherings, community events and activities both for the local community and for the more than 1 million visitors to South Australia's beaches each year.³⁴ Community recreation and tourism assets such as the foreshore and associated infrastructure (accommodation, recreation etc.) could be affected directly through the loss of remnant sand dunes such as those at Tennyson, Semaphore, South Semaphore, Largs Bay and North Haven. Increased movement of sand and longer periods of beach inundation could lead to reduced beach access and use, in addition to the decline in value and aesthetics of beaches in the region. Further, as temperatures and the incidence of heatwaves increase, so too will demand for access to the coast.

In addition to environmental values and community recreation and tourism, climate hazards also threaten the key industries and significant State economic infrastructure located in the region. Major transport and economic infrastructure is situated on the region's coast, and is therefore susceptible to the impacts of sea level rise and associated erosion and coastal recession. These include the Port of Adelaide, which comprises a container terminal, various berths and jetties, with Semaphore Jetty being the lowest and most vulnerable. Other assets include Techport Australia, a 75 hectare estate servicing maritime and naval industries, over 506 commercial buildings, 692 light industrial buildings and up to 45 kilometres of rail.³⁵

4.5. Infrastructure and essential services

Infrastructure in the Western Adelaide region is vulnerable to flooding and seawater inundation, storm surge events and extended heatwaves. This can cause damage to buildings and structures, erosion of road reserves and degradation of pavements. Fluctuating hydrological patterns may also cause the drying of land, ground movements and changes to the integrity of structures, affecting residential buildings closer to the coast.²⁷

Planning for underground infrastructure may also need to change, as impacts from sea level rise causes issues such as saline intrusion of aquifers. Changes to groundwater quality may accelerate the deterioration of underground infrastructure.³⁶

Increased strain on electricity transmission and distribution infrastructure may be experienced due to higher temperatures and increased use of air conditioning. This has the potential to result in network capacity issues and failures and strategic power outages. The energy efficiency of new development, and the capacity for existing buildings to be retrofitted, will significantly impact on this.

³³ SKM (2013) p.123

³⁴ URPS (2014)p. 23

³⁵ URPS (2014) p. 23; SKM (2013) p. 172

³⁶ SKM (2013) p. 38

Community infrastructure including parks, walking and cycling paths, recreation facilities, community buildings and health buildings throughout Western Adelaide may experience higher operational costs (energy, water and maintenance), unreliability of power and utilities, and building damage caused by storms, heat, flooding and inundation.

4.6. Management and use of stormwater

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. 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 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.³⁷

UHI effects may also change the way stormwater is managed and used. Research has shown that water retention in urban environments is essential to mitigate impacts of UHI effects. Strategies for management of stormwater, such as WSUD and stormwater capture and reuse, help limit UHI intensity.³⁸ WSUD slows the movement of water through the urban landscape, allowing the vegetation surrounding built form to cool more effectively.³⁹

4.7. Regional productivity and economic contribution to the state

Much of the region's industrial tracts and privately operated economic infrastructure is situated in or around the coastal area. These include major private assets such as energy infrastructure, maritime transport and logistics facilities (ports and wharves), rail infrastructure, and Adelaide Airport, as well as significant industries including Adelaide Brighton Limited. These assets comprise significant capital investments and play a vital economic role for the region and the state.⁴⁰

Likely impacts on private assets, whether industrial, commercial or residential, include flooding and seawater inundation, damage to buildings and structures, and shut down periods during flooding or extreme heat events. This may result in a number of flow-on impacts, including loss of productivity, higher operating costs associated with power and insurance, increased capital costs associated with retrofitting and maintenance and the accelerated depreciation of assets.⁴⁰

³⁷ SKM (2013), pp. 200-207

³⁸ Coutts, AM, Beringer, J, Jimi, S and Tapper, NJ (2013), *The urban heat island in Melbourne: drivers, spatial and temporal variability, and the vital role of stormwater*, pp.1-8

³⁹ Greening Australia (no date) *The Urban Heat Island Effect and Western Sydney*; WSUD in Sydney <http://www.wsud.org/adopting-wsud/background/climate-change/>

⁴⁰ SKM (2013), pp. 180-199

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 adapt - to adjust to potential damage, take advantage of opportunities, or respond to consequences.⁴¹

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 change.⁴² Adaptive capacity can be considered in a similar way, occurring 'naturally', or being deliberately developed to increase resilience to known challenges.

A range of Commonwealth, State and local policies, plans and strategies apply to Western Adelaide that address various aspects of urban planning and development and potentially contribute to the region's adaptive capacity. These are summarised in Appendix B.

The following discussion provides a brief overview of current features and conditions that contribute to Western Adelaide's adaptive capacity in relation to urban planning and development. 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.

5.1. Planning policy

Development Plan policies in place across the region relate to a range of issues relevant to both the regional values and climate change sensitivities including

⁴¹ IPCC (2013) Glossary

⁴² IPCC (2007) *Climate Change 2007*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Glossary

environment and natural resources, open space, coastal areas, stormwater management and WSUD, and hazards including flooding, salinity, acid sulfate soils, and landslip. These policies require new development to occur with some consideration of climate change sensitivities. Given some planning policies are qualitative and performance based, how application of these policies is realised in practice, and whether adequate information is available to apply them is less clear, but plays a significant role in actual adaptive capacity.

Each of Western Adelaide's Development Plans contains policies relating to flooding that contribute to adaptive capacity, though these differ somewhat in content and implementation:

- The West Torrens Development Plan includes flood mapping and additional policies for flood prone areas;
- Application of the City of Charles Sturt's flooding policies is triggered with reference to Council's flood mapping data by an internal referral to specialist staff. Charles Sturt have chosen not to include flood mapping in the Development Plan to enable the most up to date data to be used, particularly given changing conditions associated with ongoing stormwater management projects such as Waterproofing the West (refer Section 5.3); and
- The City of Port Adelaide Enfield will consider supplementing its existing flooding policies following completion of stormwater management plans that are currently underway. The specific mechanisms for stormwater management plans influencing planning policy and development outcomes are yet to be determined.

The City of Charles Sturt's Development Plan contains a policy that makes development within 8 metres of the Coastal Zone non-complying unless certain criteria are met. The Council has found this to be an effective policy lever to encourage development that meets all relevant policy standards relating to coastal hazards.

Work undertaken in relation to coastal planning policies across South Australia identified that while the policy provisions were considered appropriate, they were difficult to apply in some instances due to an absence of data. This led planners to apply the policies "loosely", with uncertain implications for the management of coastal risks such as sea level rise. The same study identified that in some Councils, planners were heavily reliant on referral advice from the Coast Protection Board, and that the capacity of Councils to apply coastal hazard information appropriately was influenced by high staff turnover and lack of financial resources, particularly for regional Councils.⁴³

Planners within State Government and the region's Councils interviewed for this research paper generally expressed that no significant barriers exist to applying current planning policies relating to climate hazards. The policies themselves were also considered generally adequate by those interviewed. Comments made that

⁴³URPS (2014) pp. 95-96

highlight potential limits of the adaptive capacity of planning policy in the region included that:

- WSUD policies in the Development Plan are not generally referred to, as no specific trigger is in place and the policies may not be applicable to smaller developments;
- A regional approach to hazards would be preferable to the current situation in which there are slightly differing policies and data availability between Councils (such as for flooding);
- There is a tension between directions in planning policy to have increasingly codified, streamlined processes, and the requirement to consider specific issues such as hazards at a more detailed level;
- In some areas of the region, hazard mitigation priorities can conflict with other planning policies, for example heritage conservation policies;
- The Development Plan must be agreed to by State Government which is increasingly pursuing standardisation, and in turn Councils are experiencing a reduced influence on policy;
- Councils experience resourcing pressures that limit the ability to update policy regularly and a regional or State approach to hazard policies may be beneficial;
- Within the current system, planning policy is a “clumsy tool” for responding to changing conditions such as climate hazards, as it takes a long time to change; and
- Politics and the views of elected member bodies can be barriers to policy change.

5.2. Building rules

Building rules in place across the region through the BCA and State building codes put structural standards in place that contribute to the resilience of buildings to climate change impacts such as heat, storm and flooding.

The quantitative and mandatory nature of building rules make such codes an effective driver for adaptation, with one of the region’s Councils noting that without compulsory standards for building components such as energy efficiency and hazard protection, most developers will opt for a cheaper option/lower standard. The same Council identified education and awareness raising within the building industry as an opportunity to build adaptive capacity.

5.3. Strategic land use planning

Around 8% of the region is zoned for open space and recreational and community facilities. Open spaces such as parks and golf courses can ease climate change

impacts such as UHI effect by moderating temperature,⁴⁴ as well as acting as stormwater retention areas during periods of intense rainfall.

Planning for open space will become increasingly important as the region pursues increased density of built form in residential areas around major transport networks under *The 30-Year Plan for Greater Adelaide*. The St Clair development in the City of Charles Sturt is one example, incorporating higher density residential development along with wetlands that manage stormwater discharges from the site and broader area. An interviewee noted that the current requirement for open space provision in new development was designed with greenfield development in mind, and along with other factors such as ability of design to affect UHI, may benefit from a new approach for infill development areas such as parts of Western Adelaide.

The intensively developed nature of the region, as well as the future directions in place for further densification of built form, makes stormwater management a significant priority. Unresolved flood management strategies in the Brown Hill Keswick Creek catchment was identified by an interviewee as a limitation on adaptive capacity in the region, while conversely progress has been made on Stage 1 of the major regional stormwater project Waterproofing the West. The current stage of that project includes:

- Old Port Road wetlands and Aquifer Storage and Recovery (ASR) stormwater scheme incorporating water reuse, water quality improvement, environmental enhancements all whilst reducing flood risk;
- Cooke Reserve and West Lakes Golf Course wetlands and ASR;
- St Clair wetlands which will provide treated stormwater for ASR and irrigation to the site's open space and urban development;
- Linking & Distribution Mains connecting the St Clair, Old Port Road and Cooke Reserve/West Lakes projects and Distribution Mains to supply the recycled stormwater to parts of the council area; and
- River Torrens Diversion System to divert river water to supply additional water for harvesting to all the wetlands.

An interviewee noted that there are adaptive practices in place for some land uses at risk of inundation, citing the example of the Australian Submarine Corporation being built up significantly above natural ground level. It was further noted that while there will inevitably be adaptation strategies in place for key land uses such as Adelaide Airport, managing risk to large areas of residential development in multiple ownerships was more complex, and required consideration in future iterations of the Planning Strategy.

5.4. Insurance

Insurance has a role in the region's ability to recover financially from extreme weather events, specifically in relation to replacement and repair of built form.

⁴⁴ SKM (2013) p. 126

Western Adelaide has a marginally lower rate of private home and contents insurance in comparison to metropolitan Adelaide, and a higher incidence of some characteristics associated with non-insurance such as higher density dwellings (e.g. flats and units), private and public rental tenure, and residents born outside Australia and with limited English.⁴⁵

Public infrastructure in the region is insured by the South Australian Government Financing Authority through SAICORP for State Government Assets, and the Local Government Association Mutual Asset Fund for Council assets. Assets excluded from coverage by the Mutual Asset Fund generally include roads, footpaths, bridges, underground services, wetlands/ dams and culverts. As each of these asset types may be vulnerable to climate change impacts, the inability to insure them reduces the region's adaptive capacity.

Other factors associated with local government that may impact on adaptive capacity of urban development in Western Adelaide include:

- Unclear roles and responsibilities of local government in relation to managing risks to infrastructure, especially in the area of emergency management;
- Resource constraints upon planning and asset management functions; and
- Legal liability concerns around communicating information on vulnerability of properties, infrastructure and assets to climate events in the context of potential impacts on property values or legal disputes.⁴⁶

5.5. Governance

Governance plays an important role in adaptive capacity in all regions and sectors, influencing the ability of decisions to be made and implemented effectively.

The Resilient South project found that well-functioning and relevant governance tools such as charters, strategic plans, Terms of Reference, budgeting processes and risk management practices play a key role in the adaptive capacity of organisations in Adelaide's southern region, including local governments. Conversely, governance arrangements can reduce adaptive capacity where they restrict the ability to allocate resources to long term challenges.⁴⁷

Governance challenges and opportunities including those relating to urban planning and development will be considered in future stages of the project, including through workshops with key stakeholders.

⁴⁵ SKM (2013), pp. 210 & 214

⁴⁶ Productivity Commission (2012) *Barriers to Effective Climate Change Adaptation*, Report No. 59, Final Enquiry Report, Commonwealth of Australia, Canberra

⁴⁷ Resilient South (2013) *Social & Institutional Mechanisms for Transitioning to Resilient Practices* prepared by URPS for the Resilient South consultancy led by URPS for the Cities of Onkaparinga, Holdfast Bay, Marion and Mitcham in association with the Government of South Australia and the Australian Government, pp. ii and 22

6.0 Summary of conclusions

The AdaptWest regional values, features and aspects identified by stakeholders have a relationship to urban planning and development in the region in terms of land use and the regulation of development through planning and building policy.

Residential land uses are the most common land use across Western Adelaide. The only significant areas where residential is not the primary land use are the Adelaide Airport, north and eastern LeFevre Peninsula, and north of Grand Junction Road. Industry is the second most prominent land use. Intensification of residential development in the region around key transport corridors and infill and brownfield sites is flagged in the *30-Year Plan for Greater Adelaide*. Further development of industrial areas at strategic locations is also expected, including along the coast.

Land use zoning in the region reflects the existing land use profile. Some variation exists within the region, with for example larger areas of land zoned Industry in the City of Port Adelaide Enfield, and larger areas of Open Space, Recreation, Community and Conservation Zoning in the City of Charles Sturt.

Each of the region's Development Plans is in the State Government's best practice SAPPL format, and has planning policy in place relating to climate hazards including flooding and sea level rise, through these policies do vary slightly. Building standards in the region are regulated in line with State and national codes, including in relation to energy efficiency.

In the context of the role of urban planning and development in maintaining and enhancing the Western Region's values, there is potential for sensitivity to the range of future climate hazards the region will be exposed to. Possible impacts include reduced amenity in residential areas and public and community spaces, and damage to community and economic assets such as transport infrastructure, buildings and foreshores for public and commercial use. Stormwater management is a key issue for the region for which climate change will present both challenges (e.g. water quality and flood risk) and opportunities (e.g. stormwater capture and reuse, with flow on effects in the mitigation of UHI effect).

The region's adaptive capacity in relation to urban planning and development is influenced by current and planned future land uses, and the policies in place to regulate development. A strong basis for the region's adaptive capacity exists in the systems, policies and projects currently in place such as the Development Plan and current and planned stormwater management projects. Potential constraints on adaptive capacity include inconsistency of policy across the region, challenges to implementing existing policy in an informed way, and competing strategic and policy objectives.

Institutional arrangements around insurance and governance also play a role in the region's capacity to adapt to the impacts of climate change. The level of coverage and cost of insurance of public and private assets has potential to significantly impact the region's economic and social resilience. The functionality of governance arrangements affects the ability of decisions to be made and implemented in a range of areas associated with planning and development.

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

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Appendices

Appendix A: Suggested IVA indicators

Primary indicator	Secondary indicator	Social and community resilience and health 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	Increased urban density impact on individual wellbeing		X					
Buildings	Condition of public buildings (incl. Schools, libraries, hospitals)					X		
Buildings	Condition of public realm (street scapes, street trees, paving, drinking fountains, public art)		X					
Buildings	Condition of built cultural heritage (e.g. heritage buildings, bridges, monuments, public art)		X					
Buildings	Demand for emergency evacuation centres and facilities					X		
Buildings	Demand for heat refuges					X		
Communications networks	Percentage of down time for telecommunications infrastructure					X		
Community planning and development	Frequency of public transport service interruptions					X		
Community planning and development	Quality of cycling and walking infrastructure (e.g. footpaths)					X		

Primary indicator	Secondary indicator	Social and community resilience and health 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					X		
Education	Internet access					X		
Education	School attendance		X					
Emergency management	Demand for emergency services					X		
Existing social capital	Level of support from family, friends and neighbours	X						
Existing social capital	Participation in organised sport, church or community group in local area	X						
Existing social capital	Rates of volunteerism	X						
Land assets	Condition of natural cultural heritage (e.g. scar trees, heritage vineyard, springs, rivers, burial grounds)		X					
Land assets	Quality of active recreation and sporting sites (outdoor - ovals, courts, pools, lawn bowls)		X					
Land assets	Quality of open space (predominantly green space)		X					

Primary indicator	Secondary indicator	Social and community resilience and health 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	Beach erosion				X			
Land condition	Condition of the Barker Inlet				X			
Land condition	Dune erosion				X			
Land condition	Inland area affected by soil erosion			X				
Local government services	Property values					X		X
Mental health	Impact on children < 12 years of age		X					
Mental health	Impact on people aged over 65 years and at risk		X					
Mental health	Impact on children < 12 years of age		X					
Pest plants and animals	Impact of pest plant and animal threats to the marine environment				X			
Physical health	Self assessed health		X					
Physical health	Impact on children < 12 years of age	X	X					
Physical health	Impact on people aged over 65 years and at risk	X	X					

Primary indicator	Secondary indicator	Social and community resilience and health 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
Physical health	Impact on people who require assistance for core activities	X	X					
Public safety	Levels of anti-social behaviour	X	X					
Quaternary sector	Impact on people choosing to live and work in the region							X
Quaternary sector	GRP from education and training							X
Recreation	Participation in organised sport, church or community group in local area		X					
Secondary industries	Cost of waste management							X
Secondary industries	GRP from manufacturing							X
Social inclusion/exclusion	Impact on people geographically isolated from transport services	X						
Social inclusion/exclusion	Impact on people under financial stress	X						
Social inclusion/exclusion	Number of outdoor civic events held by Councils	X						

Primary indicator	Secondary indicator	Social and community resilience and health 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	Number of outdoor civic events held by Councils		X					
Water	Condition of stormwater management infrastructure			X			X	
Water	Quantity of recycled water (treated wastewater and stormwater)			X			X	
Water	Quantity of stormwater generated			X			X	
Water	Surface water quantity and quality			X				
Water	Surface water quantity and quality – coastal/estuaries			X				
Water	Surface water quantity and quality – rivers			X				
Water	Groundwater quantity and quality			X				
Service networks	Condition of wastewater management assets					X		
Service networks	Delivery of potable water (condition of pipes and water quality)					X		
Service networks	Frequency of electricity supply disruption					X		

Primary indicator	Secondary indicator	Social and community resilience and health 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
Sporting facilities	Quality of active recreation and sporting sites (indoor)		X					
Tertiary industries	GRP from tourism (accommodation and food service)							X
Tertiary industries	GRP from healthcare and social services							X
Tertiary industries	GRP from retail trade							X
Tertiary industries	Tourist accommodation occupancy rates							X
Transport networks	Condition of jetties and boat ramps					X		
Transport networks	Condition of rail					X		
Transport networks	Condition of roads					X		

Appendix B: Policies and plans contributing to adaptive capacity

Appendix B: Policies and plans contributing to adaptive capacity

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
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			

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
Water for Good Plan 2010		x			
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	

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
WT Development Plan				x	