



Resilient South

**Strengthening the Southern Region
for changes in our climate**

Regional Climate Change Adaptation Plan

30/07/2014



Australian Government
Attorney-General's Department



**Government of
South Australia**

Government of South Australian agencies contributing include South Australian Fire and Emergency Services Commission, Department of Environment, Water And Natural Resources and the Adelaide and Mount Lofty Ranges Natural Resources Management Board

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Citation

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The Resilient South Adaptation Plan is the **product of the collective efforts of the project's Project Champions, the Project Management Committee, Project Coordinator and the consultant team.** It has received funding from the South Australian and Federal Governments.

Particular acknowledgment is made of the Project Champions who freely gave their time to actively participate in the Resilient South Adaptation Planning project and whose contribution directly influenced key outputs and shaped the direction of key stages of the **Adaptation Plan's development.** These Project Champions represented a diversity of organisations and interests across the Southern Region including State and Local Government and the community, health, business, education, research and natural resources management sectors. The Resilient South project team looks forward to continuing to work with these community leaders as the project progresses.

The Project Management Committee comprises representatives from the Cities of Onkaparinga, Holdfast Bay, Marion and Mitcham. The Project Management Committee with the support of the Resilient South Project Coordinator initiated and leads the project.

The development of the Resilient South Adaptation Plan project was undertaken by a consultant team led by URPS in association with Seed Consulting Services, SKM, Ecocreative, Econsearch, Concepts of Change and the Australian Workplace Innovation and Social Research Centre.

List of Acronyms/Glossary of Terms

Term	Definitions
Adaptation	Taking action to avoid, withstand or benefit from current and projected climate changes and impacts.
Adaptive capacity	<p>Adaptive capacity is the ability to adjust to climate change impacts (including climate variability and extremes), moderate potential damages, take advantage of opportunities, or cope with consequences.</p> <p>In determining adaptive capacity, consideration is given to what extent a feature or its function in its current form, with current management practices or funding, able to continue to function, cope or adjust to the expected climate conditions (in the case of Resilient South) at 2070.</p> <p>For example, water sensitive urban design (WSUD) can provide the ability for a streetscape to function in response to reduced rainfall, but if no WSUD measures are in place now, then the adaptive capacity would be considered to be less than if WSUD was currently in place.</p>
Adaptation Pathways	<p>An approach to adaptation planning which enables the consideration of a range of possible adaptation options, how they will be impacted by climate change through time, and whether any options have a "expiry date" (i.e. a point in time at which they are no longer viable). A key aspect of this approach is the identification of a preferred pathway which identifies those options to be progressed now and into the future based on currently available information, including Project Champion inputs.</p> <p>The preferred pathway does not preclude current actions that contribute to future adaptation from continuing and should be reviewed at least every 5 years, at which time new information may suggest that the preferred pathway should take a different course through potential options.</p> <p>Note that for the purposes of this Adaptation Plan the pathway maps are referred to as pathways.</p>
Climate	Climate summarises the average, range and variability of weather elements, e.g. precipitation, wind speed, air temperature, humidity, and sunshine hours (solar radiation), observed over many years (typically > 30 years) at a location or across an area.
Climate change	Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.
Climate variable	Climate variables are different climate impacts projected for a particular timeframe and include increased frequency of bushfire, coastal inundation, reduced rainfall, rainfall intensity, temperature increase, increased frequency of heatwaves, increased temperature of Gulf waters etc.
Domain	Resilient South viewed the Southern Region and its stakeholders through the framework of domains, specifically: <ol style="list-style-type: none"> 1. Economy and infrastructure 2. Social and community 3. Environment and natural resources
Exposure	Exposure considers the likelihood of a feature or its function being subjected to a climate variable. For example, beaches are exposed to coastal inundation, but not exposed to increased frequency of bushfires. For Resilient South, exposure relates to predicted changes in the climate at 2070.

Term	Definitions																										
IPCC	Intergovernmental Panel on Climate Change.																										
Maladaptation	Maladaptation occurs when an attempt to adapt produces unintended negative consequences.																										
Mitigation	Taking action to reduce or prevent emission of greenhouse gases.																										
Model of Receptivity	A tool for considering factors influencing the willingness and ability of organisations to change behaviours and practices which proposes that for change to occur, capacity must exist or be created across the four attributes of awareness, association, acquisition and application.																										
Project Champions	Stakeholders representing the three domains and sectors that make up the Southern Region who actively participated throughout the project. This participation directly influenced key outputs and shaped the direction of key stages of the project.																										
Receptivity	The willingness and capability to receive information and the capacity for acting upon that information.																										
Resilience	The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.																										
Sector	<p>Resilient South viewed the Southern Region and its stakeholders through the framework of the three domains described above. Under each of the domains sits the following sectors, specifically:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Environment and natural resources</td> <td style="width: 33%;">Social and Community</td> <td style="width: 33%;">Economy and infrastructure</td> </tr> <tr> <td>Water resources</td> <td>Community health and individual wellbeing</td> <td>Energy and water</td> </tr> <tr> <td>Coastal management</td> <td>Emergency management</td> <td>Waste</td> </tr> <tr> <td>Biodiversity</td> <td>Culture and heritage</td> <td>Tourism</td> </tr> <tr> <td></td> <td></td> <td>Transport</td> </tr> <tr> <td></td> <td></td> <td>Food and wine</td> </tr> <tr> <td></td> <td></td> <td>Infrastructure and urban areas</td> </tr> <tr> <td></td> <td></td> <td>Manufacturing and services</td> </tr> </table>			Environment and natural resources	Social and Community	Economy and infrastructure	Water resources	Community health and individual wellbeing	Energy and water	Coastal management	Emergency management	Waste	Biodiversity	Culture and heritage	Tourism			Transport			Food and wine			Infrastructure and urban areas			Manufacturing and services
Environment and natural resources	Social and Community	Economy and infrastructure																									
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Biodiversity	Culture and heritage	Tourism																									
		Transport																									
		Food and wine																									
		Infrastructure and urban areas																									
		Manufacturing and services																									
Sensitivity	<p>The degree to which a characteristic/feature or its functions are affected by a climate variable.</p> <p>For example, the quality of open space is sensitive to reduced rainfall, dunes are sensitive to coastal inundation, built structures are sensitive to bushfires.</p>																										
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability to the impacts of climate change is a function of exposure to climate conditions, sensitivity to those conditions, and the capacity to adapt to the changes.																										

Executive Summary

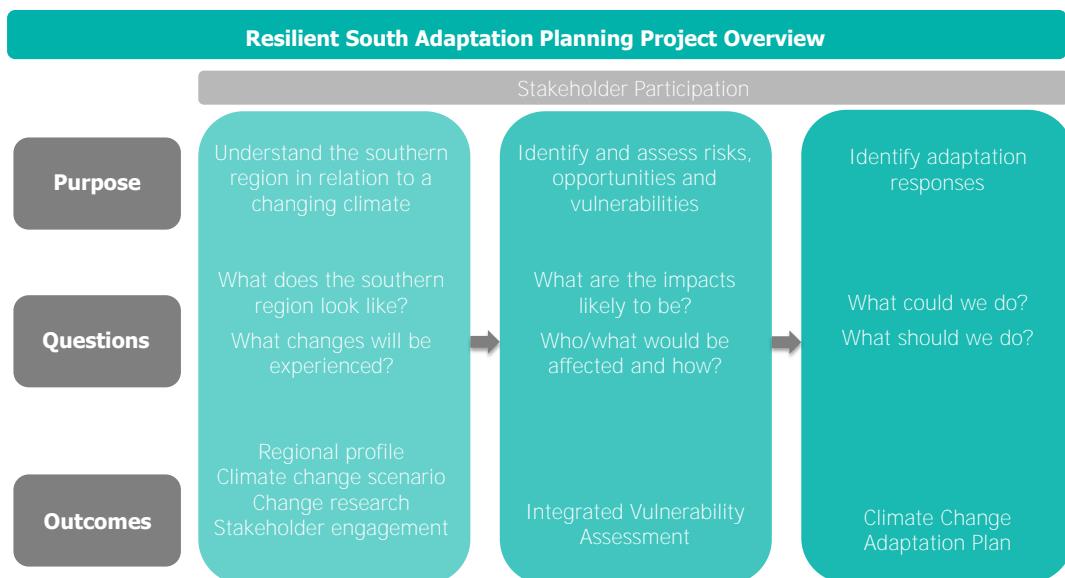
Resilient South is a partner project between the Cities of Holdfast Bay, Marion, Mitcham, and Onkaparinga. The goal of Resilient South is a region that is resilient to natural hazards associated with climate change, focused on preparedness and crisis avoidance and has captured opportunities in innovation in adapting to climate change.

Resilient South is consistent with the National and South Australian Climate Change **Adaptation Frameworks, the State's Emergency Management regime and the SA Public Health Plan**. It has received funding from the South Australian and Australian Governments and the four Partner Councils.

The Resilient South Regional Climate Change Adaptation Plan (the Regional Adaptation Plan) is one of a range of activities undertaken by the Partner Councils under the broader Resilient South project initiative. The Regional Adaptation Plan identifies preferred adaptation options and can be used by organisations and individuals across the Southern Region to guide adaptation action.

The development of the Regional Adaptation Plan has taken place over three stages as shown by Figure A.

Figure A: Adaptation Planning project overview



Generating action through engagement

The project has collaborated extensively with a broad range of stakeholder organisations from across the three domains of; economic and infrastructure, environment and natural resources and social and community. The knowledge and expertise of Project Champions **has informed the project's three stages ensuring that the Regional Adaptation Plan includes** robust and practical adaptation options. A full description of the engagement process is found in Section 1.2 and the Resilient South Engagement Feedback Report¹.

Integrating social sciences and climate science in adaptation planning

Research and analysis has also been a key component of the Resilient South Adaptation Planning project. This has included the use of the Model of Receptivity as a tool for considering factors influencing the willingness and ability to undertake actions and proposes that for change to occur, capacity must exist or be created across the four attributes of awareness, association, acquisition and application. Over the course of the Adaptation Planning project, **identification of how the project's processes and key outputs are reflected** in the Model of Receptivity has been undertaken (refer to Figure 1-4 in Section 1).

Identifying options for adaptation

The primary aim of the adaptation planning process has been to identify preferred adaptation actions that address key vulnerabilities that are presented by climate change.

In order to identify areas for focussing adaptation action in the Southern Region an Integrated Vulnerability Assessment (IVA) was undertaken in Stage 2 of the planning process². The IVA assessed risks, opportunities and vulnerabilities of various aspects of the Southern Region which were drawn directly from regional values developed from stakeholder input collected in Stage 1 of the project³.

A total of 73 indicators were assessed using the IVA tool with each indicator assessed to understand its vulnerability to different climate change variables. For Resilient South, a medium emissions scenario, median model output and timeframe of 2070 were used to describe key climate variables for the Southern Region. This climate change scenario was selected by the Resilient South Project Management Committee comprising representatives of the project partners. The decision was based on 2070 being a practical period to be undertaking long term planning within which change will occur, and the medium scenario and median output representing a moderate approach.

The climate projections⁴ considered in development of the Regional Adaptation Plan showed the following anticipated changes for the Southern Region by 2070 (refer Section 2):

- Warming temperatures;
- More frequent and intense heatwaves;
- Increased rainfall intensity;

¹ Resilient South (2014c) *Engagement Feedback Report – Resilient South*

² The IVA is an assessment process that aims to identify relative vulnerability across a series of indicators. As such the process is focussed on vulnerability, however the IVA revealed a number of aspects which have lower vulnerability and or resilience and these are also identified by this Adaptation Plan.

³ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁴ Resilient South (2014) *Climate Change Scenarios Report – Resilient South*

- Decreased annual rainfall;
- Decreased frost;
- Increased number of days of extreme fire danger;
- Rising sea levels;
- Increasing water temperature in Gulf St Vincent;
- Rising atmospheric CO₂;
- Rising pH of Gulf waters; and
- Increased evaporation.

The analysis of the IVA (refer Section 3) identified a series of priority indicators from which 10 key decision areas of focus were derived for use in the third and final stage of the adaptation planning. For each of these key decision areas adaptation pathways (refer Section 4) have been developed which enable decision makers to consider a range of possible adaptation options, how they will be impacted by climate change through time, and **whether any options have a “use by date” (i.e. a point in time at which they are no longer viable)**.

This adaptation planning approach enables exploration of what combination of options (described as pathways) are most suitable for adapting to future climate change, and how these can be sequenced over time (i.e. what should be done now, versus what can be delayed). This approach also enables adaptive management overtime.

Implementing the Regional Adaptation Plan

In total, 57 preferred options for adaptation in the Southern Region (refer Table A and Section 6) have been identified relating to the 10 key decision areas. These preferred options are brought together within the Regional Climate Change Adaptation Action Plan contained in Appendix B of the Adaptation Plan. This Action Plan can be used by organisations and individuals across the Southern Region to guide adaptation action, and where required be further developed and refined as new information becomes available or as monitoring and review occurs.

For each preferred option the Action Plan summarises:

- Key actions to progress implementation of the option;
- Timing for implementation;
- Lead responsibility for initiating and/or driving implementation;
- Others to be involved in implementation; and
- Linkages with other preferred options that may benefit from a coordinated approach to implementation.

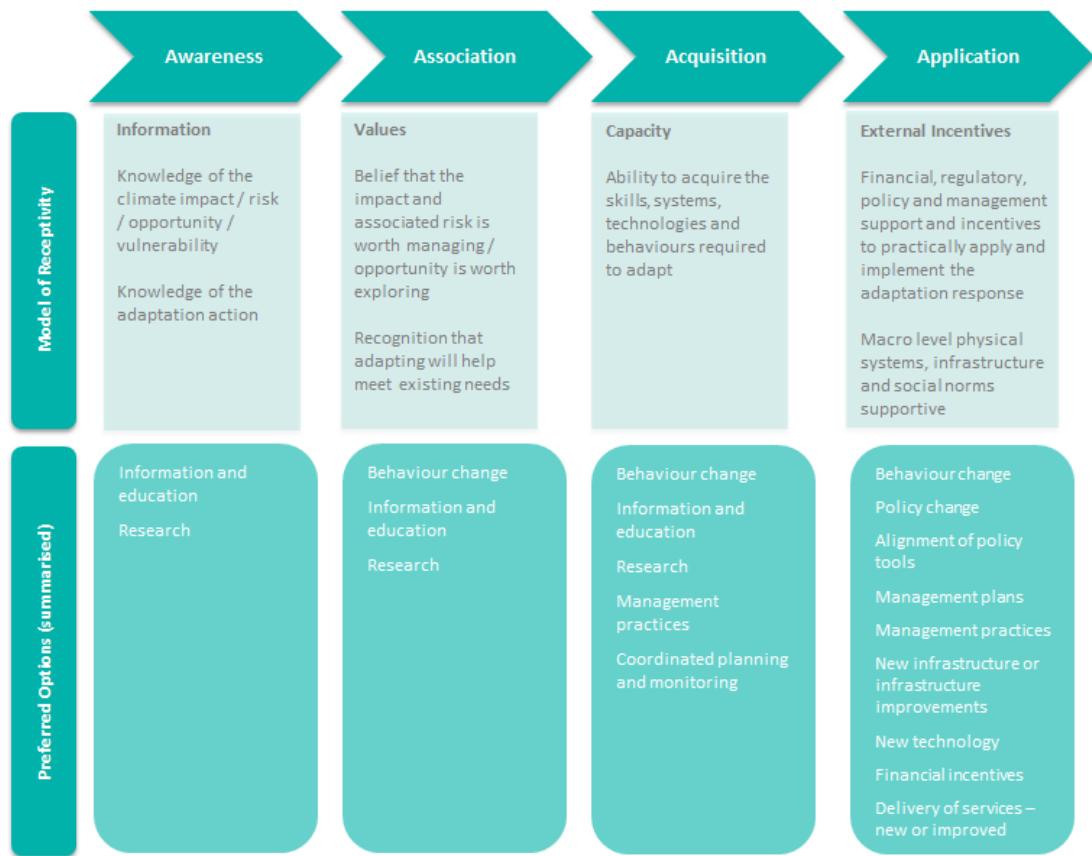
Table A: Preferred options for adaptation in the Southern Region

Key decision area	Preferred option
Coastal management	Coordinated planning and monitoring
	Inform and educate the community and encourage behaviour change
	Review and amend Development Plan policy
	Develop soft structural options
	Construct hard structural options like storm tide barriers or sea walls
Water resources management	Ongoing research to inform adaptation and management
	Educate communities
	Calibrate water resource plans, policy and legislation
	Review and amend Development Plan policy with a focus on water security
	Improve flood management and riparian rehabilitation
	Continued adoption of water sensitive urban design
	Increase domestic and industrial capture of rainwater
	Greater water recycling and waste water re-use
	Increased managed aquifer storage
Natural landscapes	Monitoring and research to undertake situation appraisal and review (hills, plains and hillsface, coastal)
	Review and amend Development Plan policy (hills, plains and hillsface, coastal)
	Address current and emerging threats (hills, plains and hillsface, coastal)
	Maintain habitat values in non-conservation areas (hills, plains and hillsface, coastal)
	Protect and improve refugia (plains and hillsface)
	Move species and ecosystems and implement ecosystem engineering (coastal and estuarine).
Marine biodiversity	Research
	Address marine biodiversity in water management plans
	Develop marine pest plant and animal management plan
	Reduce non-climate change threats to marine biodiversity
Vulnerable members of the community	Support for service systems
	Develop emergency management plans
	Education, awareness raising, cultural change and building social connectivity
	Provide essential services subsidies
	Continue to develop technology for emergency situations

Key decision area	Preferred option
	Establish emergency response centres and provide assisted transport
	Develop and maintain vegetated public realm
	Construct climate sensitive developments
Emergency services	Improve community connectivity, communication, education, awareness and preparation Review and amend development plan policy Increase the number of trained volunteers Continue to improve stormwater management
Open space and public realm	Encourage change in the way we use and manage public realm and open space Install new climate sensitive outdoor infrastructure (cycling, walking, outdoor recreation, tree shades, shading of playgrounds)
Essential services	Strategically manage power outages on high fire risk days Manage native vegetation near power lines Conduct streetscape planning that considers impacts on essential services infrastructure Protect key assets from bushfire (eg feeders) Increase distributed energy Increase electricity feeder automation Undergrounding of power cables Upgrade cooling systems for telecommunication exchanges Install backup power supplies
Manufacturing and business	Review and amend Development Plan policy Educate and build capacity of the manufacturing and business sector Improve the continuity of supply of essential services, especially electricity
Viticulture	Plant cover crops between rows to prevent erosion Improve vine canopy management Develop bushfire management plans Undertake smoke taint testing/mini fermentation Adopt irrigation efficiency measures Develop alternative irrigation sources Plant varieties more resilient to higher temperatures and less rainfall

Importantly, the integration of insights from the social sciences into the adaptation planning process has resulted in the identification of options which aim to create enabling conditions for the implementation of the Regional Adaptation Plan and build adaptive capacity throughout the Region (refer Section 5). How the preferred options (and associated actions) forming the Adaptation Plan are linked to the Model of Receptivity is shown in Figure B.

Figure B Summary of preferred options and the Model of Receptivity



Next steps

This Regional Adaptation Plan and the actions it proposes are for the consideration of the Southern Region. The Cities of Holdfast Bay, Marion, Mitcham and Onkaparinga are seeking to maintain existing and develop new partnerships with other governments, local business and industry, and non-government organisations to implement the Plan and together increase the resilience of our community.

To progress the implementation of the Regional Adaptation Plan over the next 12 months a number of key steps (refer Section 7) are anticipated including:

- Working with stakeholders (including different sectors, Elected Members, Resilient South Project Champions) to identify regional and locally specific priority adaptation options from the 57 preferred options identified by the Adaptation Plan (the map server is a useful tool that can assist with this process).

In particular, it is acknowledged that further engagement is required with local Kaurna people and the business and manufacturing, viticulture and marine biodiversity sectors;

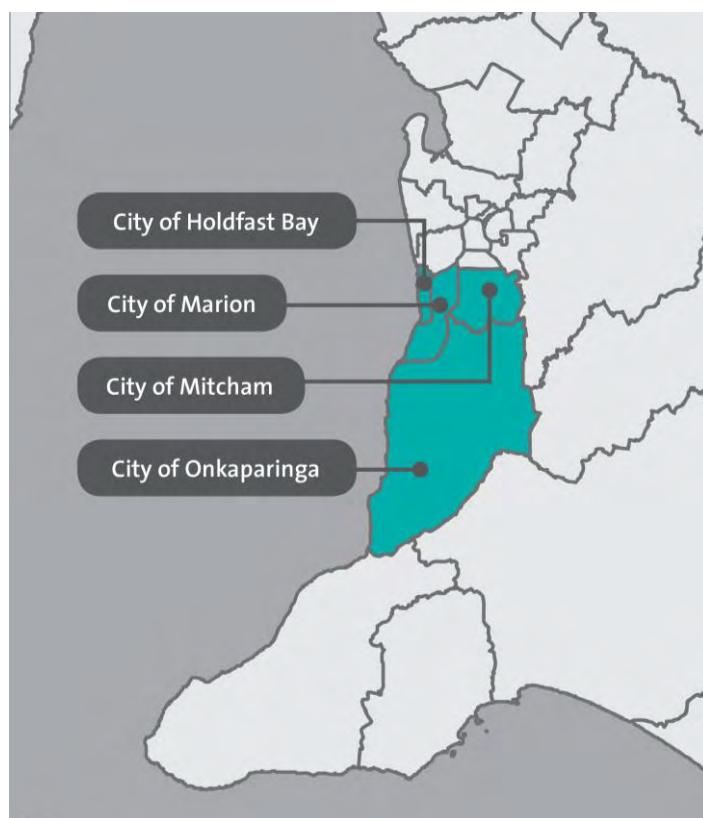
- Reviewing and renewing partnerships with the South Australian and Australian Governments;
- Reflecting on learnings of the Resilient South project and sharing these with other Councils and industry peers;
- Maintaining existing governance arrangements, including the Resilient South Project Heads of Agreement and the Resilient South Project Sector Agreement; and
- Establishing a framework to monitor and evaluate the implementation of the Regional Adaptation Plan.

1 Introduction

Resilient South is a partner project between the Cities of Holdfast Bay, Marion, Mitcham, and Onkaparinga and the South Australian and Australian Governments. The goal of Resilient South is a Region that is resilient to natural hazards associated with climate change, is focused on preparedness and crisis avoidance and has captured opportunities in innovation in adapting to climate change.

The Southern Region of Adelaide is defined broadly in the State Government's Greater Adelaide 30 Year Plan⁵ and is aligned with the boundaries of the Council areas of Holdfast Bay, Marion, Mitcham and Onkaparinga - covering some 650 km² (Figure 1-1). The four Councils have many social, economic, infrastructure, environmental and climate related characteristics and circumstances in common. The Southern Region is home to over 340,000 people, or about 21% of South Australia's population and includes 50% of Adelaide's metropolitan coastline.

Figure 1-1: The Southern Region



The Resilient South project was initiated in 2008/09 at a time when the Region was experiencing substantial heatwaves and severe storm events. This Regional Climate Change Adaptation Planning project has produced this Regional Climate Change Adaptation Plan (the Regional Adaptation Plan) as one of a range of activities undertaken by the partner Councils under the broader Resilient South project initiative.

⁵ Government of South Australia (2010) *The 30-Year Plan for Greater Adelaide*

Resilient South has been designed to be consistent with the National and South Australian Climate Change Adaptation Frameworks and **the State's Emergency Management regime**, and is **consistent with the 'Preparing for climate change' priority in the SA Public Health Plan**. The project has received funding from the National Disaster Resilience Scheme, the South Australian Government and the four Partner Councils.

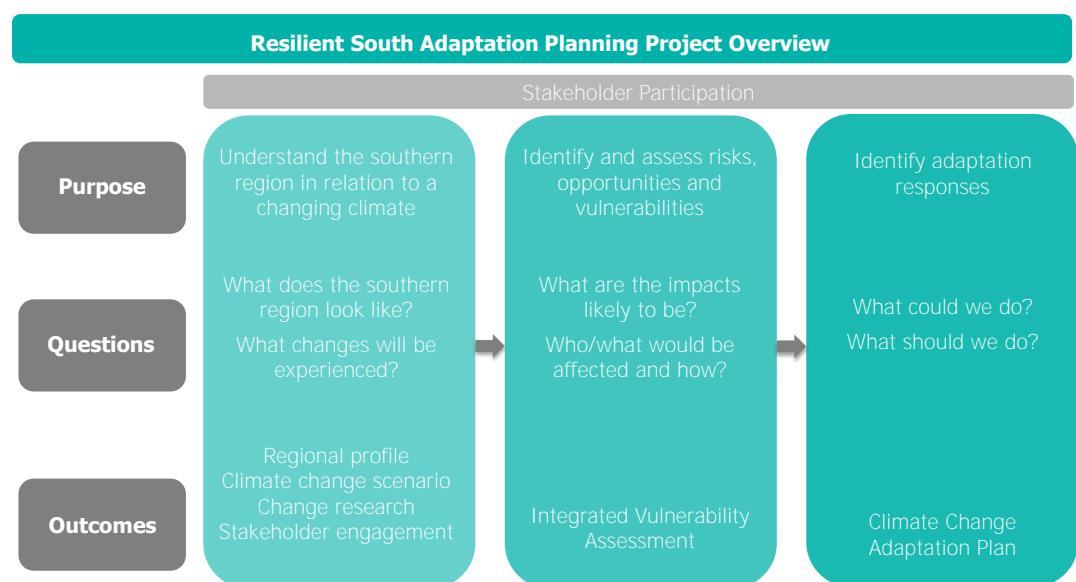
Prior to the Adaptation Planning project commencing the Southern Region Councils undertook a number of climate change risk assessments and adaptation plans for their corporate activities. The Adaptation Planning **project's objectives** were to build on this work specifically to:

- Improve hazard management and minimise risks associated with climate change impacts in the Region;
- Improve emergency response capabilities relevant to climate change impacts; and
- Increase the Region's understanding of climate change risks, vulnerability and adaptation responses.

The Resilient South Adaptation Planning project was officially launched in July 2013 at a ceremony attended by the Mayors of the four participating Councils. It has been overseen by a Project Management Committee made up of representatives from the Partner Councils and a Project Coordinator. A Strategic Reference Group consisting of representatives of key South Australian government agencies has provided guidance to the preparation of the plan, progress updates to the Minister, and assisted with the coordination of data to inform the project.

The development of the Adaptation Plan has taken place over three stages as shown on Figure 1-2.

Figure 1-2: Adaptation Planning Project overview



Delivery of these stages has generated a series of outputs relating to different aspects of climate change adaptation in the Southern Region, including:

- [Climate change scenarios](#)⁶ - a report that describes the current and potential future climate in the Region;
- [Values workshops](#)⁷ - a series of workshops undertaken in stage one to identify regional values that were used to inform the subsequent stages of the project;
- [Regional profile](#)⁸ - a description of the current key attributes of the Region under the headings of 'community', 'natural environment' and 'economy and infrastructure';
- [Map server](#)⁹ - an online map server containing spatial data relating to social, natural and economic aspects of the Region. The map server enables detailed investigation of data and analysis of multiple data sets and their interrelationships. The map server is password protected and access can be obtained on request via reisientsouth@onkaparinga.sa.gov.au;
- [Change research](#)¹⁰ - analysis of primary and secondary research undertaken to better understand how change occurs, what barriers to change exist, and the institutional characteristics, attributes and tools likely to be associated with a high degree of resilience and capacity to adapt. The change research considered how these understandings can be applied in the context of the Regional Adaptation Plan;
- [Integrated Vulnerability Assessment \(IVA\)](#)¹¹ – implementation of an assessment tool that helps to identify areas of vulnerability to the impacts of climate change, and can assist with prioritising or identifying areas for focussing adaptation action. The IVA involved assessing exposure and sensitivity to climate variables, as well as adaptive capacity – the ability of a system to adjust to climate change impacts;
- Regional Adaptation Plan – the culmination of previous work, this Plan identifies preferred adaptation options for the Region to build resilience and adapt to the impacts of climate change in key areas of vulnerability; and
- Engagement Feedback Report¹² - describes the rationale and process by which stakeholder participation has been embedded in the project methodology and delivery of **key project tasks. Includes a summary of stakeholders' evaluation of their involvement in the project, along with reflections on the lessons learned through the engagement activities.**

All outputs generated by the adaptation planning project can be downloaded at [www.resilientssouth.com](http://www.resilientsouth.com).

⁶ Resilient South (2014) *Climate Change Scenarios Report – Resilient South*

⁷ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁸ Resilient South (2014a) *Regional Profile – Resilient South*

⁹ www.resilientssouth.com

¹⁰ Resilient South (2013b) *Social & Institutional Mechanisms for Transitioning to Resilient Practices*

¹¹ Resilient South (2014b) *Climate Change Risks, Opportunities and Vulnerabilities in the Southern Region*

¹² Resilient South (2014c) *Engagement Feedback Report – Resilient South*

This Regional Adaptation Plan and the actions it proposes are for the consideration of the Southern Adelaide Region. The Cities of Holdfast Bay, Marion, Mitcham and Onkaparinga are seeking to maintain existing and develop new partnerships with other governments, local business and industry, and non-government organisations to implement the Regional Adaptation Plan and together increase the resilience of the Region.

1.1 Guide to the Regional Adaptation Plan

Table 1-1 provides an overview of the content of each section of the Adaptation Plan.

Table 1-1: Guide to the Regional Adaptation Plan

Section		Purpose
1	Introduction	Describes the Resilient South partners, objectives of the project, and the methodological approach adopted
2	How will climate change be experienced by the Southern Region?	Summarises the climate projections for the Southern Region that were used to understand risks and opportunities presented by climate change
3	Identifying focus for adaptation	Provides an overview of how preferred options for adaptation were identified by the project, specifically <ul style="list-style-type: none"> - Implementation and analysis of the IVA to understand risks and opportunities; - Identification of key decision areas for adaptation action; and - Development of adaptation pathways to identify preferred adaptation options
4	Adaptation pathways for the Southern Region	Describes the key decision areas, adaptation pathways, and preferred adaptation options for the Southern Region
5	Enabling adaptation action	Describes the project's research findings in relation to enabling conditions to support adaptation action
6	Preferred options for adaptation in the Southern Region	Summarises the preferred options for adaptation with reference to the Adaptation Action Plan, identifies relevance of key decision areas across the Region's sectors, identifies how the preferred options for adaptation relate to the Model of Receptivity, identifies enabling conditions to support implementation of preferred options, discusses resilience and opportunities
7	Next steps for implementing the Regional Adaptation Plan	Describes the next steps for progressing the implementation of the Adaptation Plan

Relationship with Zone Emergency Management Planning and National Disaster Resilience Program

The Regional Adaptation Plan has been developed in parallel to the preparation of the Zone Emergency Management Plan (ZEMP) for the Southern Region. The ZEMP process focuses on mitigating risks associated with natural disasters and other emergencies, for example earthquakes, bushfire, flooding and extreme heat. Some of the hazards considered by the ZEMP will be exacerbated by climate change, for example bushfire, flooding and heatwaves.

The ZEMP includes a risk assessment process which focuses on hazards in the current climate. This is in contrast to the IVA process undertaken for the Resilient South Adaptation Planning project which utilises projections of future conditions (i.e. future climate at 2070). Some of the hazards considered by both the ZEMP and the Regional Adaptation Plan however may have common management responses and therefore, coordination between both projects has occurred. In addition, the South Australian Fire and Emergency Services Commission (SAFECOM) is a key funding partner of the Resilient South Adaptation Planning project.

At the time of preparing this Adaptation Plan, development of the ZEMP for the Southern Region was still underway. There are a number of adaptation options in the Regional Adaptation Plan that will contribute to emergency management planning objectives and feedback has been received from SAFECOM that these options will be consistent with the ZEMP.

1.2 Generating action through engagement

Communication and engagement with stakeholders has been a critical component of the Resilient South Adaptation Planning project, and was embedded in each of the project stages¹³. **This reflects the project's methodological position** (supported by research and practice)¹⁴ that people – their values, decisions and behaviour - are central to climate change adaptation, and that the active involvement in adaptation planning of those who will need to adapt supports meaningful action and development of practical adaptation measures.

Seeking stakeholder involvement to shape the project's outcomes from the very beginning through to the final Regional Adaptation Plan has been a deliberate strategy to both generate ownership of the Plan by those with a stake in its implementation and **effectiveness, and to engender a robustness and practicality in the Plan's actions and recommendations**. **It also supports the project's objective of increasing** the Southern Region's understanding of climate change risks, vulnerability and adaptation responses.

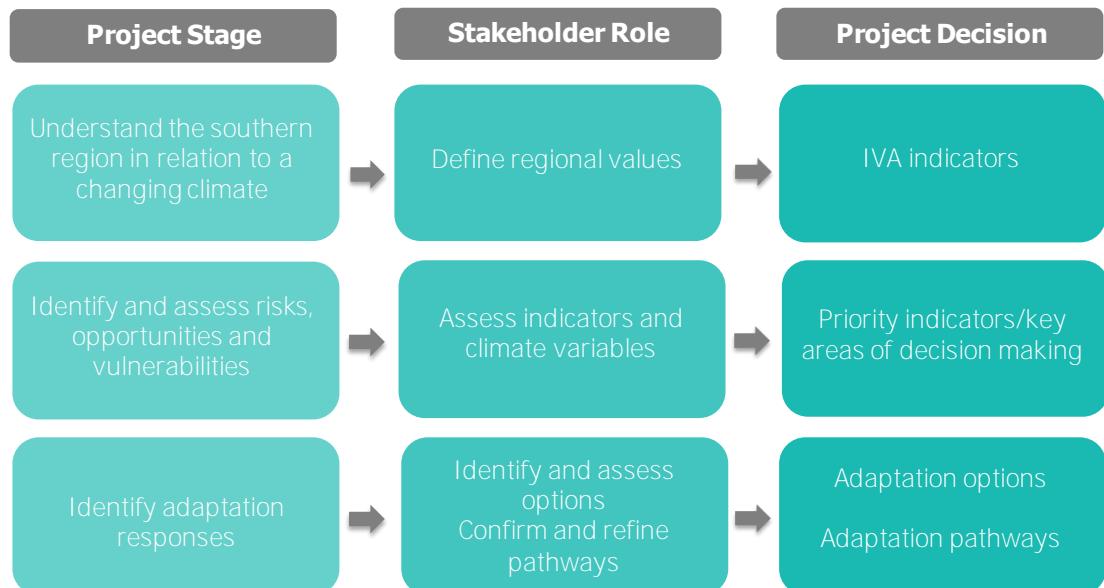
Stakeholders participated throughout the Resilient South Adaptation Planning project representing a diversity of organisations and interests across the Southern Region including State and Local Government, and the community, health, business, education, research and natural resources management sectors.¹⁵ This participation directly influenced key outputs and shaped the direction of key stages of the Regional Adaptation Plan. Figure 1-3 summarises how stakeholders participated in this process.

¹³ Resilient South (2014c) *Engagement Feedback Report – Resilient South*

¹⁴ Resilient South (2013b) *Social & Institutional Mechanisms for Transitioning to Resilient Practices*

¹⁵ Refer Appendix A for list of organisations represented on the project.

Figure 1-3: Stakeholder involvement in adaptation planning stages and decisions



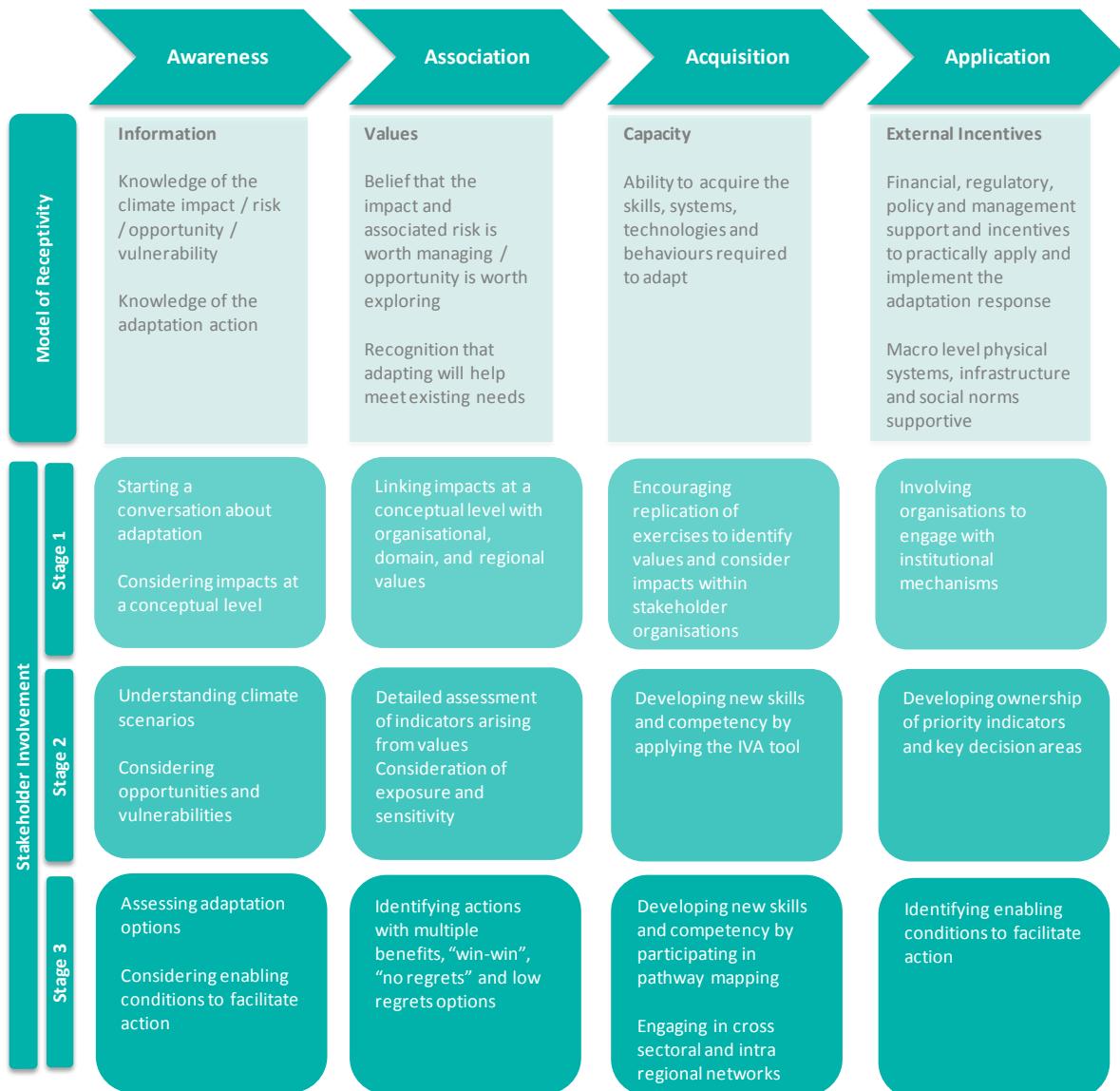
The engagement approach used to undertake the development of this Regional Adaptation Plan responds to the Model of Receptivity¹⁶ (see Figure 1-4). The model is a tool for considering factors influencing willingness and ability to undertake climate change adaptation actions and proposes that for change to occur, capacity must exist or be created across the four attributes of awareness, association, acquisition and application. This model was a key foundation of the approach taken in the Resilient South Adaptation Planning project.

The project's adoption of this model reflects its intention to integrate the social sciences into the adaptation planning process, and draw upon research insights relating to the social and institutional mechanisms required for transitioning towards more resilient and sustainable systems and practices.

How the engagement approach applied in the development of this Regional Adaptation Plan and how it responds to the Model of Receptivity is described in Figure 1-4.

¹⁶ Resilient South (2013) *Resilient South Project Background Paper*

Figure 1-4: Resilient South Adaptation Planning project stakeholder involvement and the Model of Receptivity



2 How will climate change be experienced by the Southern Region?

2.1 Climate in the Southern Region

The Southern Region has a Mediterranean-type climate, with cool, moist winters and warm, dry summers. The topography and coast influence the climate of the Region causing the weather experienced in the south to differ from other metropolitan Adelaide regions.

Temperatures in the Southern Region are generally slightly cooler along the coast and into the hills. Temperatures recorded during the January 2014 heatwave showed maximum temperatures 2-3 degrees cooler at Noarlunga compared to Adelaide (Kent Town). Annual rainfall totals are strongly influenced by the presence of the Mt Lofty Ranges, with rainfall increasing from north to south in the Region and inland from the coast.

As this Regional Adaptation Plan was being finalised Adelaide experienced: a summer of record breaking heatwaves; a severe storm that left hundreds of thousands of dollars damage and many homes without power; and an abnormally warm autumn. These events indicate a continuing trend of more extreme weather.

2.2 Understanding future climate

Climate projection models indicate the expected trends in climate variables (e.g. air and sea temperatures, rainfall, sea level rise) under various emissions scenarios, and the quantum of change over different time periods.

Using climate modelling in adaptation planning requires selecting a climate projection model to describe different climate variables in the future.

Factors considered in selecting a projection model include **the model's:**

- Emissions scenario (e.g. low, medium or high);
- Climate model output (e.g. median or 90 percentile results); and
- Year of the projection (2030, 2070 or 2100).

For the Resilient South Adaptation Planning project a medium emissions scenario, median model output and timeframe of 2070 were selected and used to describe key climate variables for the Southern Region in the future. This climate change scenario was selected by the Resilient South Project Management Committee comprising representatives of the project partners. The decision was based on 2070 being a practical period to be undertaking long term planning within which change will occur, and the medium scenario and median output representing a moderate approach.

This understanding of the future climate in the Southern Region was used along with other information to determine adaptation properties that form the basis of this Regional Adaptation Plan.

2.3 Future climate in the Southern Region

A detailed description of the historic and projected future climate of the Southern Region was prepared for Resilient South¹⁷ using modelling undertaken for the IPCC's *Fourth Assessment Report* and published on the Climate Change in Australia website.¹⁸ Where relevant, reference to recently published information including the 2014 IPCC's *Fifth Assessment Report*¹⁹ and observed weather conditions from recent years has been considered.

The following sections describe the future climate of the Southern Region in relation to the climate variables considered throughout development of the Regional Adaptation Plan. In summary, the projected changes are expected to include:

- Warming temperatures;
- More frequent and intense heatwaves;
- Increased rainfall intensity;
- Decreased annual rainfall;
- Decreased frost;
- Increased number of days of extreme fire danger;
- Rising sea levels;
- Increasing water temperature in Gulf St Vincent;
- Rising atmospheric CO₂;
- Rising pH of Gulf waters; and
- Increased evaporation.

Figure 2-1 summarises how these projected changes in climate may impact the Southern Region.

Temperature

Australia's climate has warmed by 0.9°C since 1910, and 2013 was Australia's and South Australia's hottest year on record. In South Australia, annual average maximum temperature (recorded at Adelaide Airport²⁰) has increased by 0.22°C per decade since records began in 1956. Annual temperature is projected to continue to increase by nearly 3°C by 2070 compared to the period 1980-1999.

Average temperatures in winter and summer are projected to increase by 1.7°C and average temperatures in spring are projected to increase by 2.2°C by 2070 (refer Table 2-1).

¹⁷ Resilient South (2014) *Climate Change Scenarios Report – Resilient South*

¹⁸ www.climatechangeinaustralia.gov.au

¹⁹ Intergovernmental Panel on Climate Change (2013) Fifth Assessment Report (AR5)

²⁰ Adelaide Airport data was used on the basis that it is the closest meteorological station with quality long term records, and is also representative of the climate zone that includes the Southern region.

Table 2-1: Average temperature change

Season	Average maximum temperature (Adelaide Airport) Reference period (1980-1999)	Average maximum temperature (Adelaide Airport) 2070	Change
Summer	27.2°C	28.9°C	+1.7°C
Autumn	22.0°C	23.7°C	+1.7°C
Winter	15.5°C	17.2°C	+1.7°C
Spring	21.0°C	23.2°C	+2.2°C

Extreme heat and heatwave

By 2070, maximum temperatures during January and February are projected to exceed 45°C, up from 43°C in 1980-1999 and 44°C in 2000-2012.

The duration, frequency and intensity of heatwaves has been increasing across Australia and is projected to continue to increase in coming decades. The number of days where the maximum temperatures exceeds 40°C is projected to increase from periods of up to 3 consecutive days in 1980-1999 to periods of up to five consecutive days by 2070 (refer Table 2-2).

During January 2014, four consecutive days were recorded at Noarlunga over 40 degrees.

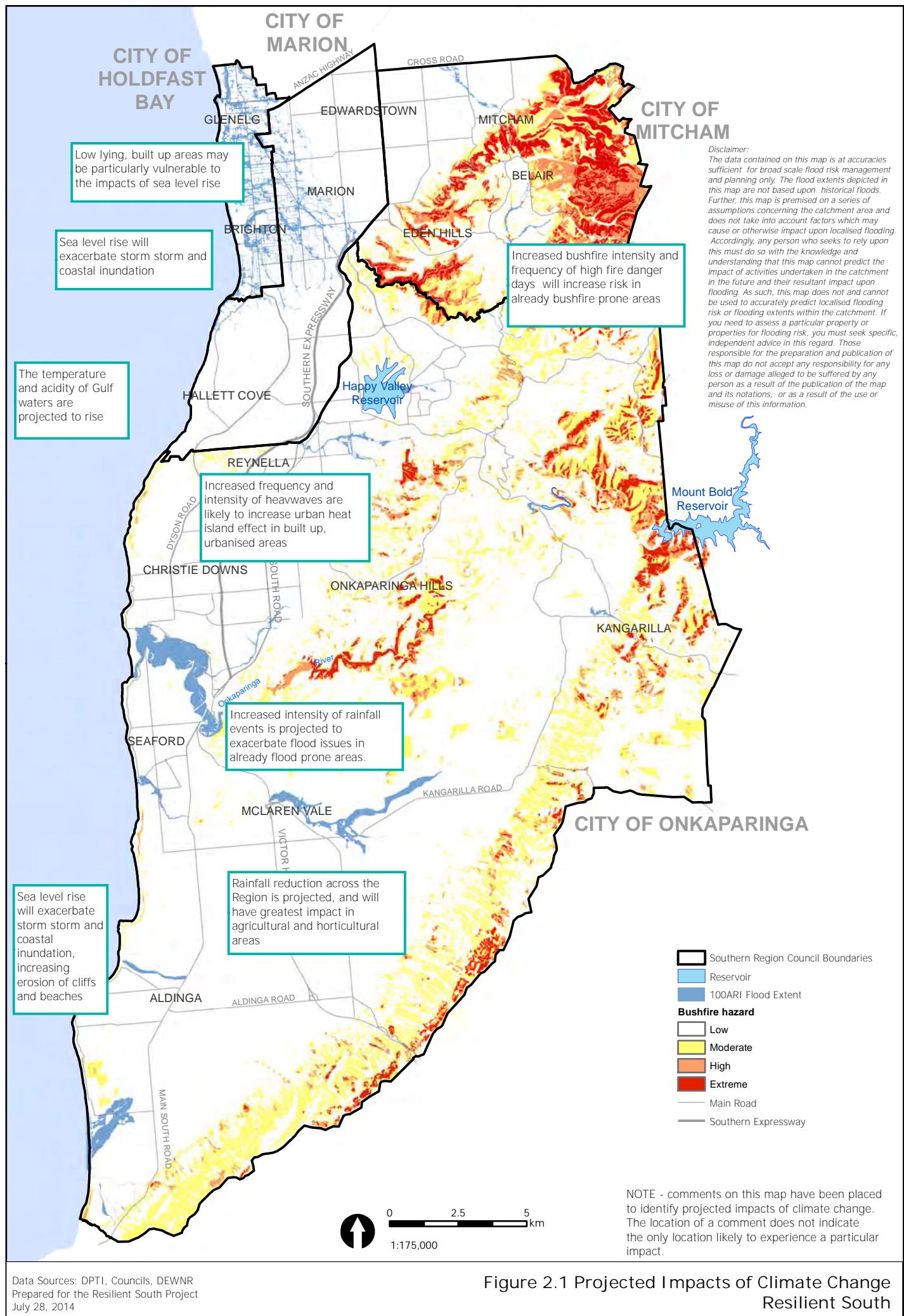
It is projected that the frequency of 2 consecutive days where maximum temperatures exceed $\geq 40^\circ\text{C}$ will increase from once every 10 years to once every 1-2 years (refer Table 2-3).

Table 2-2: Heatwave duration

Heatwaves	Consecutive days with maximum temperature over $\geq 40^\circ\text{C}$ Reference period (1980-1999)	Consecutive days with maximum temperature $\geq 40^\circ\text{C}$ 2070	Change
Number of days	Up to 3	Up to 5	Increase

Table 2-3: Heatwave frequency

Heatwaves	Two consecutive days with maximum temperature over $\geq 40^\circ\text{C}$ Reference period (1980-1999)	Two consecutive days with maximum temperature over $\geq 40^\circ\text{C}$ 2070	Change
Average frequency	Once every 10 years	Once every 1-2 years	Increase



Frost

The incidence of frost and freezing conditions in the Southern Region is projected to decrease. The incidence of freezing conditions at Adelaide Airport is projected to decline from 0.7 days per year in 1980-1999 to 1 day in 20 years in 2070. As frosts and freezing conditions are more common in inland and higher elevation locations in the Southern Region they may still occur in these areas however are likely to become much less frequent.

Annual rainfall

Annual average rainfall is projected to decrease across South Australia by 5-20% by 2070 and the frequency of drought is expected to increase. In the Southern Region, average annual rainfall is projected to decrease by about 13% by 2070. The decrease in rainfall is projected to be greater in winter and spring with a 15% reduction by 2070 projected. Summer rainfall is projected to reduce by 7.5% by 2070 (refer Table 2-4).

Table 2-4: Average annual rainfall

Location	Average annual rainfall Reference period (1980-1999)	Average annual rainfall 2070	Change
Adelaide Airport	451mm	395mm	-56mm
Clarendon	763mm	667mm	-96mm
Mt Bold Reservoir	809mm	704mm	-105 mm
Willunga	598mm	522mm	-76 mm

Rainfall intensity

Whilst annual rainfall is projected to decrease, the frequency and intensity of intense rainfall causing flooding is projected to increase by 2070. For Adelaide Airport, 100 year ARI daily rainfall is projected to increase from 76 mm to over 85 mm under the 2070 medium emissions scenario. This event is projected to increase from 102 mm to about 114 mm at Willunga.

Evaporation

Evaporation is projected to increase most in autumn and winter. Annual average potential evaporation at Mt Bold Reservoir is projected to increase from 1617 mm in 1980-1999 to 1714 mm in 2070. With the projected increase in evaporation and decrease in rainfall, the winter excess of rainfall over evaporation (which drives catchment water flows and soil water accumulation) is projected to decline from 175 mm in 1980-1999 to 115 mm in 2070.

Forest fire danger

The Forest Fire Danger Index (FFDI) is calculated from daily temperature, humidity and wind speed and longer-term changes in soil and vegetation (fuel) dryness. Values in the extreme range (≥ 50) are indicative of the potential for extreme and difficult to control behaviour in fires that become established. The incidence of such days, based on Adelaide Airport's weather, is projected to increase from 2 per year in 1980-1999 to 6 per year in 2070. A longer fire danger season is also projected.

Coast and marine

Comprehensive monitoring has shown that the sea level is rising around the world, including around Australia. At a regional scale, sea level rise is mainly determined by the distribution of change in ocean temperature. Higher rates of sea level rise have been observed in northern Australia where temperatures are higher. Sea surface temperatures in the oceans around South Australia are projected to rise by between 1 and 1.5°C.

A now decommissioned tide gauge located at Port Stanvac showed an average annual increase in sea level of 4.7 mm/year from 1992 to 2010. This observed sea level rise is close to the global averages reported in the IPCC *Fifth Assessment Report*. The projected sea level rise described for the medium emissions scenario in the *Fifth Assessment Report* is between 0.33 to 0.62m for 2081-2100 relative to 1986-2005²¹.

Downscaled sea level rise data was not prepared for the Resilient South Adaptation Planning project and there has only been limited analysis of the extent to which the southern Adelaide coast is exposed to sea level rise.

Rising CO₂ concentrations in ocean waters contributes to their increasing acidity. The pH of surface oceans will drop by 0.1 to 0.3 units by 2100.

Atmospheric CO₂ concentrations

Atmospheric carbon dioxide concentrations have been rapidly increasing in the last 200 years. Global mean CO₂ levels have risen from around 280ppm (parts per million) to 395ppm in 2013. The CO₂ concentration increase from 2011 to 2013 is the largest two-year increase ever observed²². Under the medium emissions outlook carbon dioxide concentrations in the atmosphere will increase to 700 ppm.

²¹ Intergovernmental Panel on Climate Change (2013) Fifth Assessment Report (AR5)

²² CSIRO and Bureau of Meteorology (2014) *State of the Climate 2014*, http://www.bom.gov.au/state-of-the-climate/documents/state-of-the-climate-2014_low-res.pdf?ref=button

3 Identifying focus for adaptation

The primary aim of the adaptation planning process is to identify adaptation actions that reduce or address key vulnerabilities that are presented by climate change, or equally, build on areas of resilience and take advantage of opportunities.

In order to identify areas for focussing adaptation action in the Southern Region the IVA²³ framework was implemented during Stage 2 of the project. The IVA assessed risks, opportunities and vulnerabilities of various aspects of the Southern Region which were drawn directly from the regional values developed from stakeholder input collected in Stage 1 of the project²⁴.

A total of 73 indicators were assessed using the IVA tool, with each indicator assessed to understand its vulnerability to different climate change variables. The vulnerability to climate change of different indicators was determined by considering **that indicator's** exposure and sensitivity to particular climate variables, and its adaptive capacity.

The analysis of the IVA²⁵ identified a series of priority indicators (refer Table 3-1) from which decision areas of focus for adaptation were derived (refer section 3.1).

Table 3-1: Priority indicators for adaptation planning

Domain	Priority Indicators
Economy and Infrastructure	Quantity of stormwater generated
	Condition of jetties and boat ramps
	Gross regional product (GRP) from local viticulture
	Percentage of down time for telecommunications infrastructure
	Quality of cycling and walking infrastructure (e.g. footpaths etc.)
	Increased urban density impact on individual wellbeing
	Gross Regional Profit from manufacturing
Environment and Natural Resources	Proportion of terrestrial fauna species that are threatened (regional, state)
	Impact of pest plant and animal threats to the terrestrial environment
	Surface water quantity and quality - Hills
	Surface water quantity and quality - Plains
	Area of native vegetation cover outside of State Government reserves
	Impact of pest plant and animal threats to the marine environment
	Proportion of terrestrial flora species that are threatened (regional, state)
	Cliff erosion
	Condition and extent of native vegetation by vegetation type (fernland/herbland)
	Beach erosion
	Dune erosion
	Condition and extent of native vegetation by vegetation type (samphire shrubland)

²³Refer to Resilient South (2014d) *IVA Technical Report – Resilient South*. This report provides comprehensive detail regarding the primary and secondary indicators and their assessment.

²⁴ Workshop 1 is reported on in Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

²⁵ Resilient South (2014b) *Climate Change Risks, Opportunities and Vulnerabilities in the Southern Region*

Domain	Priority Indicators
Social and Community	Demand for emergency services
	Impact on people geographically isolated from transport services
	Impact on people aged over 65 years and at risk
	Self assessed health
	Impact on people who require assistance for core activities
	School attendance
	Demand for social support services
	Impact on children < 12 years of age
	Number of outdoor civic events held by Councils
	Condition of public realm (street scapes, street trees, paving, drinking fountains, public art)
	Quality of open space (predominantly green space)

3.1 Identifying key decision areas to focus adaptation action

The Resilient South Adaptation Planning project has used adaptation pathways analysis²⁶ to prepare the Regional Adaptation Plan. Rather than being limited to identifying the best single set of adaptation options for a limited set of climate change scenarios, the pathways approach enables decision makers to consider a range of possible adaptation options, how they will be impacted by climate change through time, and whether any options have a “use by date” (i.e. a point in time at which they are no longer viable).

It also enables decision makers to explore what combination of options (described as pathways) are most suitable for adapting to future climate change, and how these can be sequenced over time (i.e. what should be done now, versus what can be delayed).

An initial step of the pathways approach is to frame key questions in the form of key areas of decision making in relation to which adaptation options are then identified. This step brings together the priority indicators identified by the IVA analysis with relevant climate change projections.

Ten key areas of decision making were identified for Resilient South, and a pathway has been prepared for each. Importantly, these key areas of decision making and associated pathways have been developed in close collaboration with Project Champions²⁷. As discussed in Section 1.2, stakeholder involvement has characterised the Resilient South Adaptation Planning project.

²⁶ Wise, R. M., Fazey, I., Stafford Smith, M., Park, S. E., Eakin, H. C., Archer, Van Garderen, E. R. M., and Campbell, B. (2014). Reconceptualising adaptation to climate change as part of pathways of change and response. Global Environmental Change (on-line). (<http://www.sciencedirect.com/science/article/pii/S095937801300232X>); Haasnoot, M., Kwakkel, J. H., Walker, W. E., and ter Maat, J. (2013). Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world. Global Environmental Change. Volume 23: 485–498.

(<http://dx.doi.org/10.1016/j.gloenvcha.2012.12.006>); Haasnoot, M., Middekoop, H., Offermans, A., Beek, E., and Deursen, W. (2012). Exploring pathways for sustainable water management in river deltas in a changing environment. Climatic Change. Volume 115: 795- 819. (<http://dx.doi.org/10.1007/s10584-012-0444-2>).

²⁷ Resilient South (2014c) *Engagement Feedback Report – Resilient South*

The following key areas of decision making are addressed by the Regional Adaptation Plan (refer Section 4):

Environment and natural resources domain

Coastal management

- How do we maintain the Southern Region's natural features (e.g. cliffs, beaches, dunes, estuaries, biodiversity) and built infrastructure along the coast in the face of increased risk of coastal degradation as a result of coastal inundation, changes in rainfall intensity and increased temperatures?

Water resources management

- Given less rainfall overall, more frequent and intense rainfall events, more frequent bushfires, increased evaporation and population densification, how do we manage and optimise all water resources for a range of fit for purpose uses?

Natural landscapes

- How do we manage natural landscapes and associated habitats on all tenures of land (public and private) in the Southern Region when exposed to warmer and drier conditions, more frequent and intense bushfires and the combined effects of sea level rise and storm surge?

Marine biodiversity

- How do we protect marine biodiversity given increasing sea surface temperatures, ocean acidification and changing stormwater input due to changing rainfall patterns?

Social and community domain

Vulnerable members of the community

- How do we support and facilitate the safety and wellbeing of more vulnerable members of our community so that they are more resilient in the face of more frequent intensity of rainfall events, bushfires and heatwaves, increased temperatures and increased risk of coastal inundation as a result of sea level rise?

Emergency services

- How can we better manage demand for emergency services given more frequent intensity of rainfall events, more frequent bushfires and heatwaves and increased risk of coastal inundation as a result of sea level rise?

Economy and infrastructure domain

Open space and public realm

- How do we provide, protect and enhance quality usable open space and public realm in the face of less rainfall, more frequent flash flooding events, higher average temperatures, more frequent bushfires and heatwaves, increased evaporation and greater risk of coastal inundation?

Essential services

- How do we maintain the continuity of communications services given more frequent intensity of rainfall events and more frequent bushfires and heatwaves?

Manufacturing and business

- How do we maintain and increase the viability of the manufacturing and business sector given increasing bushfire hazard, flood events and more frequent heatwaves?

Viticulture

- How do we maintain the productivity of local viticulture given a warmer and drier climate with more frequent and intense bushfires?

4 Adaptation pathways for the Southern Region

This section presents the adaptation pathways for each of the key decision areas identified by the Adaptation Planning project.

In developing the pathways for each key decision area a range of information generated by the project has been drawn on, specifically the outputs and processes shown in Table 4-1.

Table 4-1: Summary of information and sources provided for key decision areas

Information provided for key decision area	Information sources
Discussion regarding why focus on the key decision area is important for the Southern Region	Values workshops ²⁸ Regional Profile ²⁹
Overview of how climate change will impact the key decision area	Climate Change Scenarios Report ³⁰ Integrated Vulnerability Assessment Technical Report ³¹ Climate Change Risks, Opportunities and Vulnerabilities in the Southern Region Report ³²
Discussion regarding preferred options for progressing adaptation in relation to the key decision area	Adaptation Planning workshops with Project Champions ³³
Identification of actions for progressing preferred adaptation options	Adaptation Planning workshops with Project Champions and targeted one on one conversations with identified experts where additional expertise was required
Adaptation pathways	Adaptation Planning workshops with Project Champions and targeted one on one conversations with identified experts where additional expertise was required
Figure/s that show preferred adaptation options and features relevant to the key decision area (where information is able to be represented spatially)	On-line map server ³⁴ Regional Profile

4.1 Interpreting the pathways

The pathways in Sections 4.4 to 4.13 set out both the range of adaptation options considered for each key decision area, and the preferred adaptation pathway made up of the preferred options. The timing for each option and the relationship with other preferred options are also shown on the pathways.

Each pathway should be read in conjunction with the description of the relevant key decision area.

²⁸ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

²⁹ Resilient South (2014a) *Regional Profile – Resilient South*

³⁰ Resilient South (2014) *Climate Change Scenarios Report – Resilient South*

³¹ Resilient South (2014d) *IVA Technical Report – Resilient South*

³² Resilient South (2014b) *Climate Change Risks, Opportunities and Vulnerabilities in the Southern Region*

³³ Resilient South (2014c) *Engagement Feedback Report – Resilient South*

³⁴ www.resilientsouth.com

The horizontal axis of the pathway shows both a timescale, and expected changes to the climate that are relevant to the key decision area.

The range of adaptation options considered for the decision area are listed along the left hand side of the pathway.

Against each option is a combination of dots and lines that indicate:

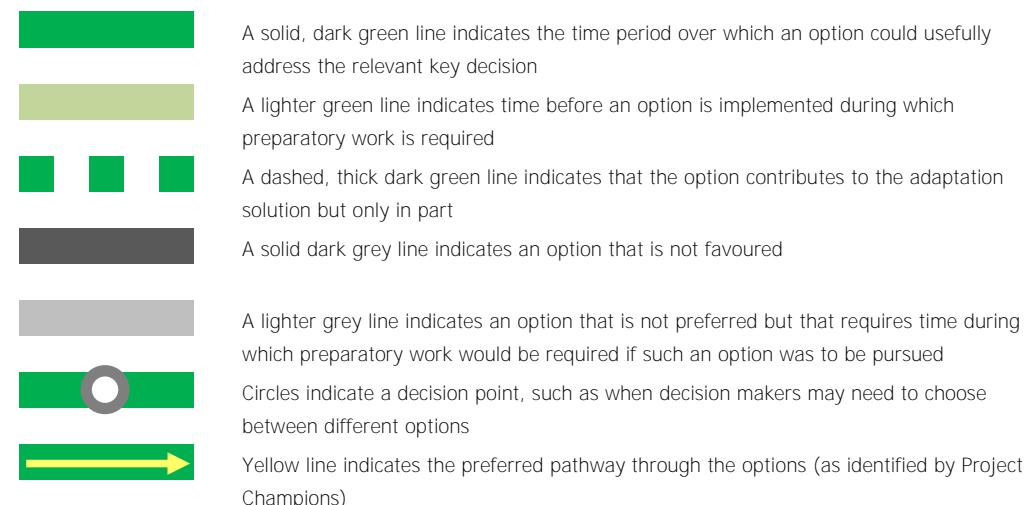
- The contribution of the option to the relevant key decision – whether it fully or partly addresses the decision;
- The favourability of the option;
- The time period over which the option is effective;
- The time period before an option is implemented during which preparatory work is required;
- Decision points where decision makers need to choose between options; and
- The preferred pathway through the options listed.

Figure 4-1 further describes the symbology used, and should be referred to in reading of the pathways.

A vertical line through “decision point” circles identifies a point in time at which a decision needs to be made between different options. The timing of the decision is indicative relative to the x-axis. This is based on the premise that as climate changes some options will become less suitable as adaptation measures and so new ones may be required.

For each pathway, “no changes” is the first listed option. This relates to all aspects of the current approach being taken to the decision area - for example current funding, management, and maintenance regimes. The length of the adjacent line shows how long the current approach with no changes can be expected to effectively address the area of decision making.

Figure 4-1: Pathway legend



4.2 Understanding preferred pathways

The preferred pathway (yellow line/s) identifies which options should be progressed now and into the future based on currently available information, including information provided by Project Champions.

The preferred pathway does not preclude current actions that contribute to future adaptation from continuing. The pathways should be reviewed at least every 5 years, at which time new information may suggest that the preferred pathway should take a different course through potential options.

It should be noted that although there was significant stakeholder involvement in the preparation of the pathways, further assessment of options by relevant individual sectors may still be required. In particular, it is acknowledged that further engagement is required with local Kaurna people and the business and manufacturing, viticulture and marine biodiversity sectors.

4.3 Spatial maps and use of map server to progress implementation

Spatial maps accompany the pathways for each key decision area where information is able to be represented spatially and describe preferred adaptation options and features relevant to the key decision area. For each key decision area a regional map is provided, and where relevant, individual Council maps.

These maps can assist in understanding where preferred adaptation options could be targeted for implementation across the Southern Region. The online map server can be utilised to further interrogate where adaptation options could be implemented. For example, heatwaves have been identified as a particular concern for more vulnerable members of the community. One way to adapt during heatwaves is to access facilities which provide respite from the heat such as cooler (air-conditioned) places. The map server can be used to identify the location of such facilities including libraries and major shopping centres as well as census collection area data to identify areas which have a greater proportion of people that may be more vulnerable (e.g. people aged over 65). The map server could be further interrogated to identify where vulnerable communities may not have local and ready access to facilities where they can take relief from extreme heat, and adaptation action can then be planned accordingly.

4.4 Coastal management

Key area of decision making

How do we maintain the Southern Region's natural features (e.g. cliffs, beaches, dunes, estuaries, biodiversity) and built infrastructure along the coast in the face of an increased risk of coastal degradation as a result of coastal inundation, changes in rainfall intensity and increased temperatures?

Why is maintaining the Southern Region's natural features and built infrastructure along the coast important?

The coast and marine environment of Southern metropolitan Adelaide is highly valued for its natural and built assets and is integral to the character of the Region³⁵. Beaches and the nearby coastal zone are highly valued and are used by the local community and tourists alike for recreation and contain a number of significant cultural sites. The coast supports unique natural ecosystems such as beaches, dunes, rockyshores and cliffs.

In the northern part of the Region including Glenelg, Somerton Park and Brighton, beaches are backed by built infrastructure that:

- Prevents movement of the sand dunes and vegetation inland; and
- In some cases enhance erosive forces from the sea.

South of Kingston Park there is a much greater diversity of coastal features including:

- Estuaries;
- Rocky shoreline backed by cliffs;
- Beaches fronting more extensive dune systems;
- Jetties;
- Boat ramps;
- Board walks; and
- Surf lifesaving clubs.

How will climate change impact the Southern Region's natural features (e.g. cliffs, beaches, dunes, estuaries, biodiversity) and built infrastructure along the coast?

Sea level rise impacts

The IVA identified that climate change will impact the coastal environment of the Southern Region in a number of ways³⁶. Sea level rise, which is projected to increase by nearly 0.8 m by 2100, when combined with naturally occurring storm surge events will result in greater rates of coastal degradation. Where dunes exist, it can be expected that beaches will move further inland while in areas with existing hard structures like rock walls sandy beaches can be expected to disappear over a period of 50-100 years and the effectiveness of existing rock walls diminish. Rising sea levels will also increase the erosion of cliffs along the coast.

³⁵ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

³⁶ Resilient South (2014d) *IVA Technical Report – Resilient South*

Without adaptation, in some low lying areas periodic inundation of built infrastructure will start to occur leading to direct damage or loss of access to some facilities like surf lifesaving clubs, roads and open space and public realm (e.g. Coast Park, pathways, stairs and ramp access to beaches, playgrounds).

Warmer and drier conditions

While sea level rise will be a significant impact, other aspects of climate change will also affect the coastal zone³⁷. For example, warmer and drier conditions will lead to the loss of some types of vegetation increasing the risk of dune erosion. Cliffs will also become more susceptible to erosion as warmer and drier conditions lead to greater cracking, and the chance of more intense rainfall events increases the risk of erosion at the top of cliffs, particularly where stormwater outfall pipes are located.

How might the Southern Region's natural features and built infrastructure along the coast adapt to changes in climate?

The coastal management pathway (refer Figure 4-2) shows a range of adaptation options for the coast, with four being identified by Project Champions as preferred options to be progressed for the Region.

Accelerating current best practice

In the short term adaptation to climate change in the coastal zone should focus on several options that are part of current best practice management, including:

- Awareness raising and education in the community to help people better respond to periodic hazards like flooding from storm events;
- Coordinated planning and monitoring to assist in understanding when the impacts of sea level rise will become critical. Importantly, adaptation will involve increased focus of efforts toward these activities rather than simply continuing with what is already being done; and
- Amendments to Development Plan policy regarding the construction of buildings or other infrastructure on the coast.

Amendments to Development Plan policy is particularly relevant in areas that will be at higher risk in the future, especially where the functional life of infrastructure is in the order of 50 years or more (i.e. when the more significant impacts of climate change are expected to occur). While such areas may not be impacted substantially in the next two to three decades, action now will reduce the need to relocate or protect infrastructure in the future. Review and amendment of Development Plan policy should include:

- Revising policy based on assessment of hazards,
- Promoting development in appropriate locations (and conversely, restricting development occurring in high risk areas); and
- Use of design guidelines that address or respond to anticipated climate impacts where appropriate (e.g. finished floor levels).

³⁷ Resilient South (2014d) *IVA Technical Report – Resilient South*

Protection strategies

Soft structural options: Soft structural protection options like dune management can play an important role in mitigating the impact of future sea level rise, and should occur now. Dune care programs already exist and should continue or be enhanced where possible, recognising the future role they can play as an adaptation measure. Consideration should also be given to whether sea level rise impacts will make it easier to establish other types of soft structural options such as wetlands. Figure 4.3 shows the locations of back shore dunes that may be the focus for revegetation and dune care activities.

Hard structural options: Assuming that changes to Development Plan policy prove effective in the short to medium term, the preferred adaptation option in some areas in the longer term will be the construction of hard structural options like sea walls, storm tide barriers or cliff base stabilisation that will become necessary to protect built assets in particular. While construction may not be required in the short term, preliminary scoping is advisable to identify future locations for these structures and construction options.

It should be noted that the Southern Region already has some protective hard infrastructure in place that accounts for future sea level rise, for example:

- City of Onkaparinga has commenced installation of cliff toe armouring under its Cliff Stability Strategy, which will also provide protection against rising sea levels³⁸; and
- Sea walls that provide protection against existing erosion impacts (e.g. the Broadway in Holdfast Bay) must account for 0.3 metres of sea level rise as standard practice when being upgraded. It is understood that these existing structures can be adjusted to allow for a further 0.7 metres of sea level rise.

Figure 4-3 shows the location of current priorities for cliff stabilisation in the City of Onkaparinga. These may change or be expanded as the City of Onkaparinga Cliff Stability Strategy is reviewed. Figure 4-3 also identifies where hard structural options may require investigation.

Monitoring

Periodically collecting information to determine when action needs to occur will be important for coastal adaptation. The Bureau of Meteorology currently leads the Australian Baseline Sea Level Monitoring Project while measurement of change in the nearshore beach and dune environment is undertaken by the SA Coast Protection Board. It is recommended that a monitoring strategy be developed to inform decision making regarding the timing of construction of hard structural barriers. This could be led by local Councils, potentially through the Metropolitan Seaside Councils Committee, with input from Bureau of Meteorology and the SA Coast Protection Board.

Figure 4-3 shows the location of current boat ramps and jetties which may be suitable locations for beach sand and sea level rise monitoring.

³⁸ Caton, B (2007) *The Impact of Climate Change on the Coastal Lands of the City of Onkaparinga*

Summary of preferred options for maintaining the Southern Region's natural features (e.g. cliffs, beaches, dunes, estuaries, biodiversity) and built infrastructure along the coast as our climate changes

Now

- Coordinated planning and monitoring;
- Inform and educate the community and encourage behaviour change;
- Review and amend Development Plan policy; and
- Develop soft structural options.

Within 20 to 30 years

- Construct hard structural options like storm tide barriers or sea walls.

Preparatory work

- It is recommended that a monitoring strategy be developed to inform decision making regarding the timing of construction of hard structural barriers.

Figure 4-3 identifies where these preferred options might apply spatially for the Southern Region.

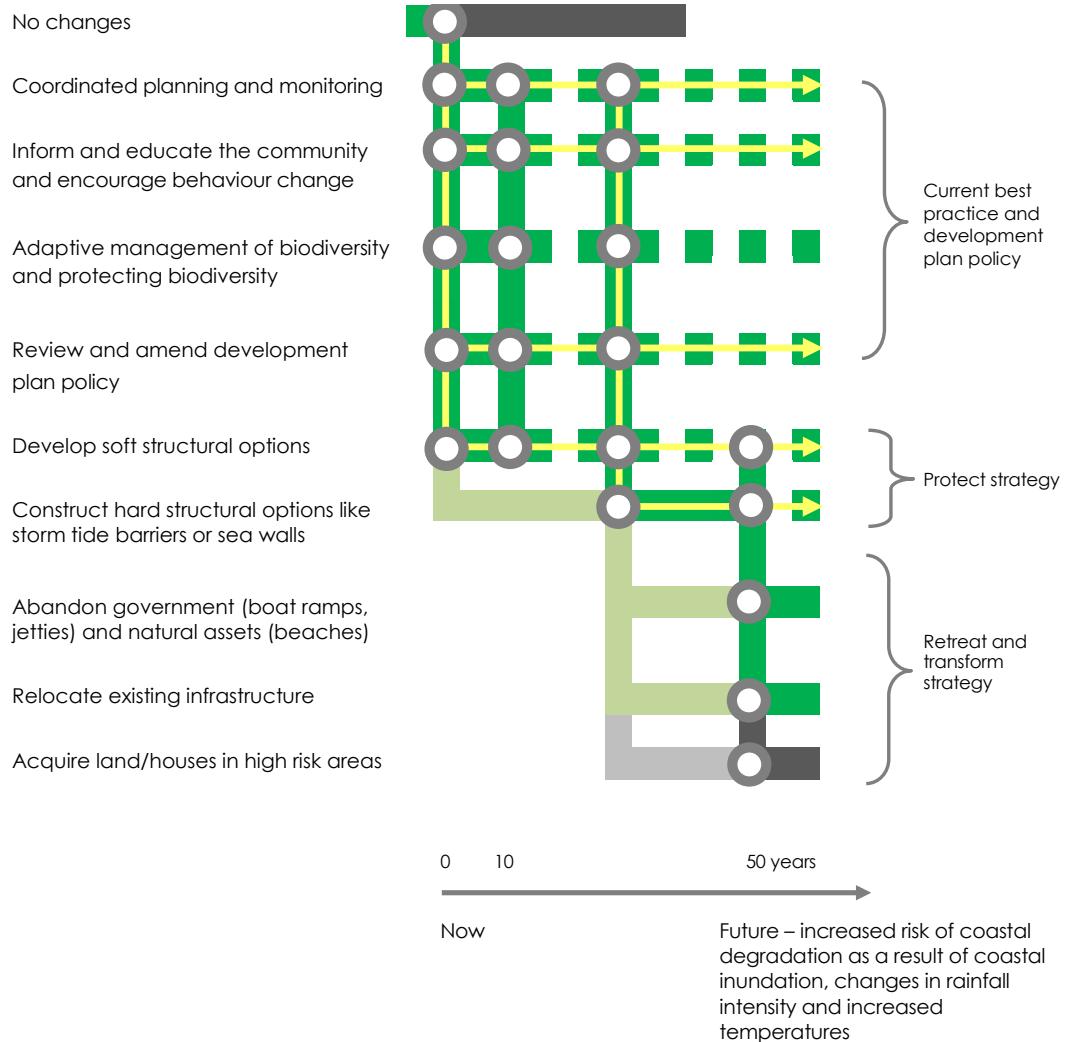
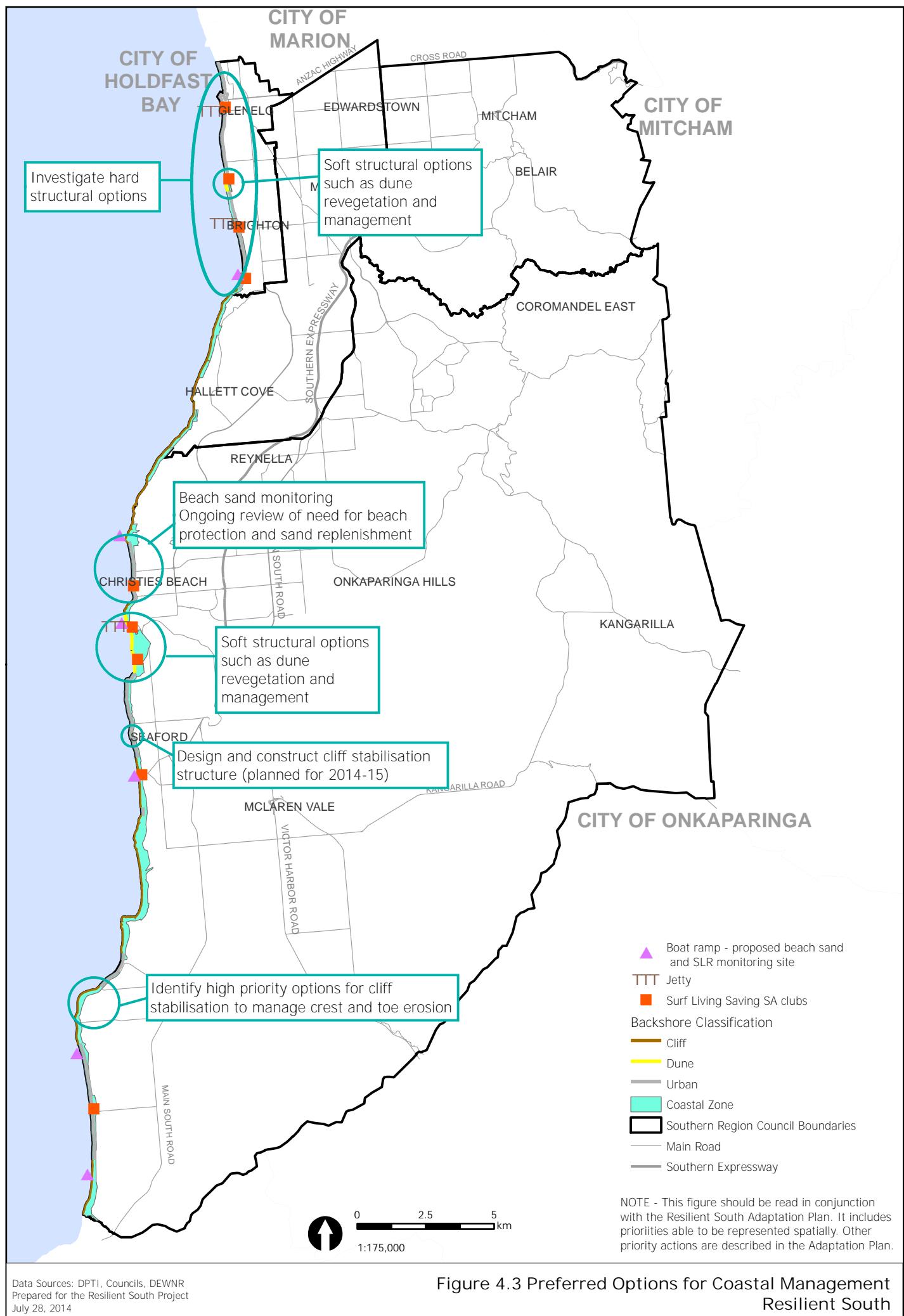
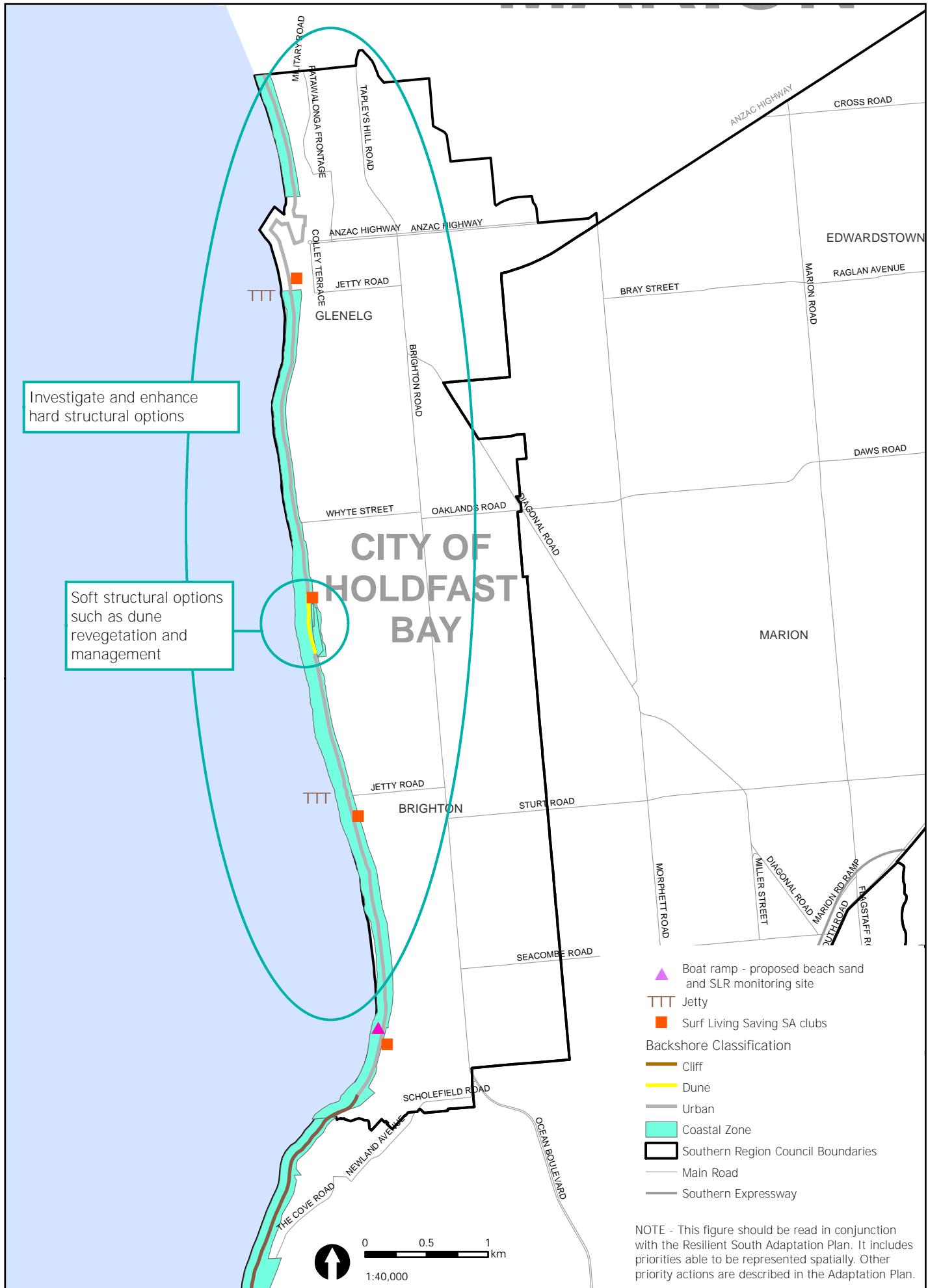


Figure 4-2: Coastal management pathway

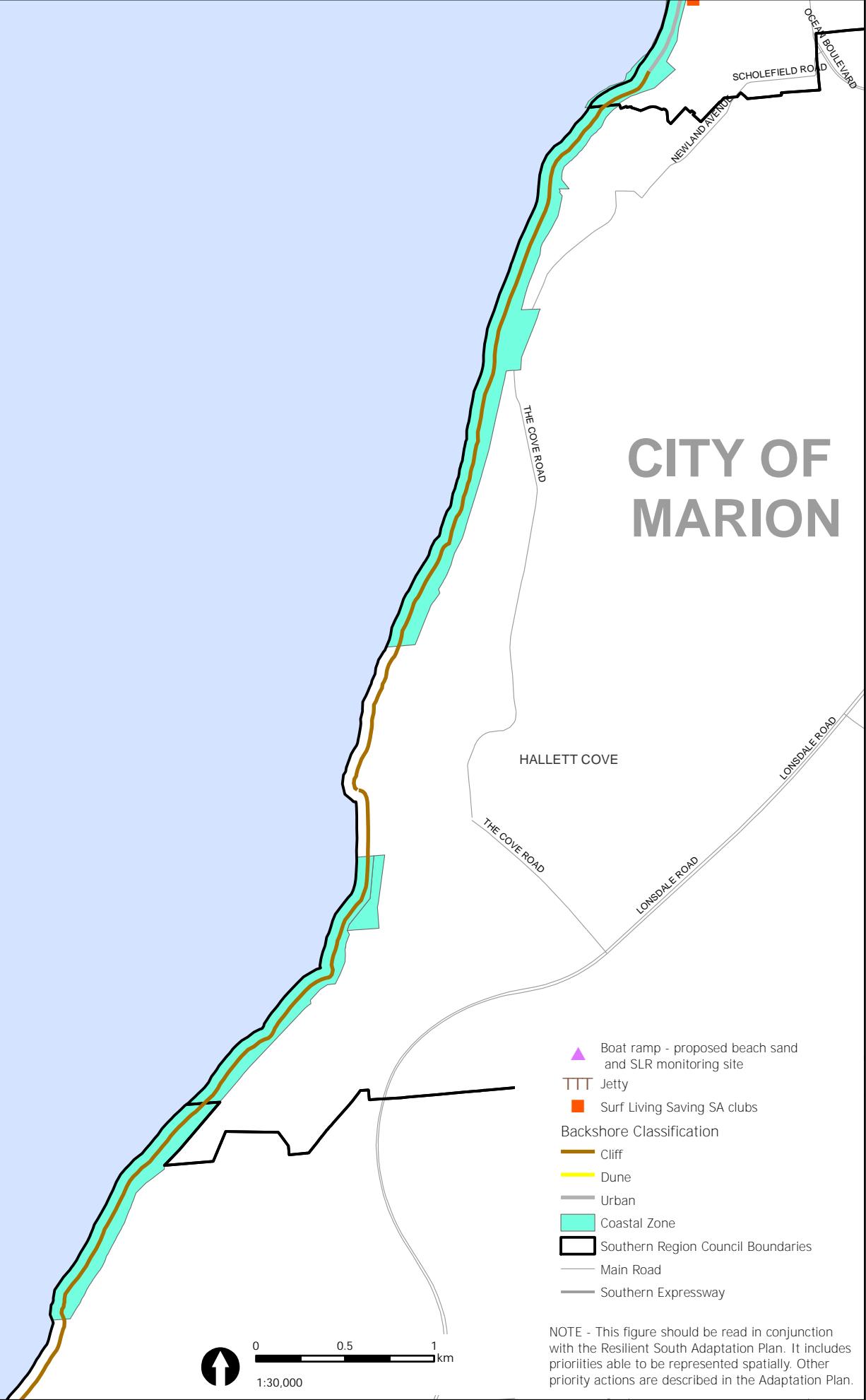
See Figure 4-1 for an explanation of how to interpret this figure.

- Time period over which an option can usefully address the key decision area
- Time before an option is implemented during which preparatory work is required
- An option that contributes to the adaptation solution but only in part
- An option that is not favoured
- An option that is not preferred but that would require preparatory work if pursued
- When decision makers may need to choose between different options
- Preferred pathway as identified by Project Champions





CITY OF MARION



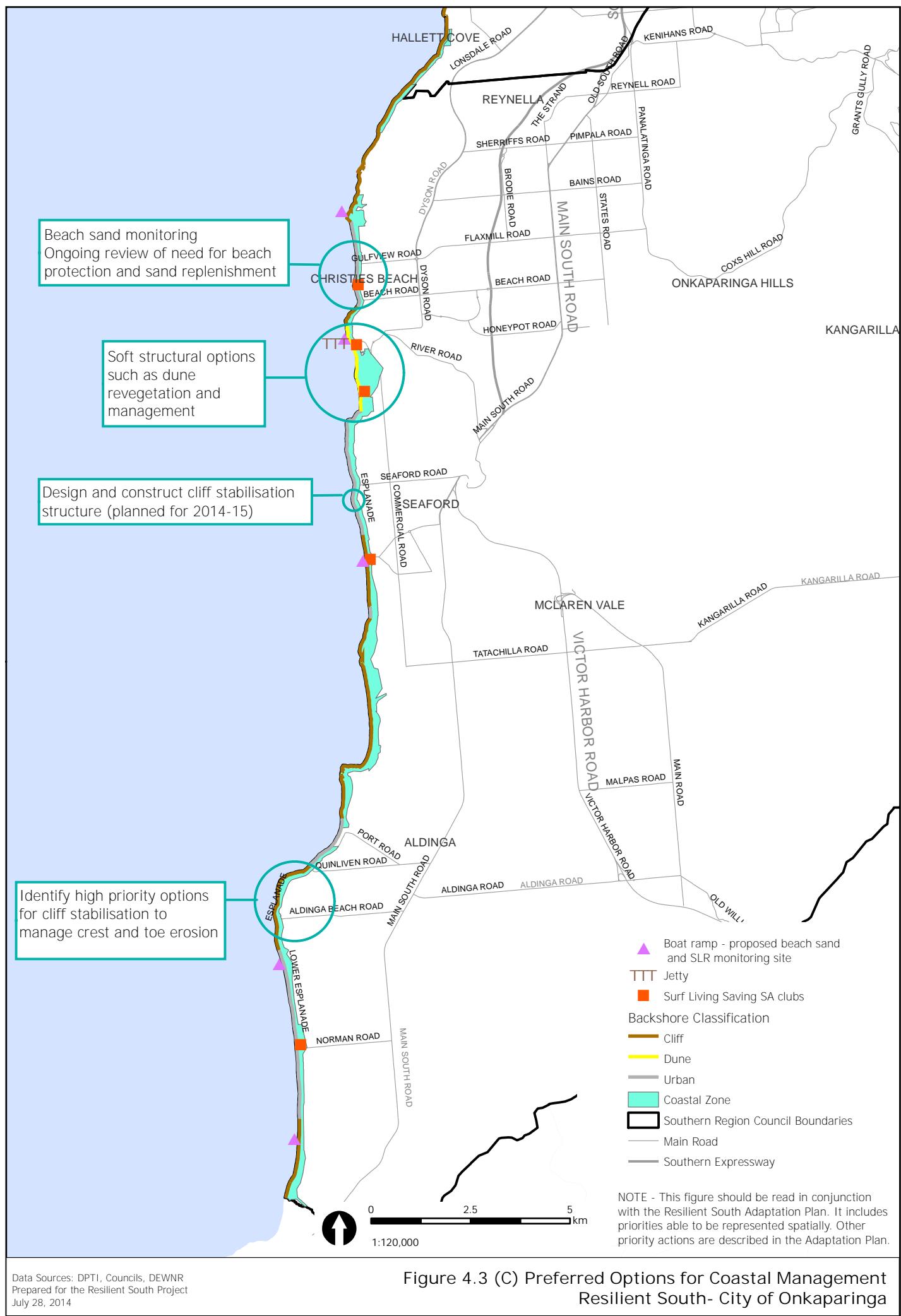


Figure 4.3 (C) Preferred Options for Coastal Management
Resilient South- City of Onkaparinga

4.5 Water resources management

Key area of decision making

How do we manage and/or maximise the quantity and quality of water resources available for a range of uses given less rainfall overall, more frequent and intense rainfall events, more frequent bushfires and increased evaporation?

Why is water resources management important?

The quality and quantity of water is of critical importance to the Southern Region from an environmental, economic, cultural and social perspective³⁹. Potable water comes from the River Murray, local catchments and reservoirs and the Adelaide Desalination Plant.

Natural watercourses include the:

- Onkaparinga River (part of the Western Mount Lofty Ranges Water Allocation Plan);
- Sturt River;
- Brownhill Creek;
- Minno Creek;
- Waterfall Creek;
- Field River;
- Christie Creek;
- Pedler Creek;
- Maslin Creek;
- Willunga Creek; and
- Other coastal springs and gullies.

Many watercourses have been highly modified from their natural state having been deepened, widened and the course altered as a result of catchment development and increased catchment runoff.

Groundwater is used across the Region for a variety of purposes including irrigation of:

- Open space and recreational facilities;
- Manufacturing;
- Horticulture; and
- Viticulture.

The enhancement of water security by the use of managed aquifer recharge schemes is also very important in the Southern Region. Within the Region there are two prescribed wells areas (PWAs) where water allocation plans (WAPs) are in place or under development, to guide the management and use of groundwater resources. The Central Adelaide PWA covers most of the area north of the Onkaparinga River and the McLaren Vale PWA covers most of the area to the south. The prescription of these groundwater resources under the *Natural Resources Management Act 2004* means that, when a WAP is adopted and water licenses issued, groundwater cannot be used without a license, except for small volumes for stock and domestic uses.

³⁹ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

Floods also create hazards that can impact on all members of the community, infrastructure and service delivery. Flood hazards exist in areas such as the Brown Hill Keswick Creek, coastal catchments in the City of Holdfast Bay and the City of Marion, Pedler Creek floodplain, Silver Sands and Washpool Catchment and the Christie Creek in the City of Onkaparinga.

How will climate change impact water resources management?

Declining rainfall

The IVA identified that reduced rainfall as a result of climate change will decrease the quantity and quality of surface water flows⁴⁰. With the projected increase in evaporation and decrease in rainfall, the winter excess of rainfall over evaporation (which drives catchment water flows and soil water accumulation) is projected to decline from 175 mm in 1980-1999 to 115 mm in 2070⁴¹. It has been suggested in other catchments in Australia that a single unit reduction in rainfall could lead to a two to three unit reduction in streamflow⁴². How the projected increase in the area of hard surfaces in metropolitan areas compares with declines in rainfall driven by climate change will impact surface water flows needs further assessment. Reduction in the availability of surface water may result in more demand for the use of groundwater in this area, which is not expected to be significantly affected by climate change for a number of decades.

Rainfall intensity

Despite an overall drying trend, an increased frequency of intense rainfall events could have implications for infrastructure both in terms of its ability to cope with extreme events and management of stormwater to prevent flooding and loss of life, as well as opportunities to collect and harvest water for reuse⁴³. Warmer and drier conditions could also result in increased demand for maintenance and/or replacement of stormwater infrastructure as a result of soil heaveage.

How can we respond to the impacts of climate change on water resources management?

The water resources management pathway (Figure 4-4) shows that a wide range of adaptation options will be required to respond to the projected change in the timing, quantity and quality of water. The pathway indicates that all identified adaptation options are part of the preferred pathway and reflects the significant work that has already been done to address water security issues in the Region supported by Water for Good, the Goyder Project, Water Proofing the South and other related plans and strategies. The options in this pathway reflects the extensive work already undertaken to manage demand and supply of water as well as the decision already taken to construct the desalination plant to address water supply security.

Behaviour change and improved planning

One water management option for immediate action is building on existing initiatives and further investing in supporting behaviour change and improved planning. Behaviour change

⁴⁰ Resilient South (2014d) *IVA Technical Report – Resilient South*

⁴¹ Resilient South (2014) *Climate Change Scenarios Report – Resilient South*

⁴² Chiew, F.H., and T. A. McMahon (2002) 'Modelling the impacts of climate change on Australian streamflow', *Hydrological Processes*, vol. 16, pp. 1235–1245

⁴³ Resilient South (2014d) *IVA Technical Report – Resilient South*

was identified as a preferred option to manage potable water security issues during the past water shortages (e.g. the Millennium Drought) and will continue to be a strategy in the future requiring community education and improved knowledge to support it. Research is also required to better understand the changing nature of rainfall events, soil movement impacts, interactions at the coast such as salt water intrusion and ground water recharge. As this research is undertaken, relevant plans will need to be calibrated with this information such as Water Allocation Plans, Stormwater Management Plans and Development Plans. Ongoing investment in reviewing, updating and implementing relevant plans should occur across the Region.

Project Champions were strongly supportive of the option of riparian rehabilitation. Rehabilitation should initially focus on riparian mapping to show high priority areas from a strategic regional ecosystem and water perspective. Priority areas for riparian rehabilitation will include areas located on public land, particularly in the hills, and areas which will provide biodiversity and water quality benefits. Riparian rehabilitation should be driven by an integrated water resources management approach and identify areas for strategic land acquisition to reclaim rivers from concrete or otherwise modified channels.

Figure 4-5 shows where watercourses are located on public land, providing an opportunity for riparian rehabilitation.

Major supply initiatives

The Southern Region has already made significant investments in water resource management infrastructure. Given projected climate change impacts though, it is expected that further major investment will need to be made in water management infrastructure in the Region. Delaying major investment for a decade will provide the opportunity to better understand changing rainfall patterns. The major options likely to be required at this time include further adoption of:

- Water sensitive urban design (WSUD);
- Domestic, commercial and industrial rainwater capture schemes;
- Water recycling and waste water re-use; and
- Managed aquifer recharge.

A key challenge is to determine sequencing and investment in adoption of responses in new developments versus retrofitting existing developments. Although this investment may be a decade away, preliminary work is required now to determine the best mix of options, building on the current Goyder Institute project on the Optimal Water Resources Mix for Adelaide. Additional work now could also focus on targeted monitoring of supply and demand to inform when a decision about additional investment will be required.

Figure 4-5 shows:

- The location of the Tonsley development site at which WSUD opportunities are planned;
- Industry zones where there may be opportunity for rainwater capture;
- Existing waste water treatment plants and opportunities to expand recycled water use from these plants; and
- Wetlands across the Region, a number of which support managed aquifer recharge schemes.

Summary of preferred options for the adaptation of water resources management

Now

- Ongoing research to inform adaptation and management;
- Educate communities;
- Calibrate water resources plans, policy and legislation;
- Review and amend Development Plan policy with focus on water security;
- Improve flood management and riparian rehabilitation; and
- Continued adoption of water sensitive urban design.

Within 10 years

- Increased domestic, commercial and industrial capture of rainwater;
- Greater water recycling and waste water re-use; and
- Increased managed aquifer recharge.

Preparatory work

- **Build on the results of the Goyder Institute's project to determine the best mix of** investment options regarding capture of rainwater, re-use of recycled and waste water and managed aquifer recharge; and
- Targeted monitoring of supply and demand should commence to inform when a decision about additional investment will be required.

Figure 4-5 identifies where these preferred options might apply spatially for the Southern Region

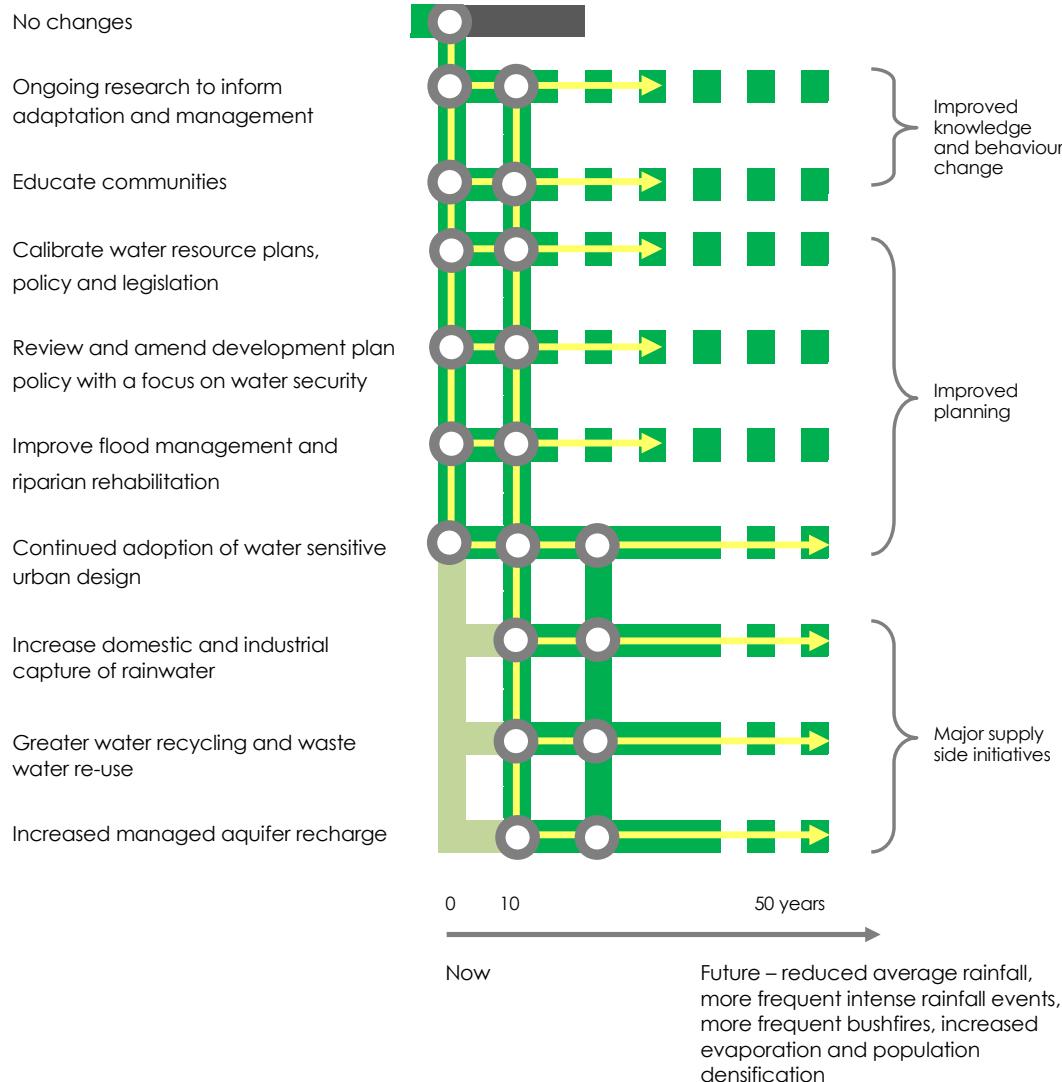
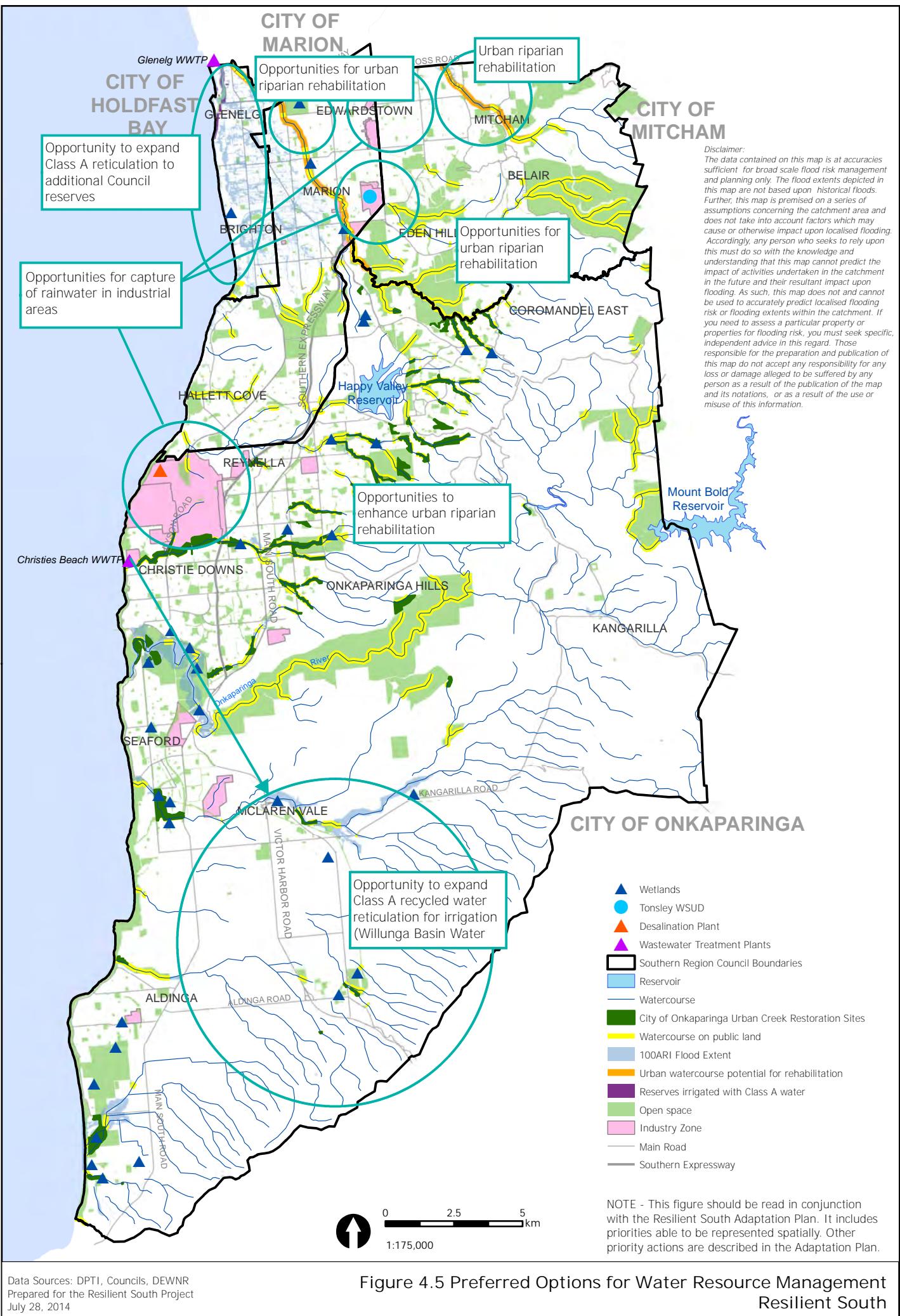
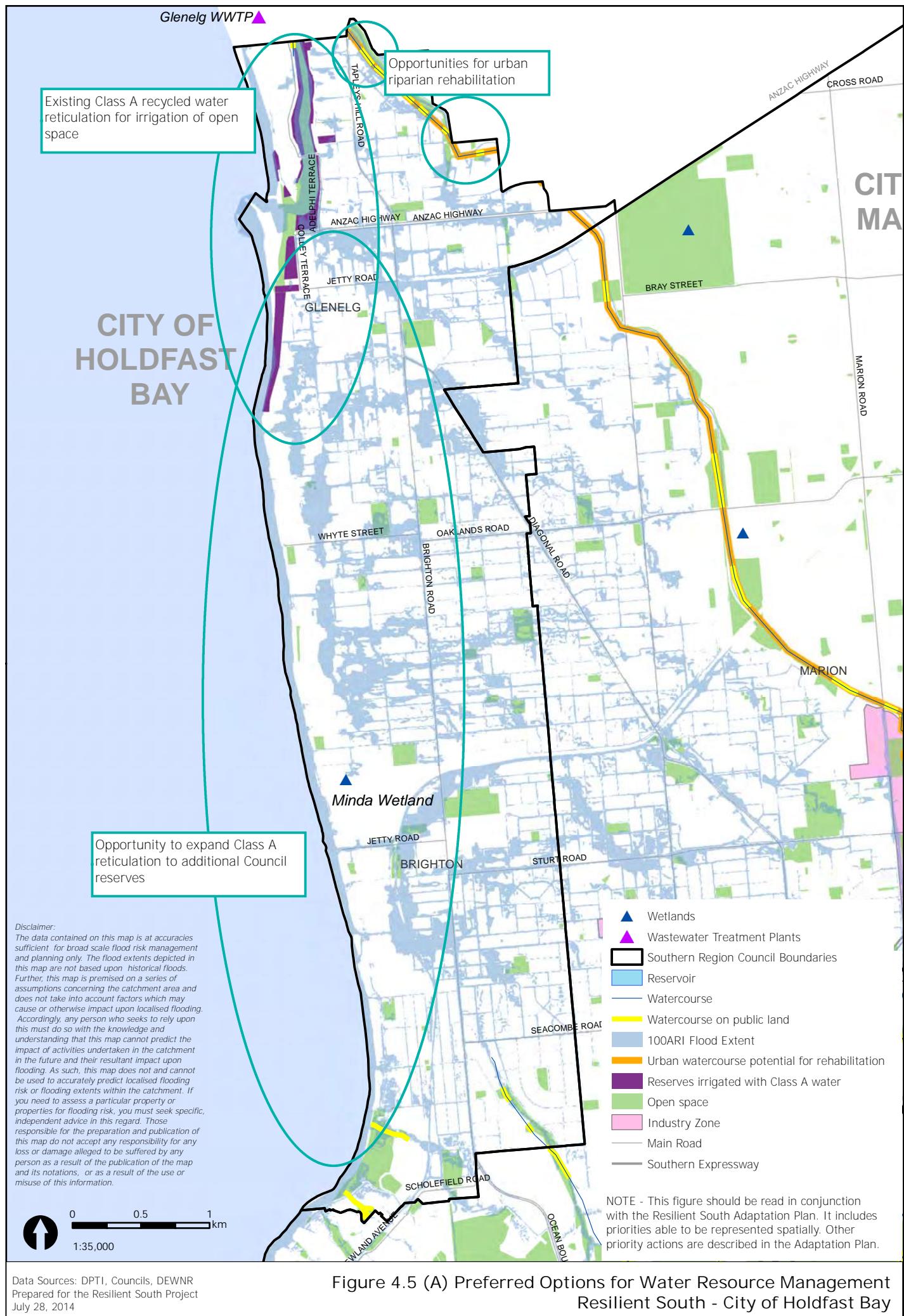


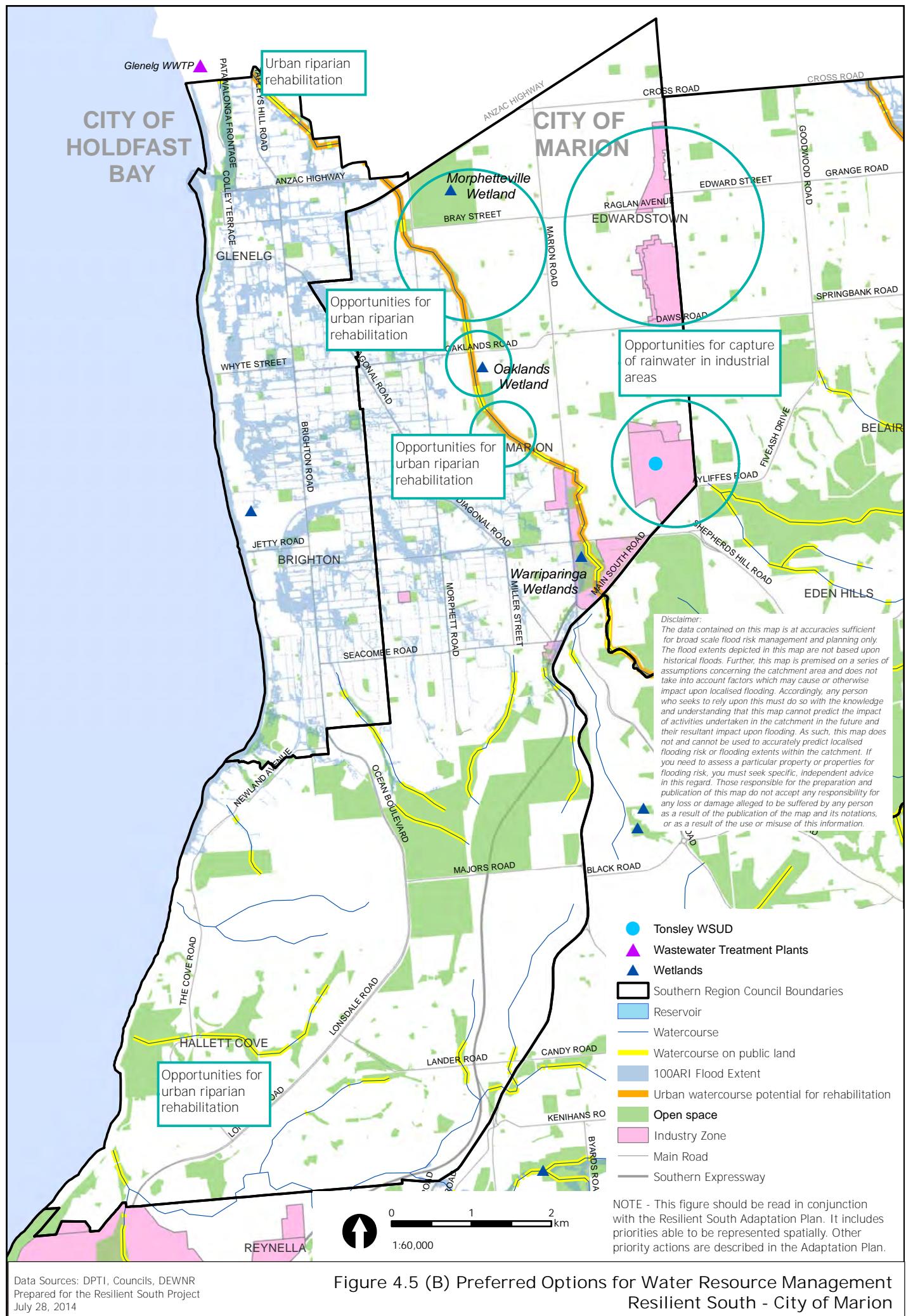
Figure 4-4: Water resources management pathway

See Figure 4-1 for an explanation of how to interpret this figure.

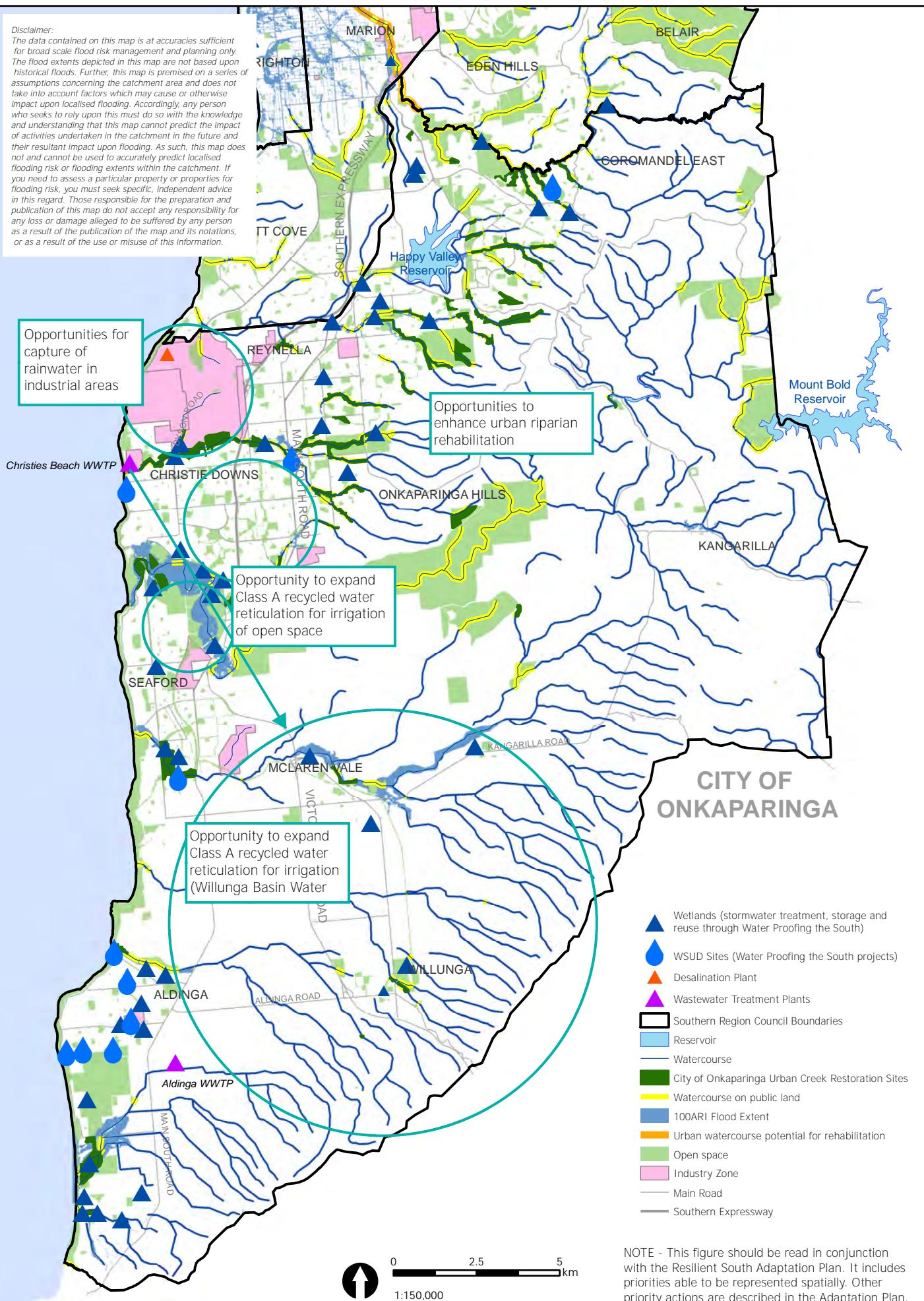
- [Green bar] Time period over which an option can usefully address the key decision area
- [Light green bar] Time before an option is implemented during which preparatory work is required
- [Three small green squares] An option that contributes to the adaptation solution but only in part
- [Dark grey bar] An option that is not favoured
- [Grey bar] An option that is not preferred but that would require preparatory work if pursued
- [Green bar with circle] When decision makers may need to choose between different options
- [Yellow arrow] Preferred pathway as identified by Project Champions

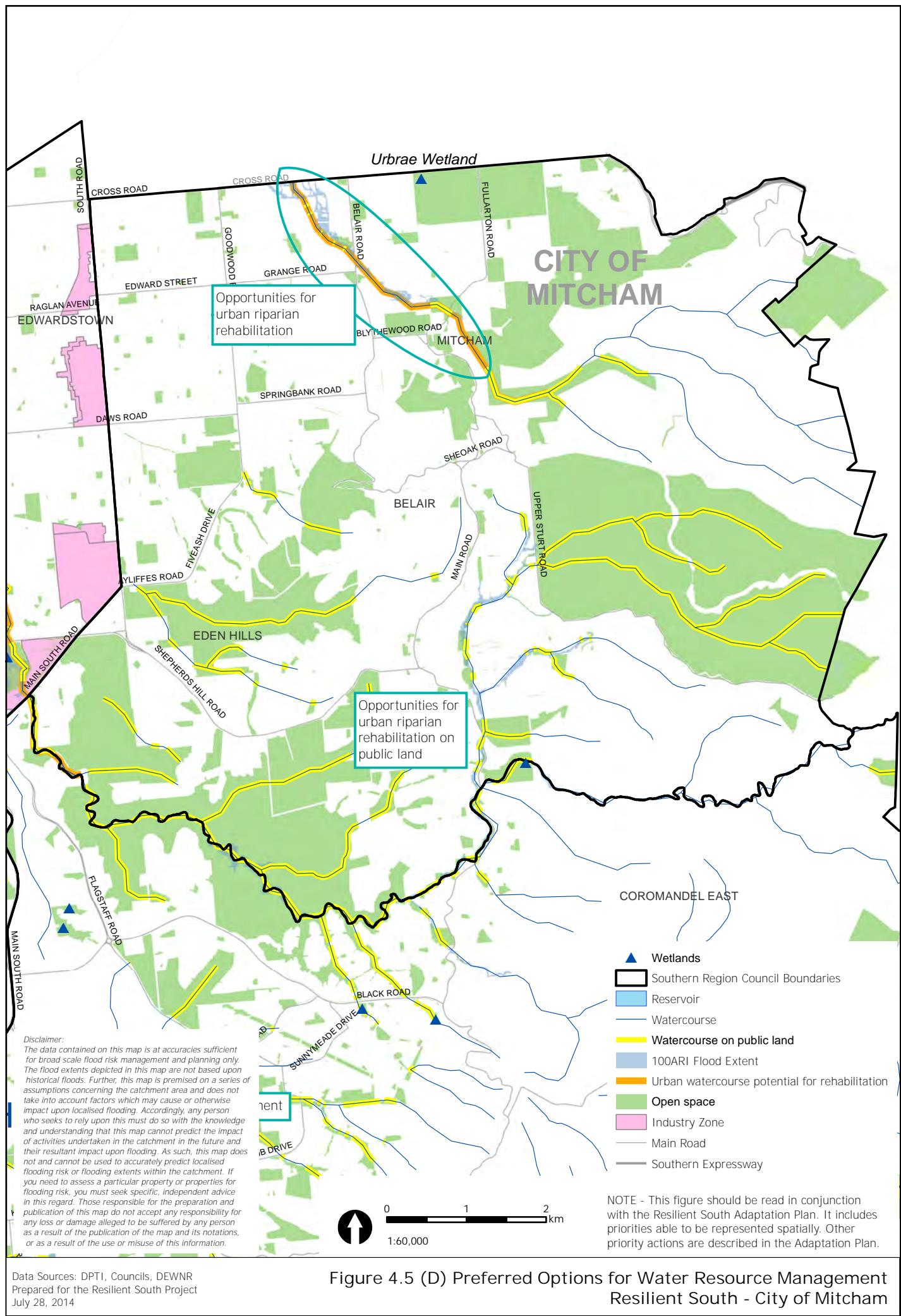






Disclaimer:
The data contained on this map is at accuracies sufficient for broad scale flood risk management and planning only. The flood extents depicted in this map are not based upon historical floods. Further, this map is premised on a series of assumptions concerning the catchment area and does not take into account factors which may cause or otherwise impact upon localised flooding. Accordingly, any person who seeks to rely upon this must do so with the knowledge and understanding that this map cannot predict the impact of activities undertaken in the catchment in the future and their resultant impact upon flooding. As such, this map does not and cannot be used to accurately predict localised flooding risk or flooding extents within the catchment. If you need to assess a particular property or properties for flooding risk, you must seek specific, independent advice in this regard. Those responsible for the preparation and publication of this map do not accept any responsibility for any loss or damage alleged to be suffered by any person as a result of the publication of the map and its notations, or as a result of the use or misuse of this information.





4.6 Natural landscapes

Key area of decision making

How do we manage natural landscapes and associated habitats on all tenures of land (public and private) in the Southern Region when exposed to warmer and drier conditions, more frequent and intense bushfires and the combined effects of sea level rise and storm surge?

Why is managing natural landscapes in the Southern Region important?

Protecting the environment and natural resources of the Southern Region is a high priority reflecting the value the community places on natural assets such as coastal environments, open space, parks and reserves⁴⁴. These assets are important for biodiversity conservation, providing habitat for native fauna and delivering a range of ecosystem services that underpin both social and economic wellbeing for the community such as:

- Areas for recreation, tourism and general amenity;
- Purification of air and water;
- Creation of soil;
- Pollination of native plants and crops; and
- Breakdown of wastes.

The Southern Region has three distinct natural landscape types:

- Hills - Higher rainfall, higher elevation and mainly rural land areas which contain most of the **Region's remnant vegetation**;
- Plains and hillsface - Lower rainfall area of the Adelaide plains where the majority of the land has been cleared to make way for urban settlements. This landscape type also includes the hills face zone; and
- Coastal - Area along the coast, which contains a mixture of beach, estuary and cliff environments, some of which are heavily modified with no dunes such as in the northern part of the Region.

Natural landscape types are shown on Figure 4-7.

How will climate change impact natural landscapes in the Southern Region?

The IVA found that the natural landscapes of the Southern Region will be significantly impacted by climate change⁴⁵. Some landscape types will undergo transformation and certain ecosystems and species will no longer exist in the Region. The impacts for the three natural landscape types in the Region are likely to include the following:

- The **hills landscape**, which has higher rainfall and retains a greater cover of remnant ecosystems, has some buffering capacity from climate change due to its topographic and microclimatic diversity and its species assemblages show a comparatively high level of climatic stability. Increased bushfire frequency and intensity will be another driver of change in the hills, which has the potential to further exacerbate the direct impact of climate change. A consequence of major disturbances like fire will be opportunities for pest plants and animals to increase in distribution and abundance.

⁴⁴ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁴⁵ Resilient South (2014d) *IVA Technical Report – Resilient South*

- The **plains and hillsface landscape**, which has lower rainfall and have been more intensively developed for urban, peri-urban and horticultural uses, has less buffering capacity from climate change and the species assemblages show a comparatively low level of climatic stability. In addition to being impacted by warmer and drier conditions, this landscape will experience fire regime change impacts in the hills face zone and sea level rise impacts at least on the western plains.
- Along the **coast** the main driver of change will be sea level rise in conjunction with storm surge which will lead to beach recession, landward migration of coastal ecosystems and the loss of some dune areas. This represents one of the most significant climate change threats for a natural landscape in the Southern Region. For example, salt marsh complexes, which are expected to be particularly vulnerable to sea level rise, will be unable to migrate to new areas when artificial barriers such as roads or levees limit landward migration.

All three natural landscape types will find it difficult to migrate to more suitable locations in the future because of the fragmented nature of the landscape.

How can we respond to the impacts of climate change on the ability for native ecosystems to persist in the Southern Region?

Natural landscapes pathways (refer Figures 4-6A, B and C) have been prepared reflecting the three natural landscape types in the Region. The sequencing of options in the pathways differs because of the rate and extent of the predicted impact of climate change on each landscape type.

Responses in general should focus on maintaining as much of the natural landscape as possible in the Region, while at the same time seeking to minimise the broader consequences of losses from the Region and **support the emergence of new “novel” ecosystems** that may support some ecosystem services.

Current best practice (“passive” adaptation)

Adaptation in all three ecosystems requires current best practice planning and management options to be accelerated now, with the preferred pathway for each focussing on:

- Monitoring and research to undertake situation appraisal and review;
- Review and amend Development Plan policy; and
- Addressing current and emerging threats (e.g. rabbits, which can exacerbate cliff destabilisation).

Monitoring and research needs to focus on developing baselines on current distribution and abundance patterns, identifying potential changes and then recording what occurs in the Region. Potential changes include altered resource availability patterns, species interactions, and changes in processes and disturbance dynamics.

Protect strategy (“active” adaptation)

Maintaining habitat values in non-conservation areas is a priority for all three natural landscape types. This includes improving and restoring the matrix of remnant patches in existing primary production systems. While a priority for all three landscape types, it is of more immediate importance for the plains and hills face and coast.

Figure 4-7 shows isolated patches of remnant vegetation, many of which are located within the plains and hills face landscape.

Protecting and improving refugia is of most importance to the plains and hillsface landscape type. It is not as critical for the hills because of the topographic and microclimatic diversity in this area. In contrast, it is not a priority action for the coast because of the limited areas that could perform this function. This option could include protecting isolated patches of native vegetation, providing additional buffers and managing parts of the environment that provide refuge during climatic extremes.

Transformation strategies

In coastal and estuarine areas (refer Figure 4-7) the preferred pathway suggests that within two to three decades, retreat and transformational options will be required such as species translocations (i.e. moving species to new areas outside the Region), ex-situ conservation (e.g. moving species to zoos or seed banks) and ecosystem engineering (i.e. replacing ecosystems no longer viable in the Region with new ones). These are major actions and would be pursued only if there is a risk of species or communities being lost from the Region altogether.

The preferred pathways for the hills and plains and hills face landscape types only pursue these more transformational strategies in about 50 years suggesting that while ecosystems in these regions will be impacted, they are not under threat of being lost completely from the Region within this timeframe.

Species translocations, ex-situ conservation and ecosystem engineering are all major interventions that could have a high cost to implement. They would also require significant coordination between natural resources management organisations within and external to the Region, especially if species were to be moved outside of the Region.

Preliminary work is required now to determine how such an option would be implemented and how species translocations would be managed given historical experiences where native species have been moved into new habitats only to then become a dominant and damaging species. This should commence with a risk and vulnerability assessment to identify those species that cannot adapt and the implications of losing them in the Region.

Summary of preferred options to manage natural landscapes and associated habitats in the Region

Now (hills, plains and hillsface, coastal)

- Monitoring and research to undertake situation appraisal and review;
- Review and amend Development Plan policy;
- Address current and emerging threats; and
- Maintain habitat values in non-conservation areas.

Now (plains and hillsface)

- Protect and improve refugia.

Within 20-30 years (coastal)

- Move species and ecosystems and implement ecosystem engineering (coastal and estuarine).

Preliminary work

- Commence work with Department of Environment, Water and Natural Resources (DEWNR), Natural Resources Management (NRM) organisations, the South Australian museum, research institutions and the Royal Zoological Society of South Australia to undertake a risk and vulnerability assessment to identify those species that cannot adapt and the implications of losing them in the Region.

Figure 4-7 identifies where these preferred options might apply spatially for the Southern Region.

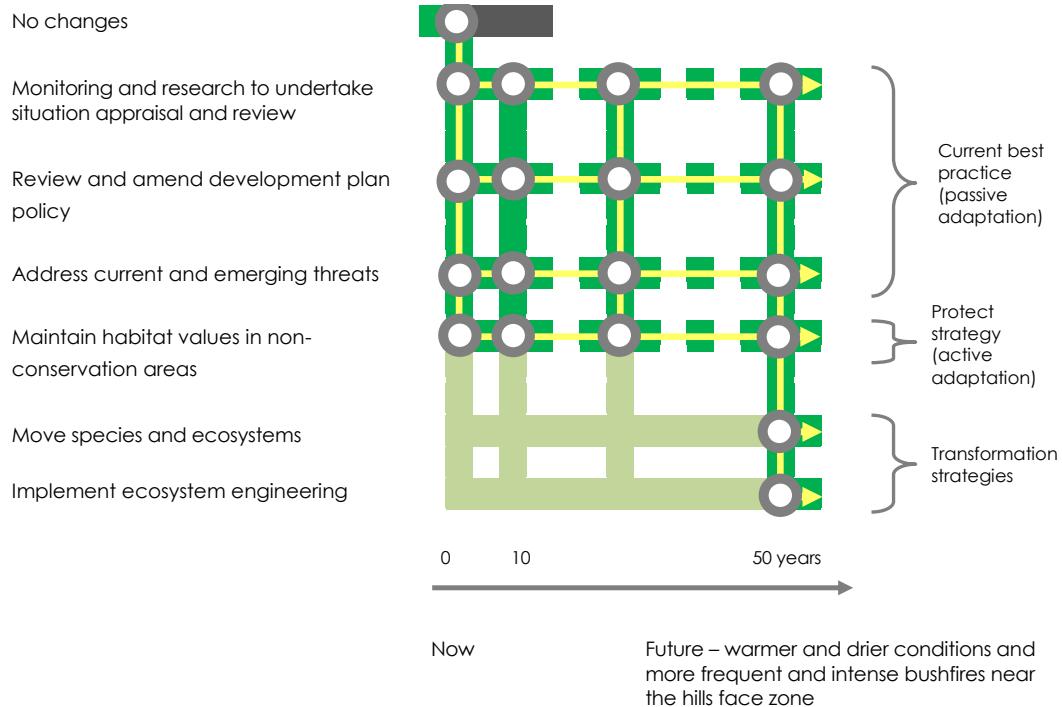


Figure 4-6A: Natural landscapes pathway (hills)

See Figure 4-1 for an explanation of how to interpret this figure.

- Time period over which an option can usefully address the key decision area
- Time before an option is implemented during which preparatory work is required
- ■ ■ An option that contributes to the adaptation solution but only in part
- An option that is not favoured
- An option that is not preferred but that would require preparatory work if pursued
- When decision makers may need to choose between different options
- Preferred pathway as identified by Project Champions

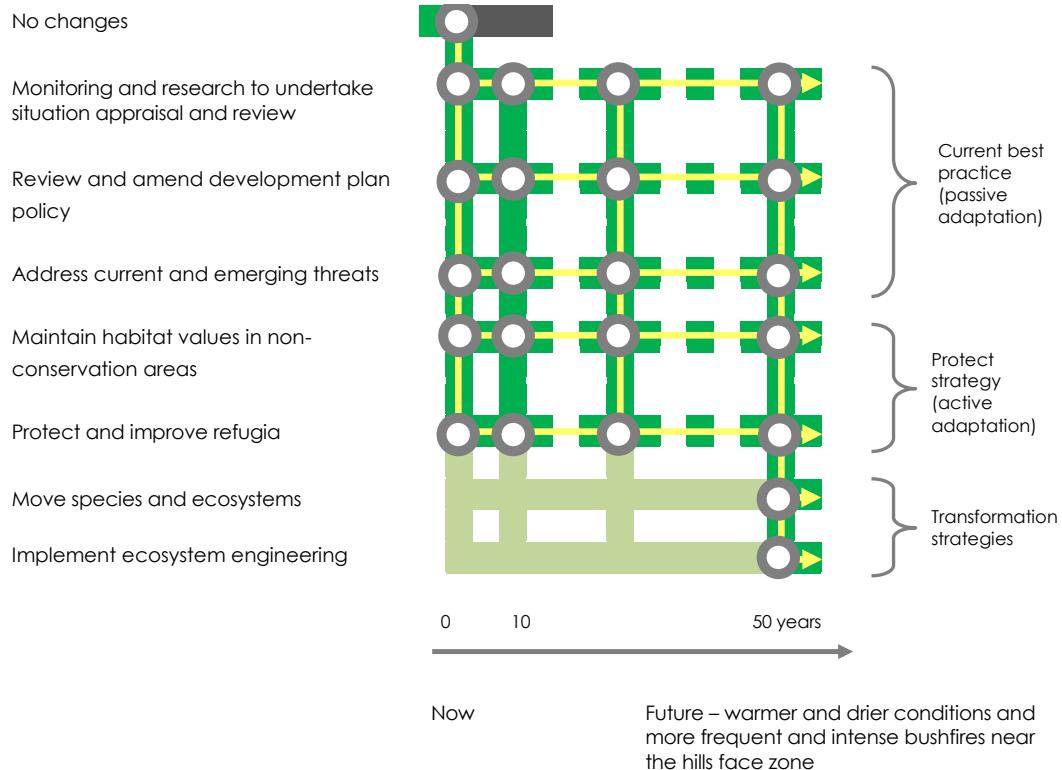


Figure 4-6B: Natural landscapes pathway (plains and hills face)

See Figure 4-1 for an explanation of how to interpret this figure.

- [Green bar] Time period over which an option can usefully address the key decision area
- [Light green bar] Time before an option is implemented during which preparatory work is required
- [Three green squares] An option that contributes to the adaptation solution but only in part
- [Dark grey bar] An option that is not favoured
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- [Yellow arrow] Preferred pathway as identified by Project Champions

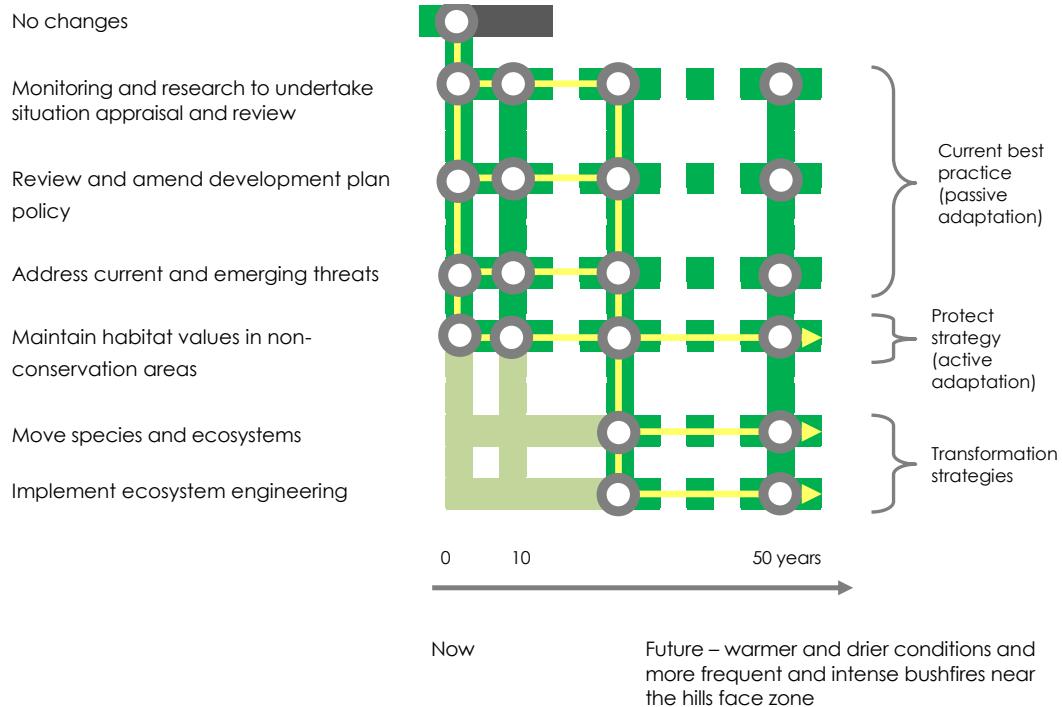
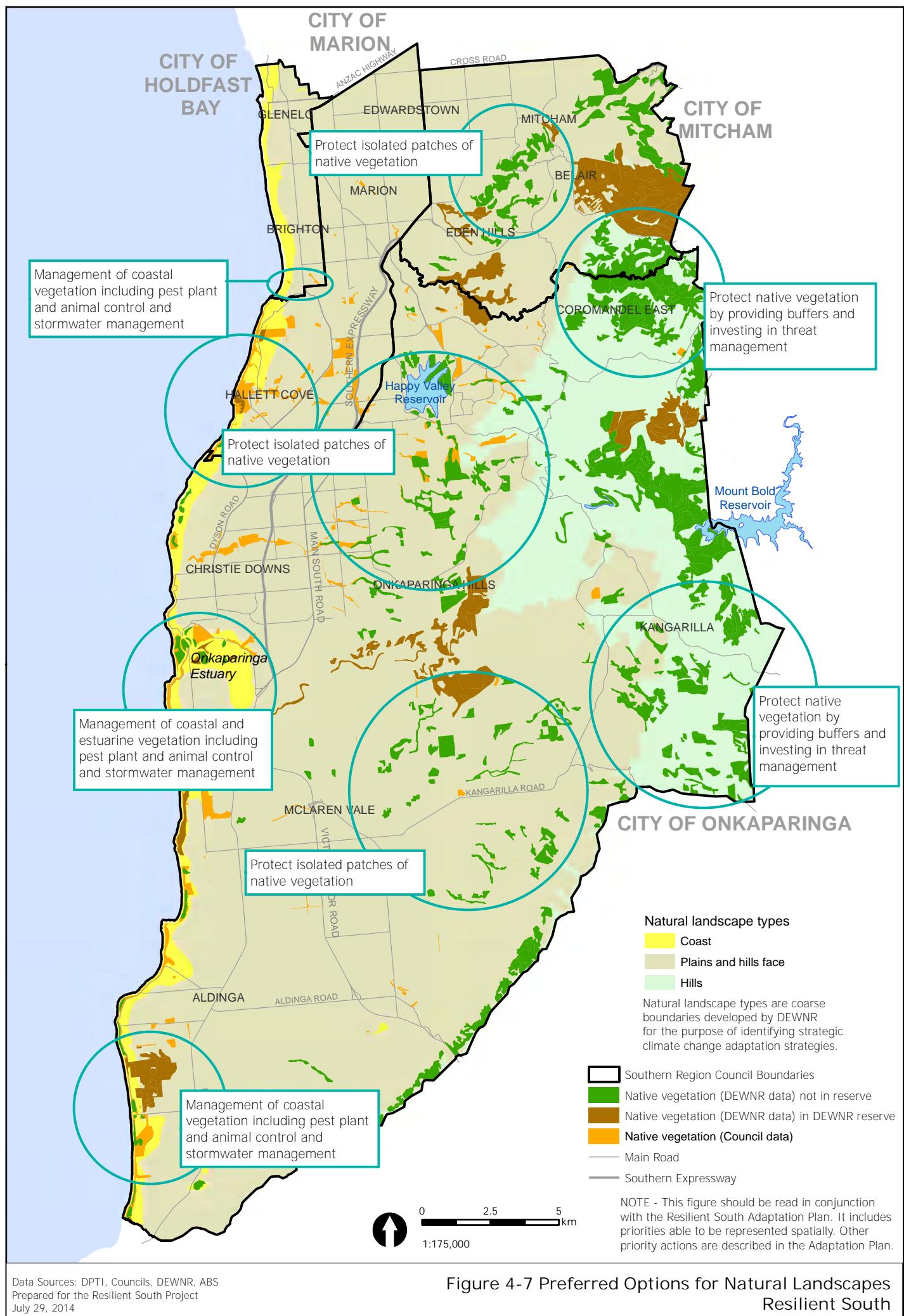
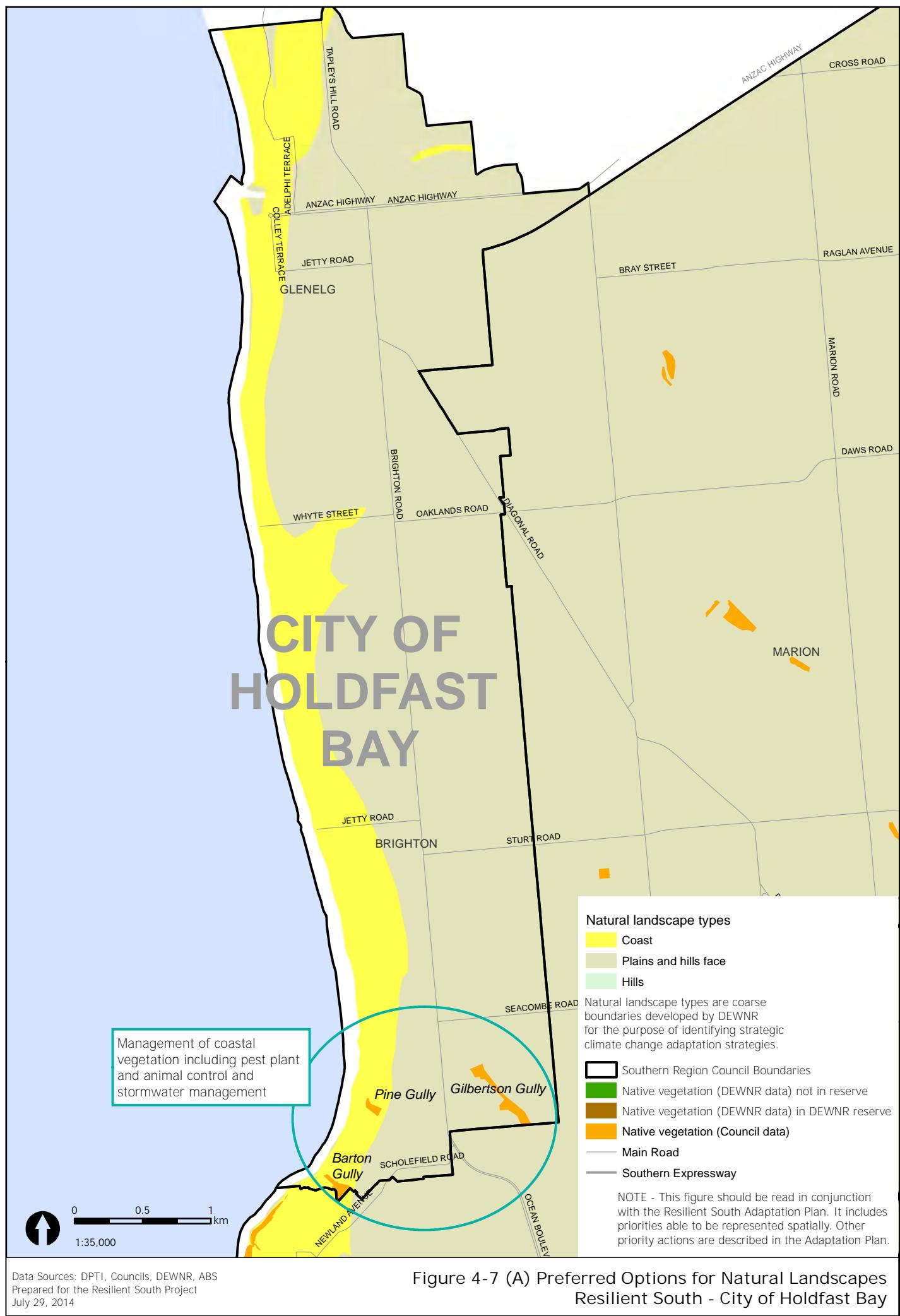


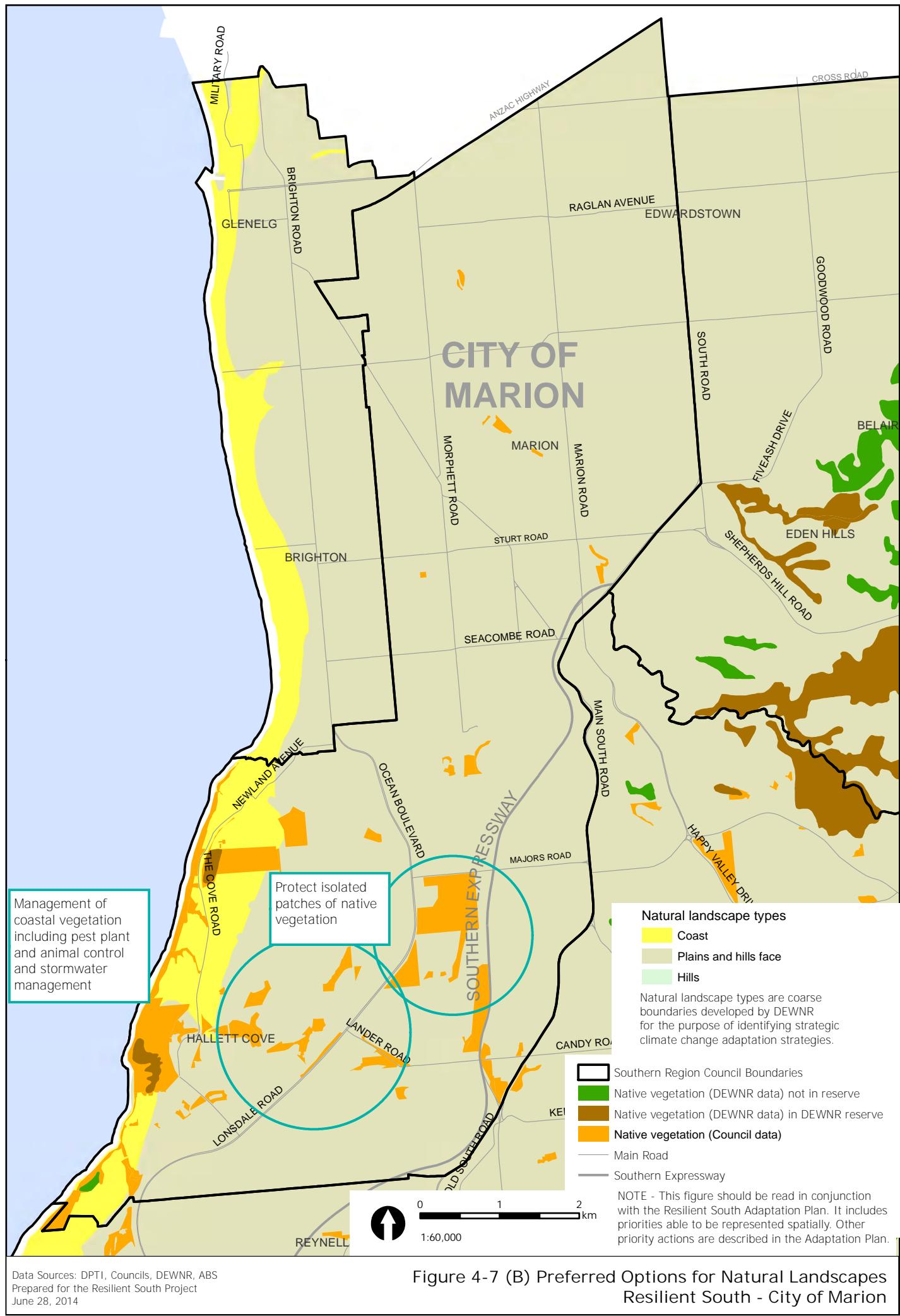
Figure 4-6C: Natural landscapes pathway (coastal)

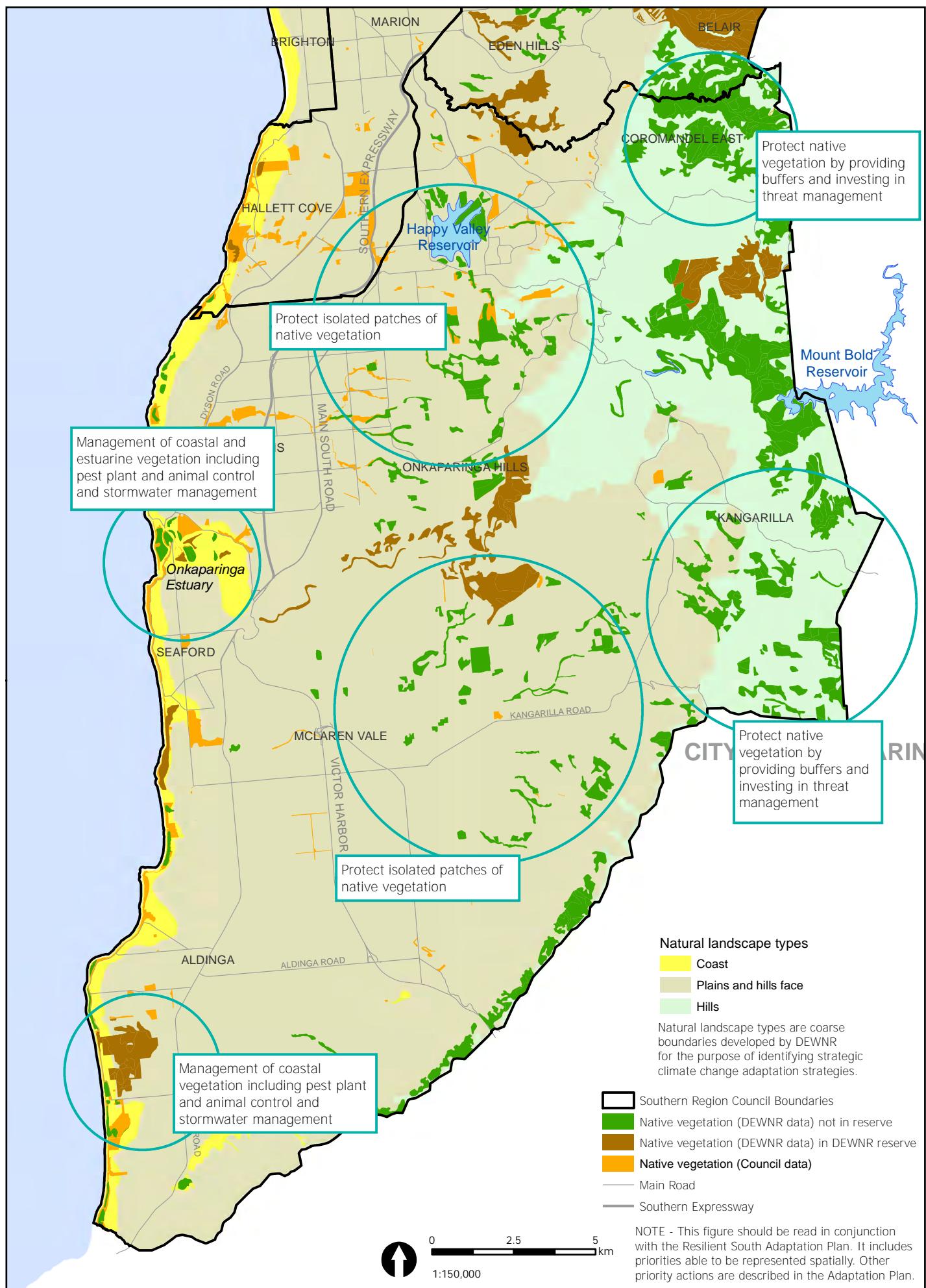
See Figure 4-1 for an explanation of how to interpret this figure.

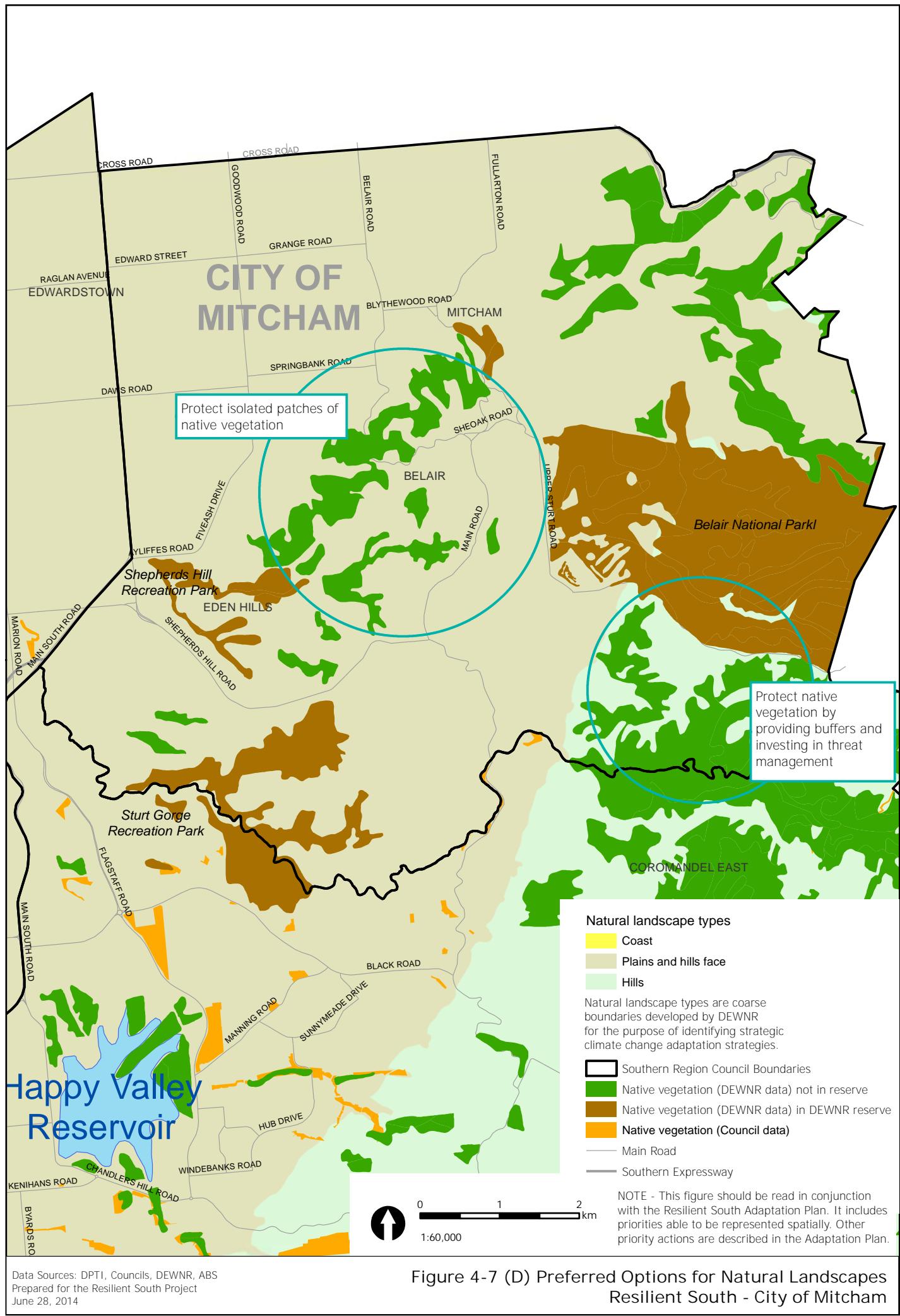
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- [Green bar with circle] When decision makers may need to choose between different options
- [Yellow arrow] Preferred pathway as identified by Project Champions











4.7 Marine biodiversity

Key area of decision making

How do we protect marine biodiversity given increasing sea surface temperatures, ocean acidification and changing stormwater input due to changing rainfall patterns?

Why is protecting marine biodiversity important?

The waters and biodiversity of Gulf St Vincent are highly valued by the Southern Region and beyond⁴⁶. The Gulf waters are used for commercial fishing, recreational pursuits such as fishing, diving and boating and have high conservation significance. Marine biodiversity consists of important areas of native flora and fauna. Notable in the Region are extensive areas of seagrass, kelp and reef, although the area of seagrass has reduced as a consequence of pollution induced dieback. As a result work has already commenced to consider ways to reduce water quality impacts in Adelaide's coastal waters (e.g. the Environment Protection Agency's Adelaide Coastal Water Quality Improvement Plan⁴⁷).

How will climate change impact marine biodiversity?

The IVA found that increasing sea surface temperatures, ocean acidification, rising sea levels and changing rainfall patterns will have a negative impact on marine biodiversity⁴⁸. For example:

- The waters of Gulf St Vincent are warmer than the surrounding Southern Ocean and characterised by a unique flora and fauna. Warming of these waters poses a unique challenge where the full range of the current species may no longer be able to persist in the Region, yet species more tolerant of warmer conditions may be unable to migrate to the Region;
- Ocean acidification is expected to threaten calcifying marine organisms such as coral, plankton, crustaceans (e.g. crabs and prawns) and molluscs (e.g. scallops, cephalopods); and
- Changes to rainfall patterns could have a major impact on sea grass. Low rainfall combined with an increased frequency of intense rainfall events can have an adverse impact on marine biodiversity. This is because if rivers and creeks are not regularly "flushed" and an intense rainfall event occurs there will most likely be a higher nutrient load released to the Gulf compared to regular flows with lower nutrient loads.

Stress from changing temperatures, acidification and pollution will create ecological disturbances in the marine ecosystem. Marine pest plants and animals by their nature are less likely to be sensitive to climate change impacts than native species. Declining native species diversity and distribution will likely result in increases in the population size and distribution of pest plant and animal species.

⁴⁶ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁴⁷ Environment Protection Authority (2013) *Adelaide Coastal Water Quality Improvement Plan*

⁴⁸ Resilient South (2014d) *IVA Technical Report – Resilient South*

How can we respond to the impacts of climate change on marine biodiversity?

The marine biodiversity pathway (refer Figure 4-8) shows four preferred options that all require implementation now and form the current preferred pathway.

Research: More information is required about the potential impacts of climate change on the marine environment. Research needs to focus on the sensitivity and adaptive capacity of key marine species (e.g. seagrasses and kelp) to climate change impacts including research into the effects of individual stressors (e.g. increased temperatures) and multiple stressors (e.g. increased temperature and intensity of rainfall). Figure 4-9 shows benthic habitat including locations of seagrass communities.

Management plans: Management plans will provide an important tool to help respond to climate change and must consider emerging issues. Stormwater Management Plans and Water Quality Improvement Plans have scope to consider impacts on the receiving environment including marine biodiversity. Figure 4-9 shows locations where there is a high density of stormwater outlets that may be the focus for end of pipe management. More effort is required to develop marine pest plant and animal management plans.

Threat reduction: While better understanding the precise impacts of climate change on marine biodiversity in the Region requires further research, work can commence now to reduce non-climate change threats by further reducing stormwater and wastewater discharges and managing the potential spread of marine pest plant and animal species.

The best mix of adaptations options and whether new actions should be considered and in what sequence should be reviewed within 10 years once the results of further research becomes available.

Additional engagement is required in future adaptation planning projects to further develop this pathway.

Summary of preferred options for protecting marine biodiversity

Now

- Research;
- Address marine biodiversity in water management plans;
- Marine pest and plant animal management plan; and
- Reduce non-climate change threats to marine biodiversity.

Within 10 years

- Reassess potential climate impacts and adaptation options once the result of further research becomes available.

Figure 4-9 identifies where these preferred options might apply spatially for the Southern Region

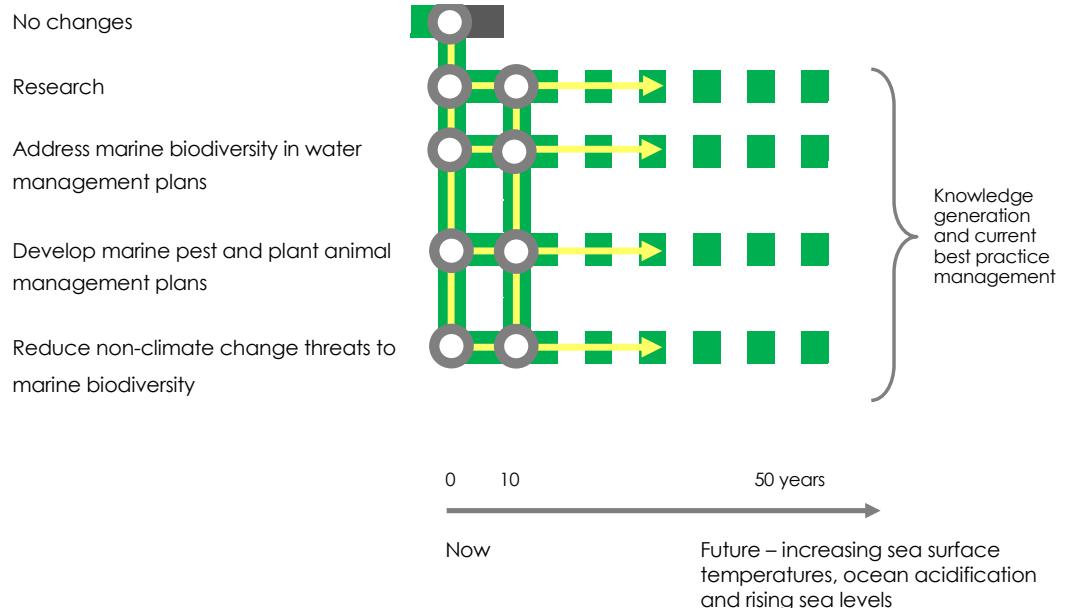
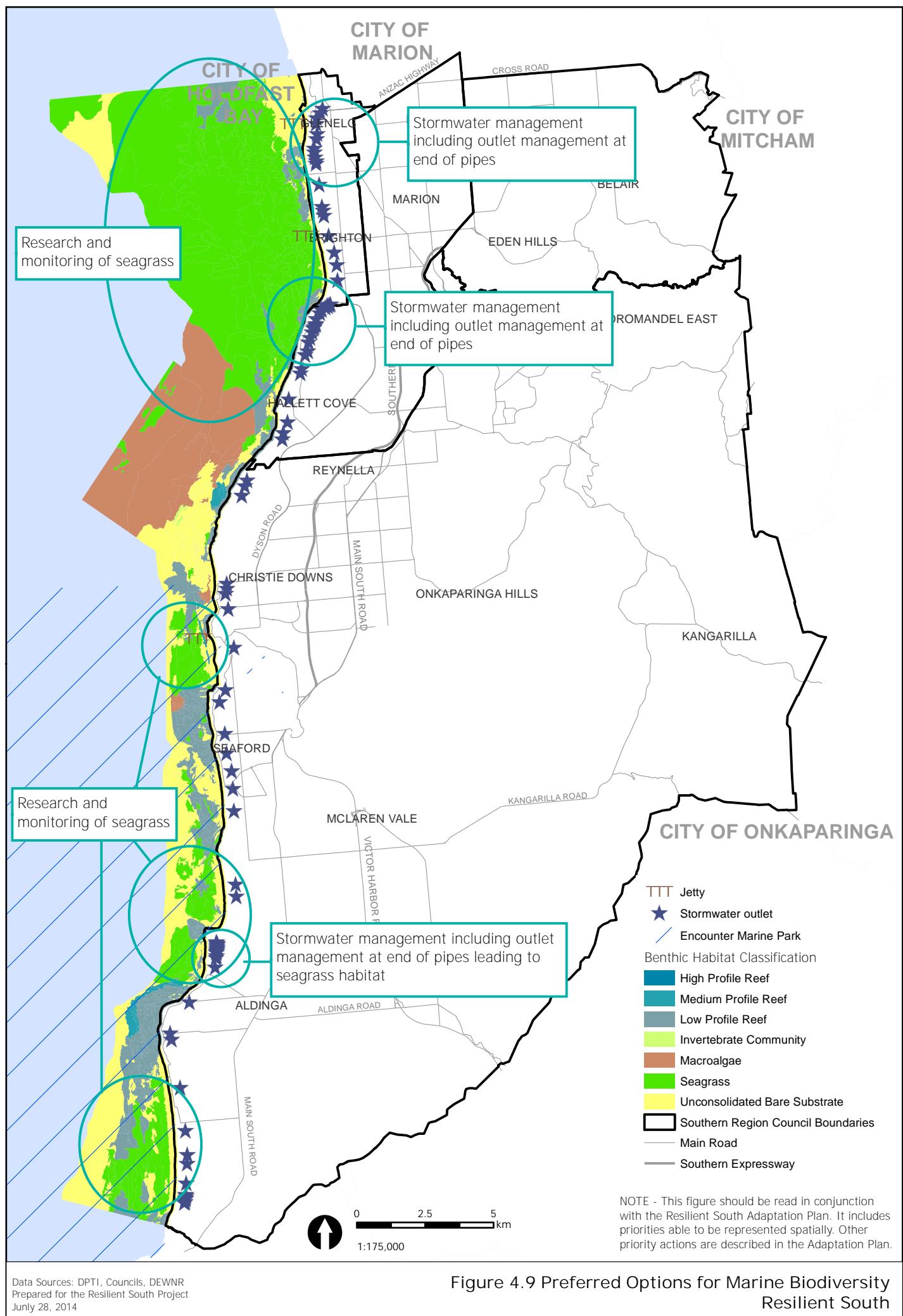
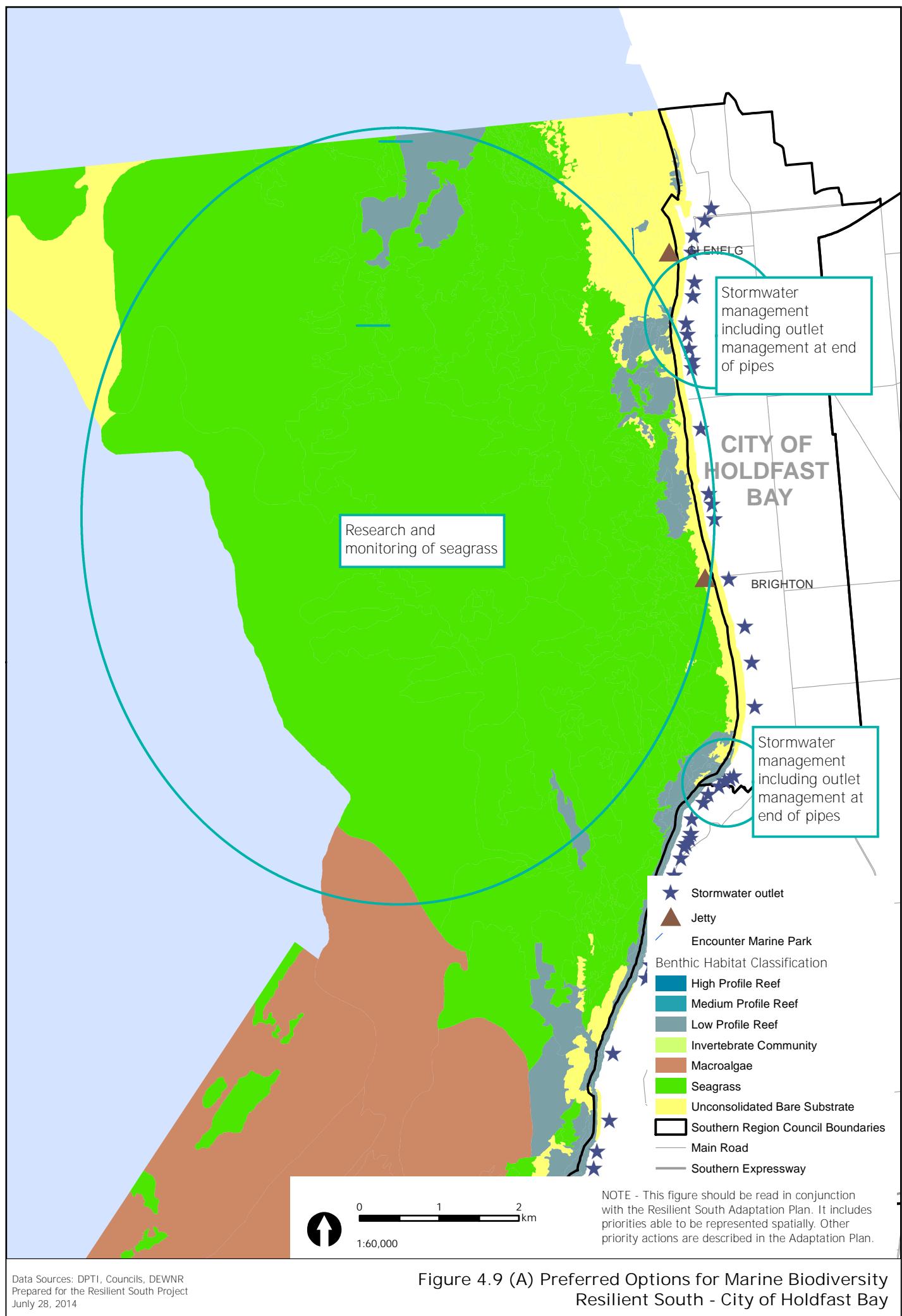


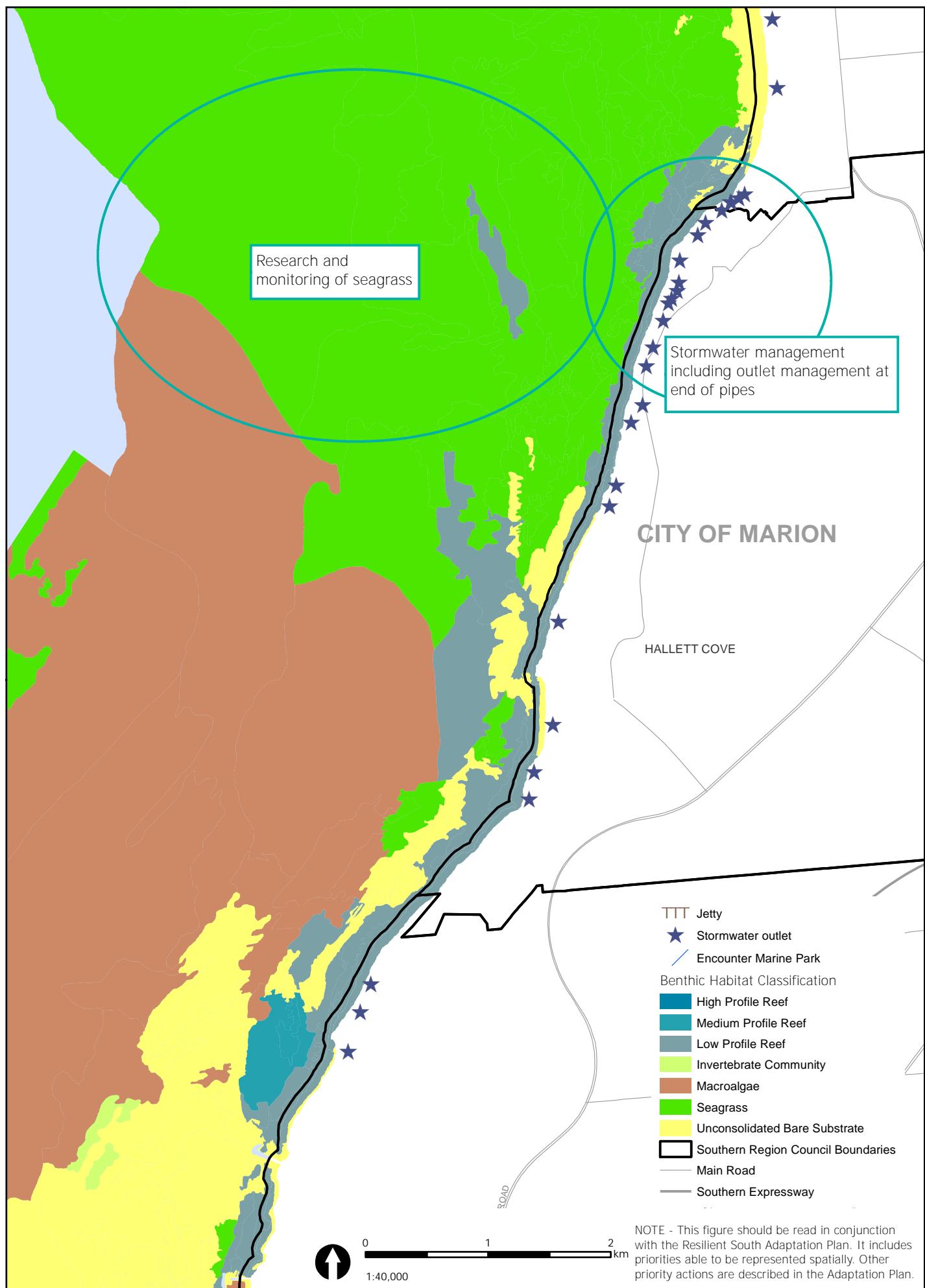
Figure 4-8: Marine biodiversity pathway

See Figure 4-1 for an explanation of how to interpret this figure.

- [Green bar] Time period over which an option can usefully address the key decision area
- [Light green bar] Time before an option is implemented during which preparatory work is required
- [Three green squares] An option that contributes to the adaptation solution but only in part
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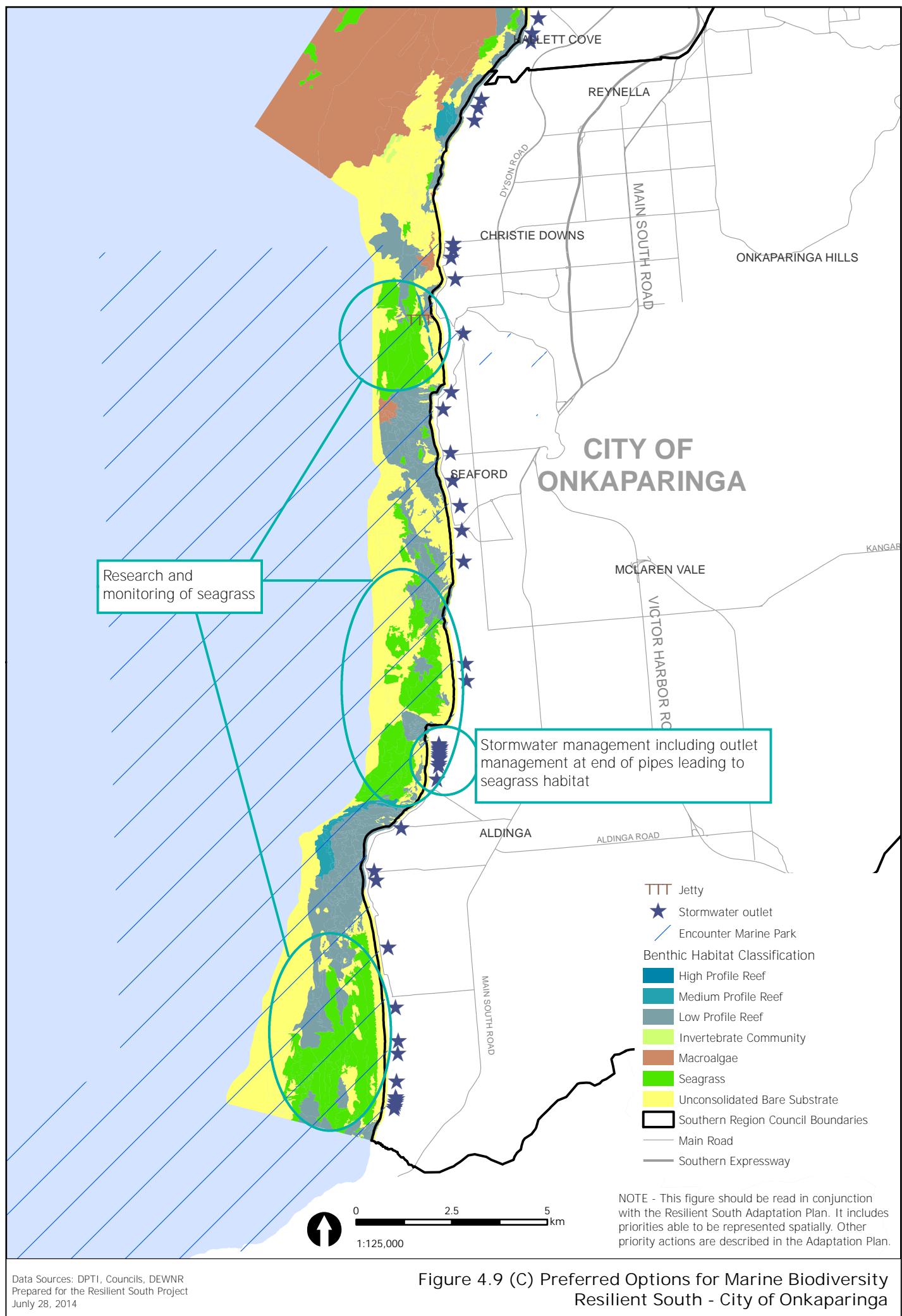






Data Sources: DPTI, Councils, DEWNR
Prepared for the Resilient South Project
July 28, 2014

Figure 4.9 (B) Preferred Options for Marine Biodiversity
Resilient South - City of Marion



4.8 Vulnerable members of the community

Key area of decision making

How do we support and facilitate the safety and wellbeing of vulnerable members of our community so that they are more resilient in the face of more frequent intense rainfall events, more frequent bushfires and heatwaves, increased temperatures and increased risk of coastal inundation as a result of sea level rise?

Why is supporting vulnerable members of the community important?

Members of the community who are already vulnerable due to isolation from transport services, poor health and dependence on others for care and mobility (such as frail aged, children and those people receiving support from social services) will be more vulnerable to climate change impacts, particularly during extreme events. These may be impacts on access to health care services and school attendance rates.

Areas where more than 50% of the resident population is over 65 years old are located in the northern areas of the City of Marion and western areas of the City of Mitcham⁴⁹. In contrast, nearly 60% of areas in the City of Onkaparinga have more than 25% of the resident population aged 0-19 years. Supporting and facilitating the safety and wellbeing of vulnerable members of the community is a priority for Project Champions in the Region⁵⁰.

'Preparing for Climate Change' is also a priority of the SA Public Health Plan.

How will climate change impact vulnerable members of the community?

The IVA found that without adaptation climate change will adversely impact vulnerable members of the community in the Region, and that impacts associated with climate change will further exacerbate existing vulnerability⁵¹. The types of impacts will vary between council areas as climate risks change from the hills to the plains and coast.

Heatwaves

Heatwaves are of significant concern across the entire Region for vulnerable members of the community and are known to cause greater morbidity and mortality than other climate extremes. Access to heat refuges or cooler (air conditioned) places is an essential part of **people's adaptive capacity under such circumstances**. Yet many elderly people and those reliant on assistance for core activities in particular may not have access to air-conditioning or the ability to finance its use, may live in non-climate sensitive housing or may not be mobile enough to access heat refuges or other support services when needed. School attendance rates can also be negatively impacted by heatwaves, although schools are sometimes seen as heat refuges for people with insufficient cooling in their home.

Bushfires

Some older people living independently find it more difficult to maintain properties to reduce bushfire risk and may need to rely on community bushfire response plans. People living in bush fire risk zones that are geographically isolated from transport face similar risks as older people with low mobility. In contrast, while children under 12 years may be more mobile

⁴⁹ Resilient South (2014a) *Regional Profile – Resilient South*

⁵⁰ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁵¹ Resilient South (2014d) *IVA Technical Report – Resilient South*

and likely to be taken to safe havens, they are also more impacted by smoke and likely to experience psychological impacts from bushfire events which may in turn impact school attendance rates during and after bushfires.

Flooding

Increased flood risk either from more frequent, intense rainfall events or rising sea levels and storm surge will impact people that are less mobile in the community, including people aged over 65 years and those geographically isolated from transport.

How can we respond to the impacts of climate change on vulnerable members of the community?

The vulnerable members of the community pathway (refer Figure 4-10) shows a range of preferred adaptation options. All but one of these options have been identified by Project Champions for immediate acceleration, emphasising the need for an urgent response.

Accelerating current best practice and protection strategies

A number of preferred options are already considered best practice and require further expansion, including:

- Supporting service systems to assist the young, elderly/frail aged and those reliant on assistance for core activities;
- Developing emergency management plans such as the Red Cross Emergency REDiPlan which provides people with general information to help them prepare for an emergency;
- Facilitating access to counselling and trauma services;
- Recognising the role of carers; and
- Supporting non-government organisations which provide many of these services.

Emergency management planning and building social connectivity were also considered current best practice activities that require further support and expansion (Section 4.9 further describes emergency services adaptation actions). Building social connectivity can be achieved in a number of ways including education and awareness raising about the health impacts of climate hazards and how to prepare for and recover from extreme events, developing a culture of civic leadership and community action, building social participation, protecting and promoting individual health and well being, and encouraging collaboration to enhance formal and informal support networks. Project Champions strongly encouraged diverse thinking on how to raise awareness and suggested greater use of social media, engagement with special interest groups and State-wide advertising campaigns.

Figure 4-11 identifies areas of higher vulnerability (e.g. higher proportion of population aged over 65 years, low income, low educational attainment, aged living facilities and schools) where education and awareness programs could be targeted regarding flooding, heatwave and bushfire.

Other adaptation options to protect vulnerable members of the community include:

- Provision of essential services subsidies to offset the full cost of electricity as a way to support people on low incomes to use air-conditioners or other cooling strategies during heat waves. Essential services adaptation actions are described further in Section 4.8;

- Utilising and expanding existing technology for emergency situations such as existing services like the Red Cross Telecross service, which checks on the well being of isolated people with a daily phone call;
- Establish emergency response centres and provide assisted transport such as for elderly people and young children and/or students; and
- Developing and maintaining a vegetated public realm to create climate resilient neighbourhoods, reduce the impacts of the urban heat island effect, and contribute to the health and wellbeing of communities.

Figure 4-11 shows:

- Areas with lowest income households which could be supported through essential services subsidies; and
- Libraries and major shopping centres which may provide relief from extreme heat.

Figure 4-12 shows areas with highest vulnerability to heatwave and increased presentation at hospital emergency departments on hot days adapted from research into heatwave vulnerability in Australian cities⁵². These areas could be targeted for public realm vegetation.

Emerging protection strategy

Fundamental to re-thinking how to support and facilitate the resilience of vulnerable members of the community is encouraging climate sensitive housing and infrastructure, including the incorporation of alternative energy sources. Implementation of this option should commence within 10 years. Not only will this benefit vulnerable members of the community but if adopted more broadly could result in more climate resilient urban development. This could be achieved through increasing solar rebates and rewarding ecofriendly households and businesses. Preparatory work needs to commence now to determine how best to encourage design and construction of climate sensitive housing and infrastructure.

Summary of preferred options for supporting and facilitating the resilience of vulnerable members of the community to the impacts of climate change:

Now

- Support for service systems to assist the young, elderly/frail aged and those reliant on assistance for core activities;
- Develop emergency management plans;
- Education, awareness raising, cultural change and building social connectivity;
- Provide essential services subsidies;
- Continue to develop technology for emergency situations;
- Establish emergency response centres and provide assisted transport; and
- Develop and maintain vegetated public realm.

⁵² Loughnan, M., N. Tapper, et al. (2013). *A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities*, pp.128.

Within 10 years

- Construct climate sensitive development.

Preparatory work

- Investigate ways to support adoption of climate sensitive development.

Figures 4-11 and 4-12 identify where these preferred options might apply spatially for the Southern Region.

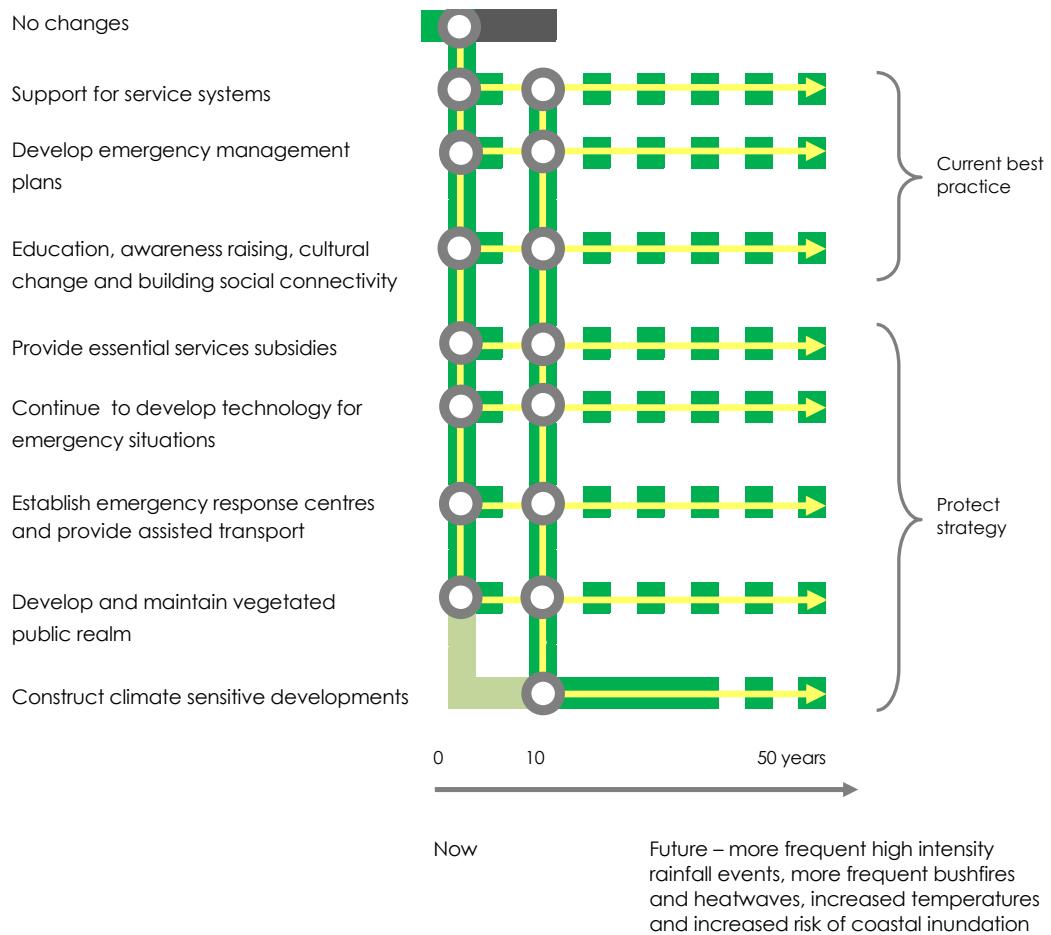
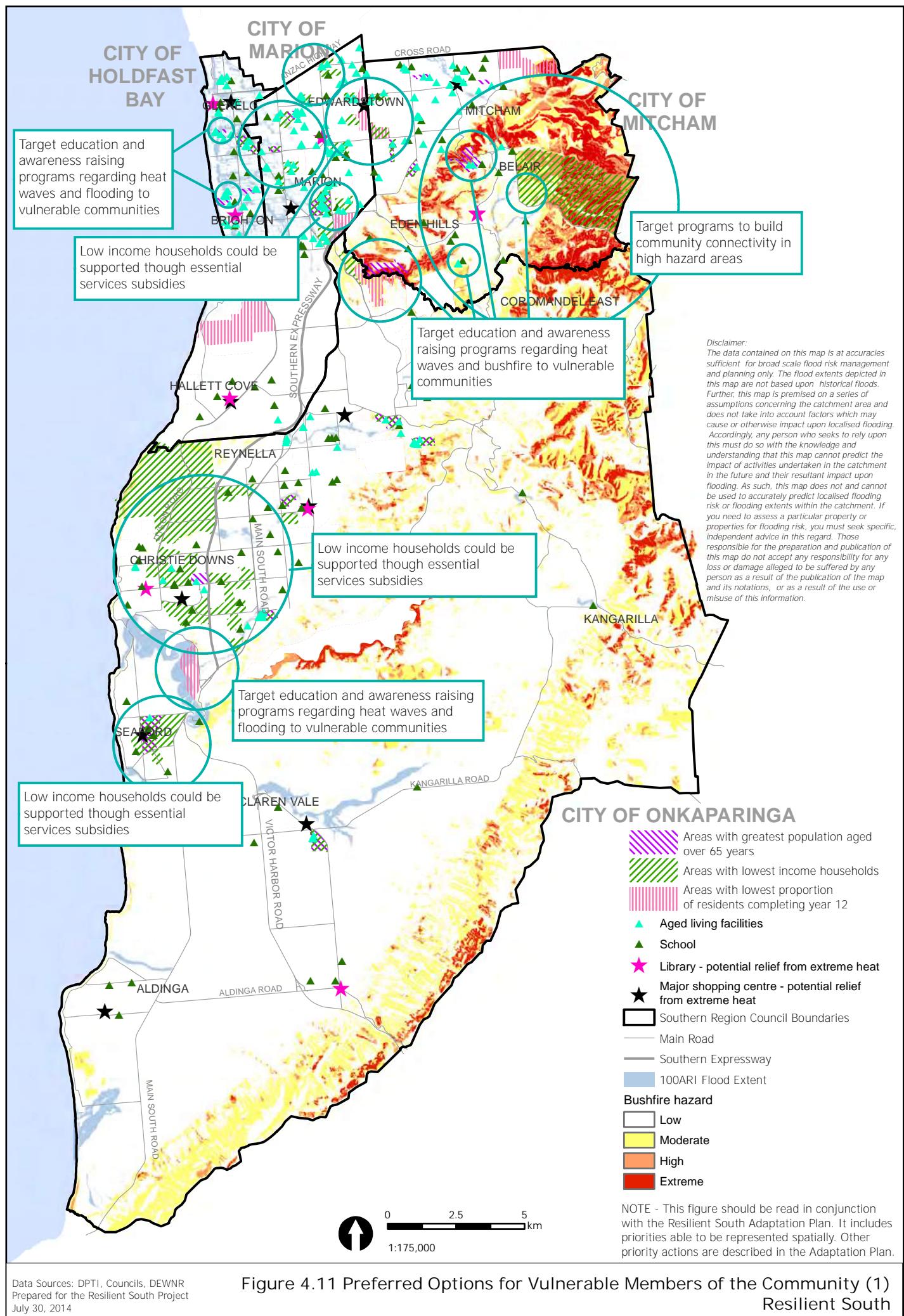
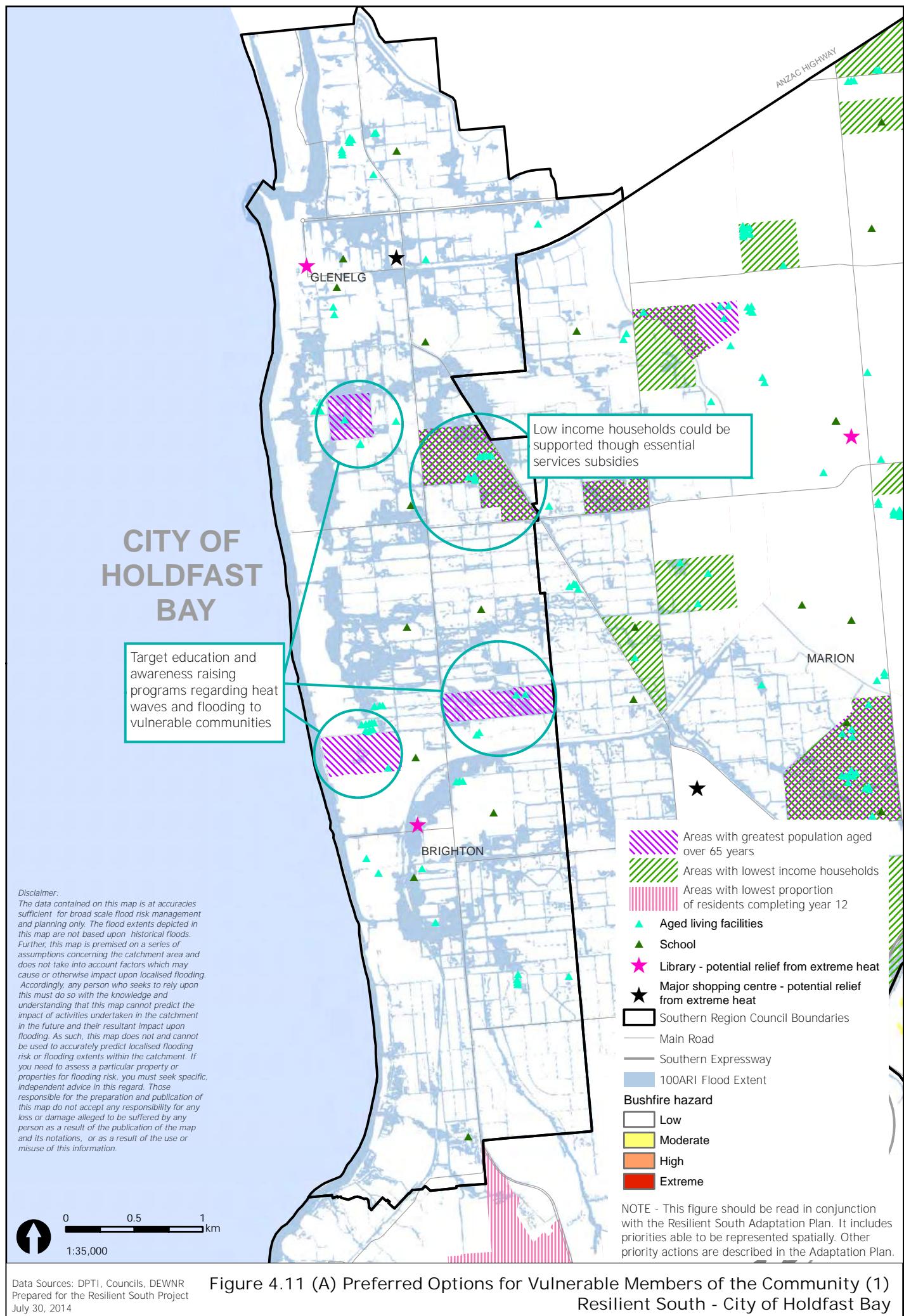


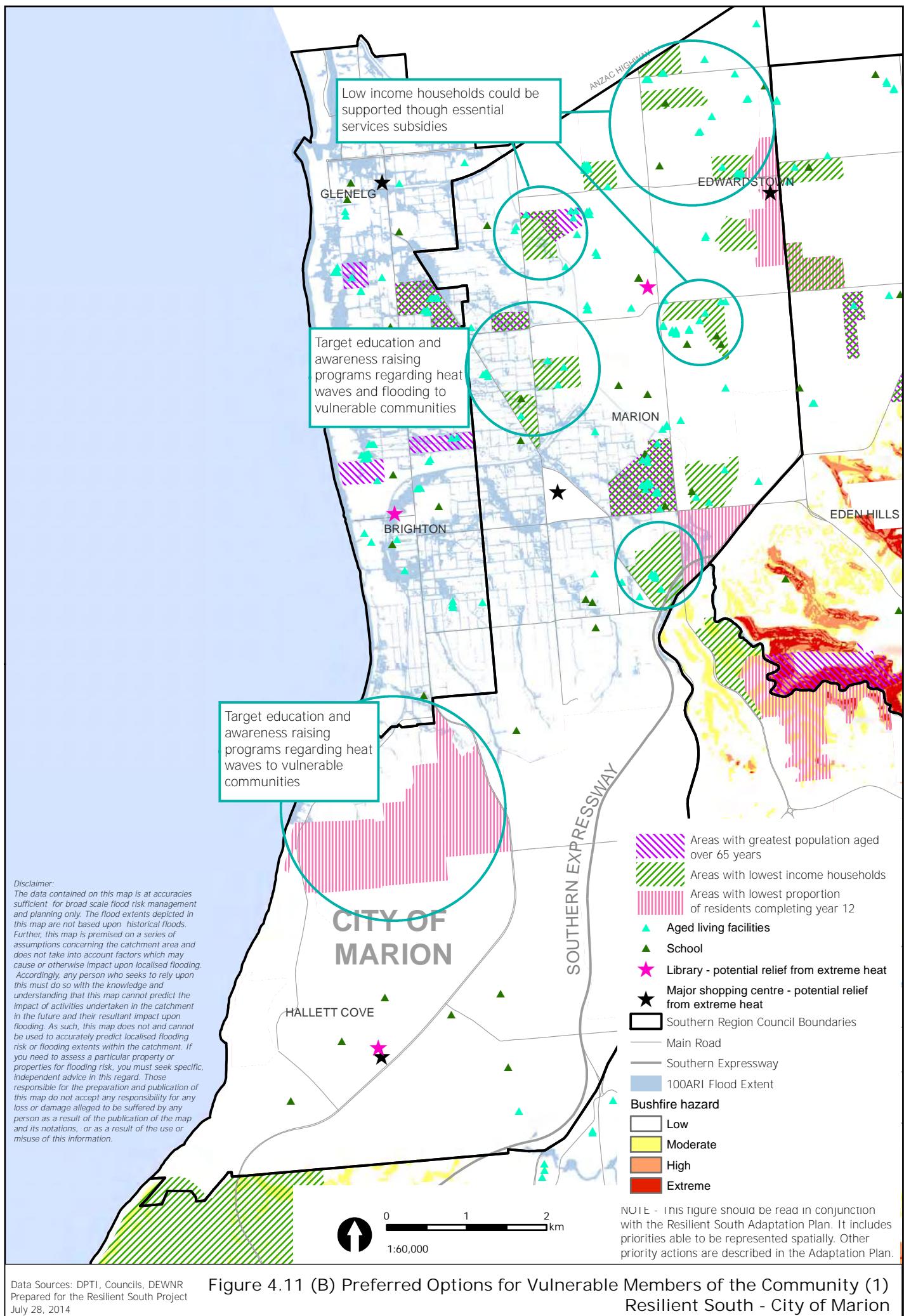
Figure 4-10: Vulnerable members of the community pathway

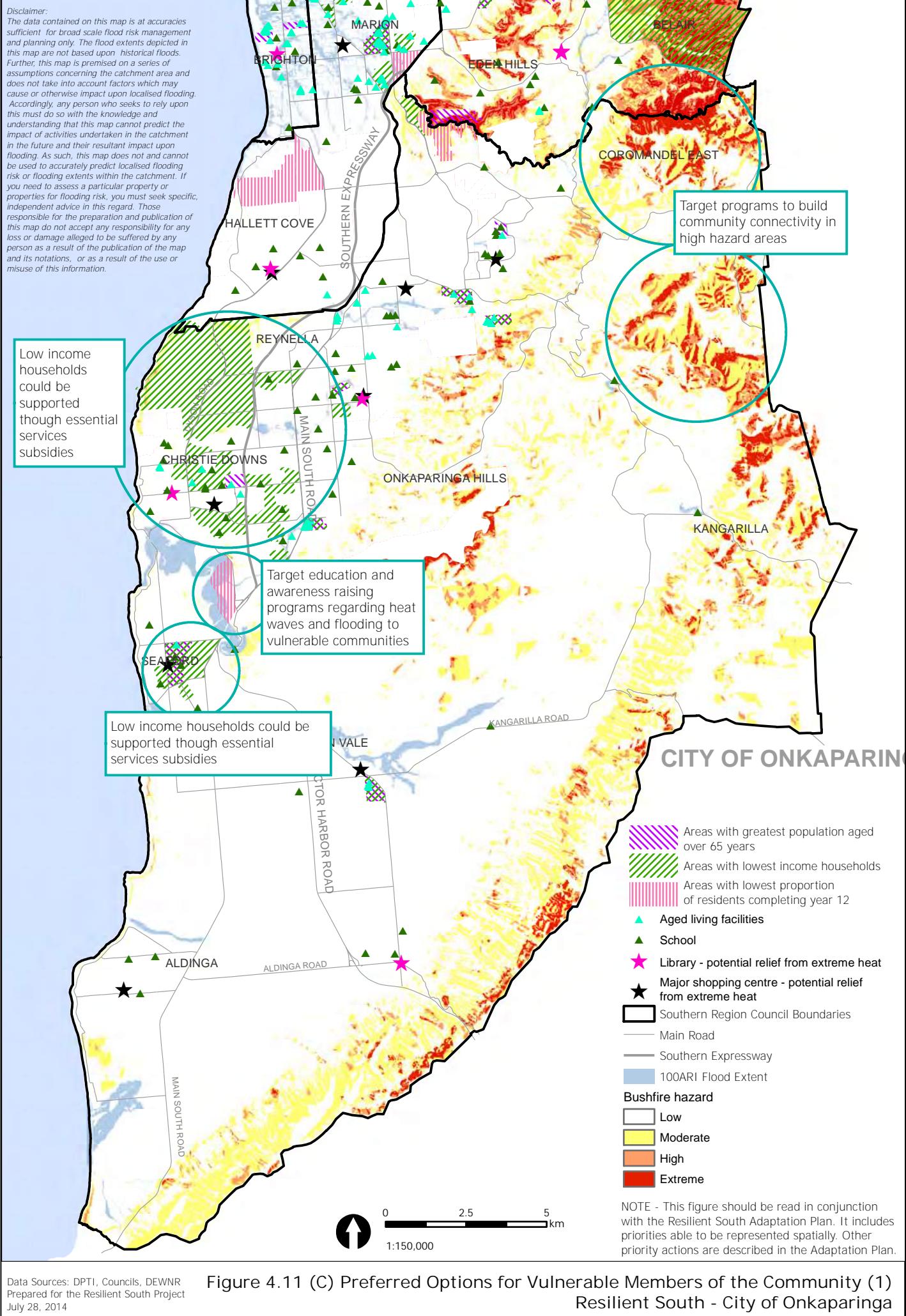
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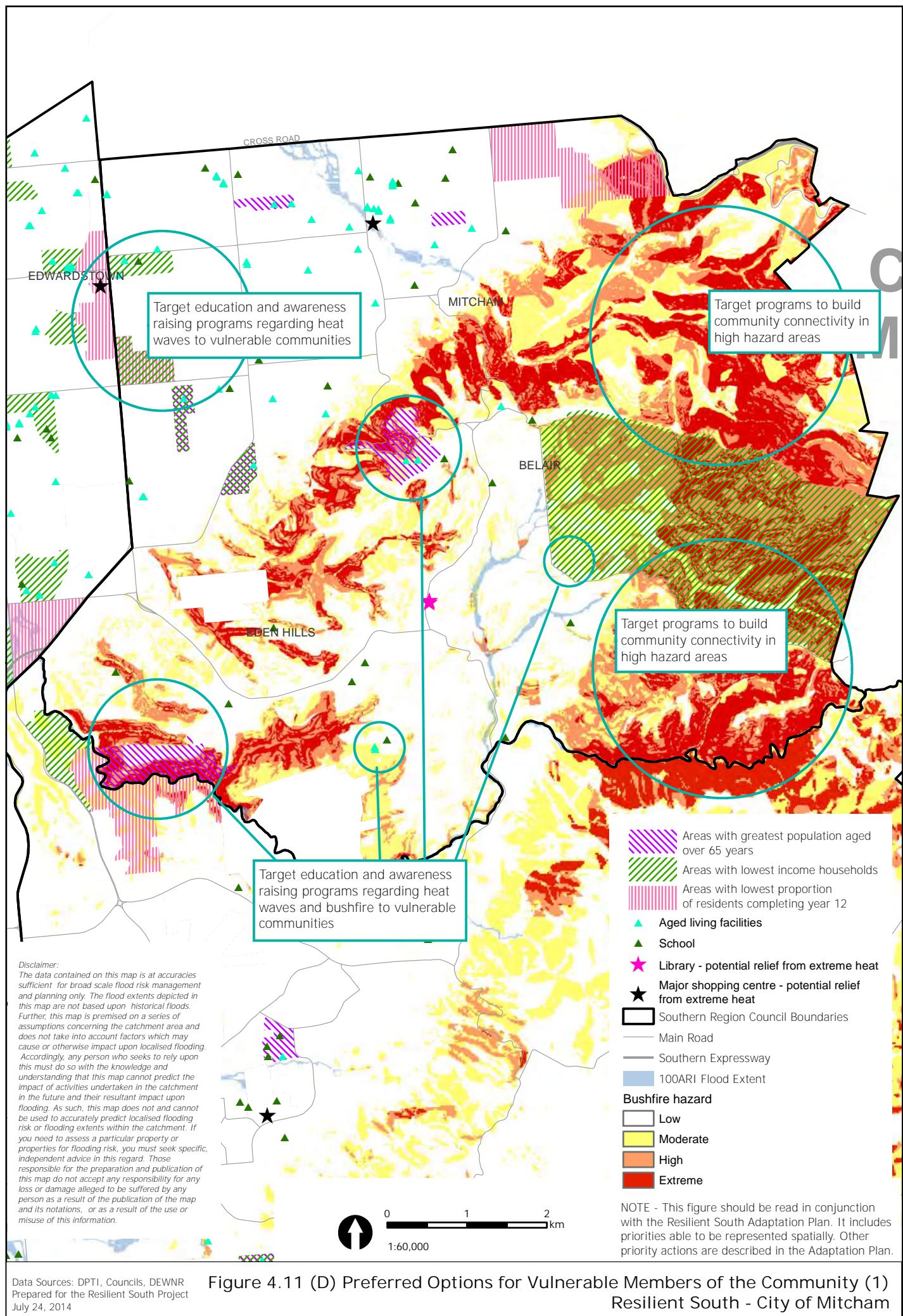
- Time period over which an option can usefully address the key decision area
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 - An option that contributes to the adaptation solution but only in part
 - An option that is not favoured
 - An option that is not preferred but that would require preparatory work if pursued
 - When decision makers may need to choose between different options
 - Preferred pathway as identified by Project Champions

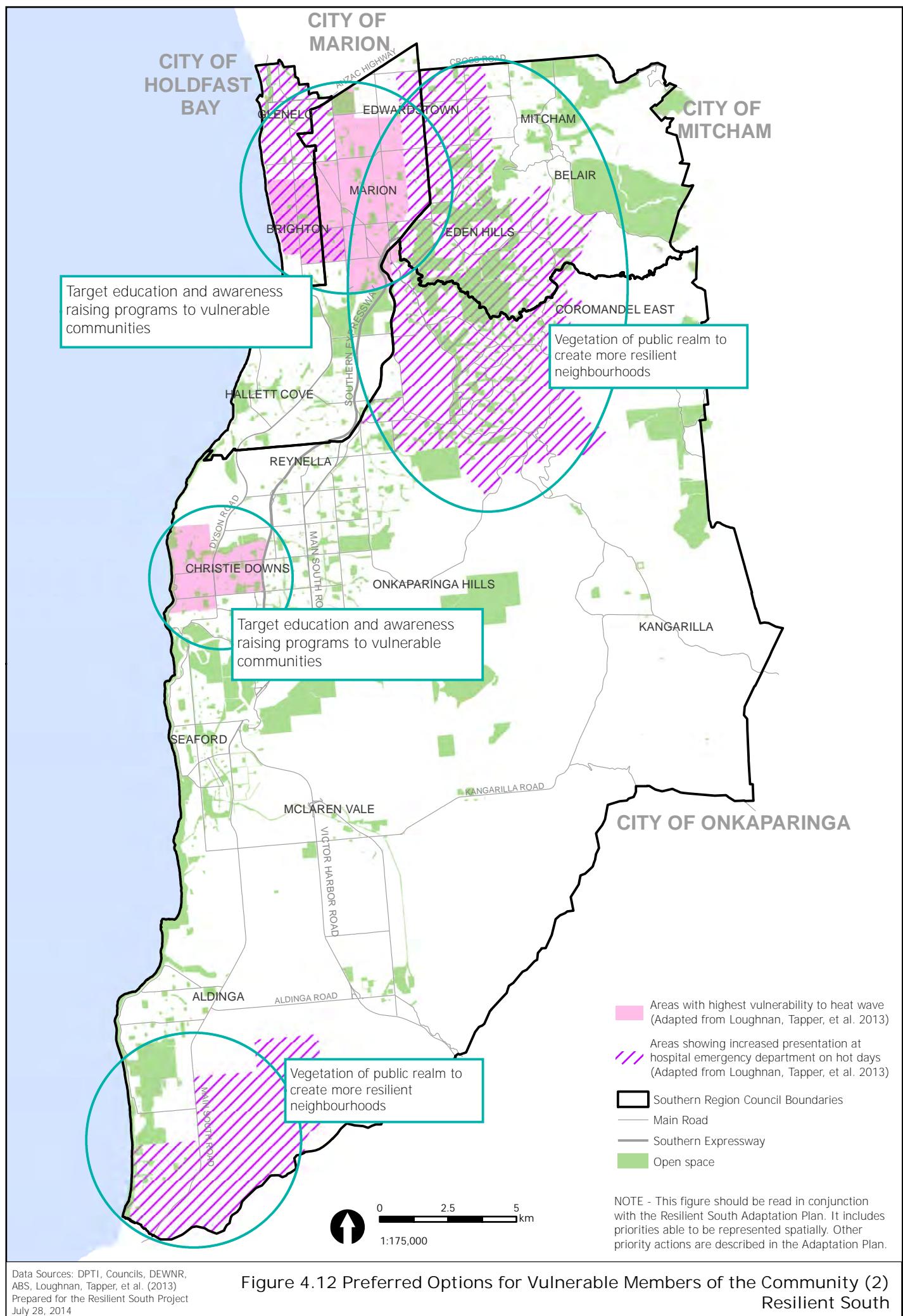


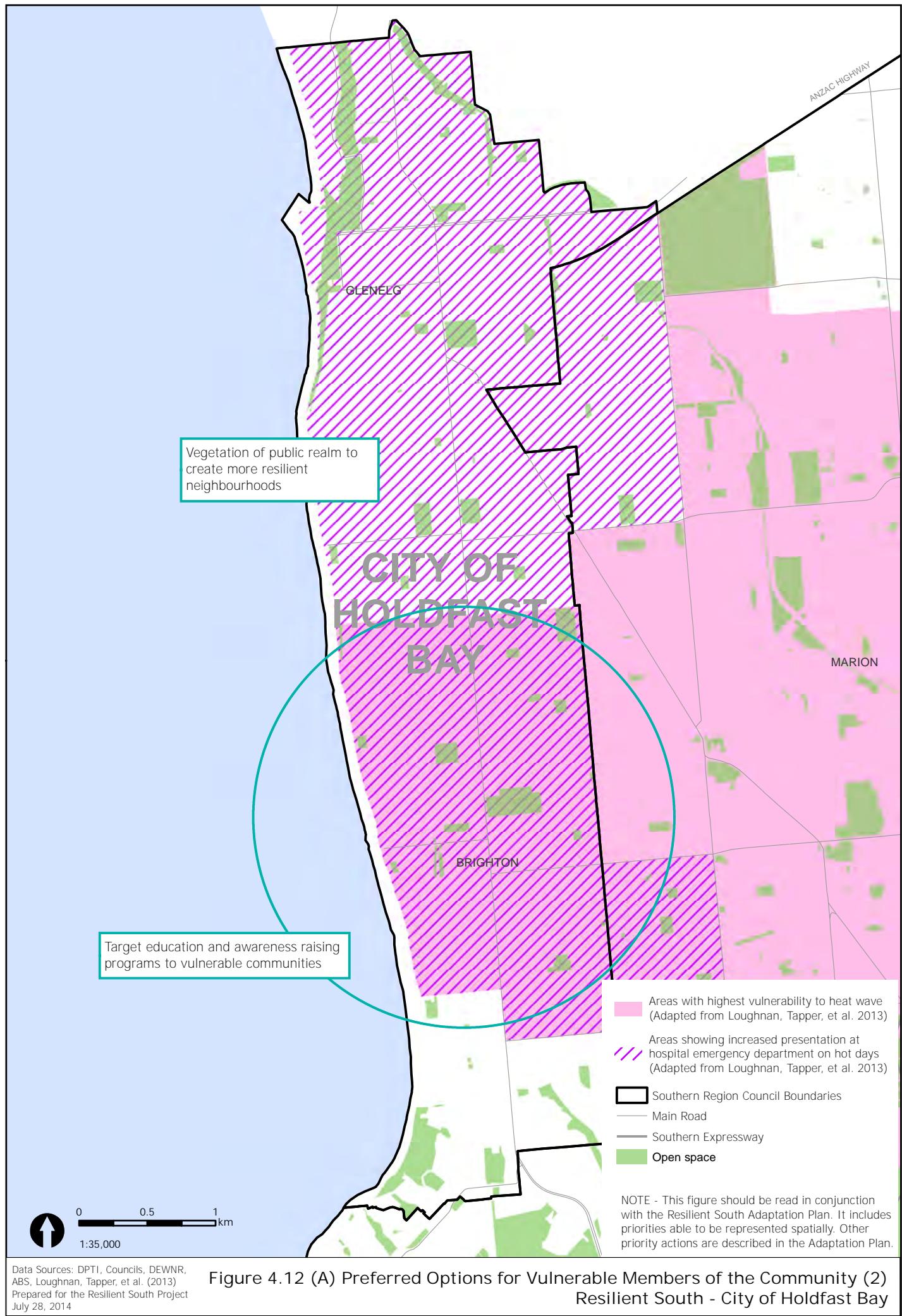


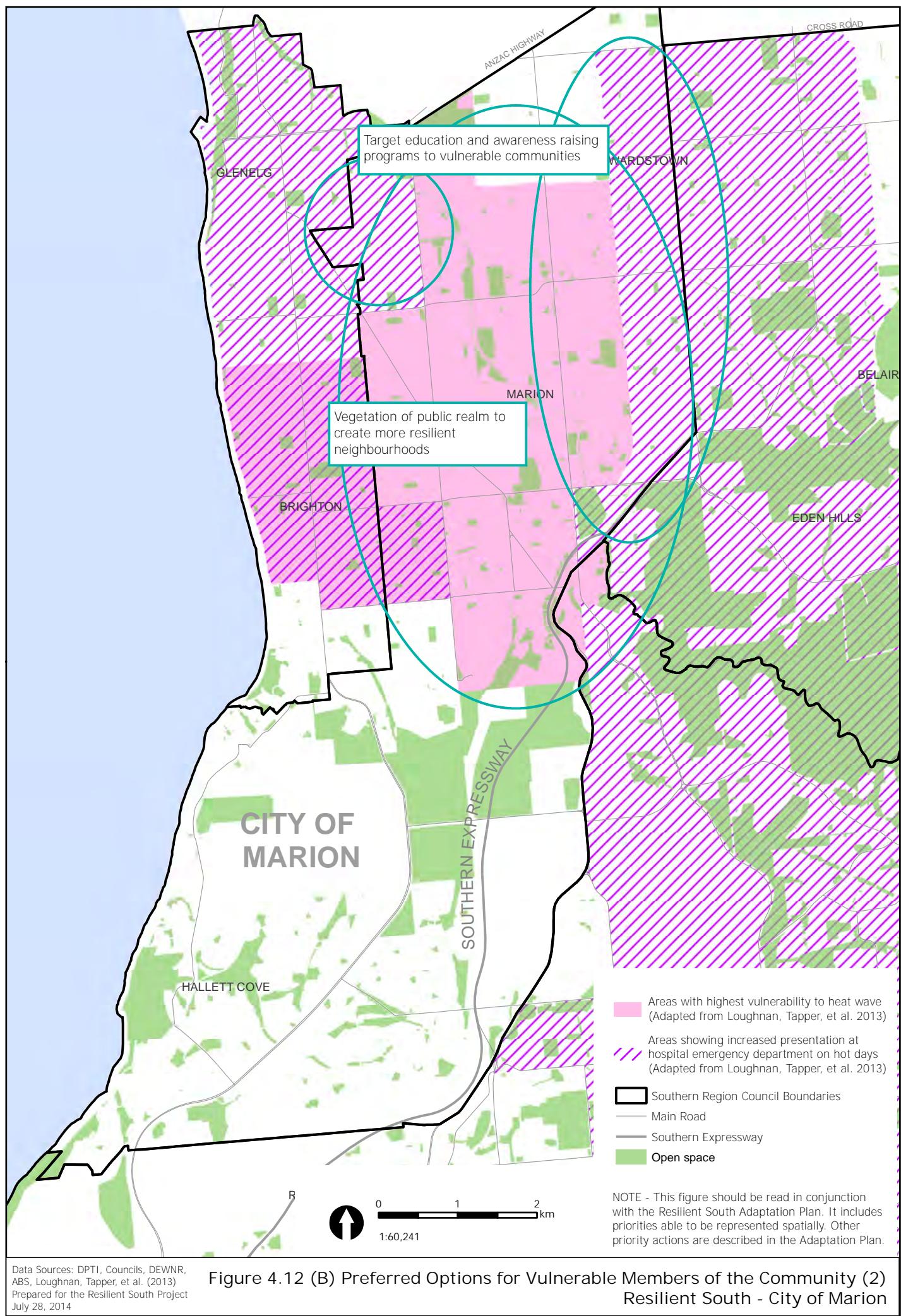


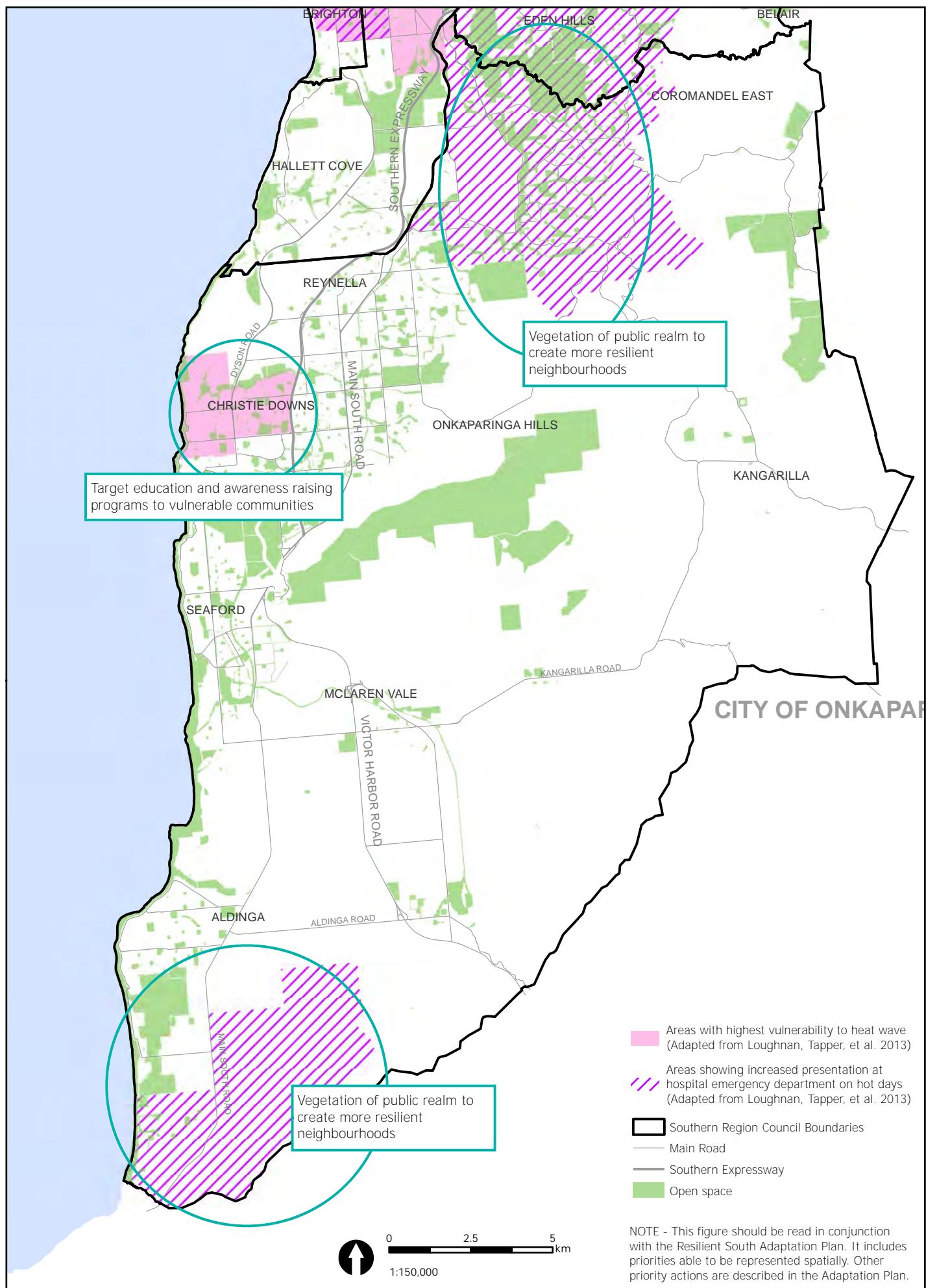


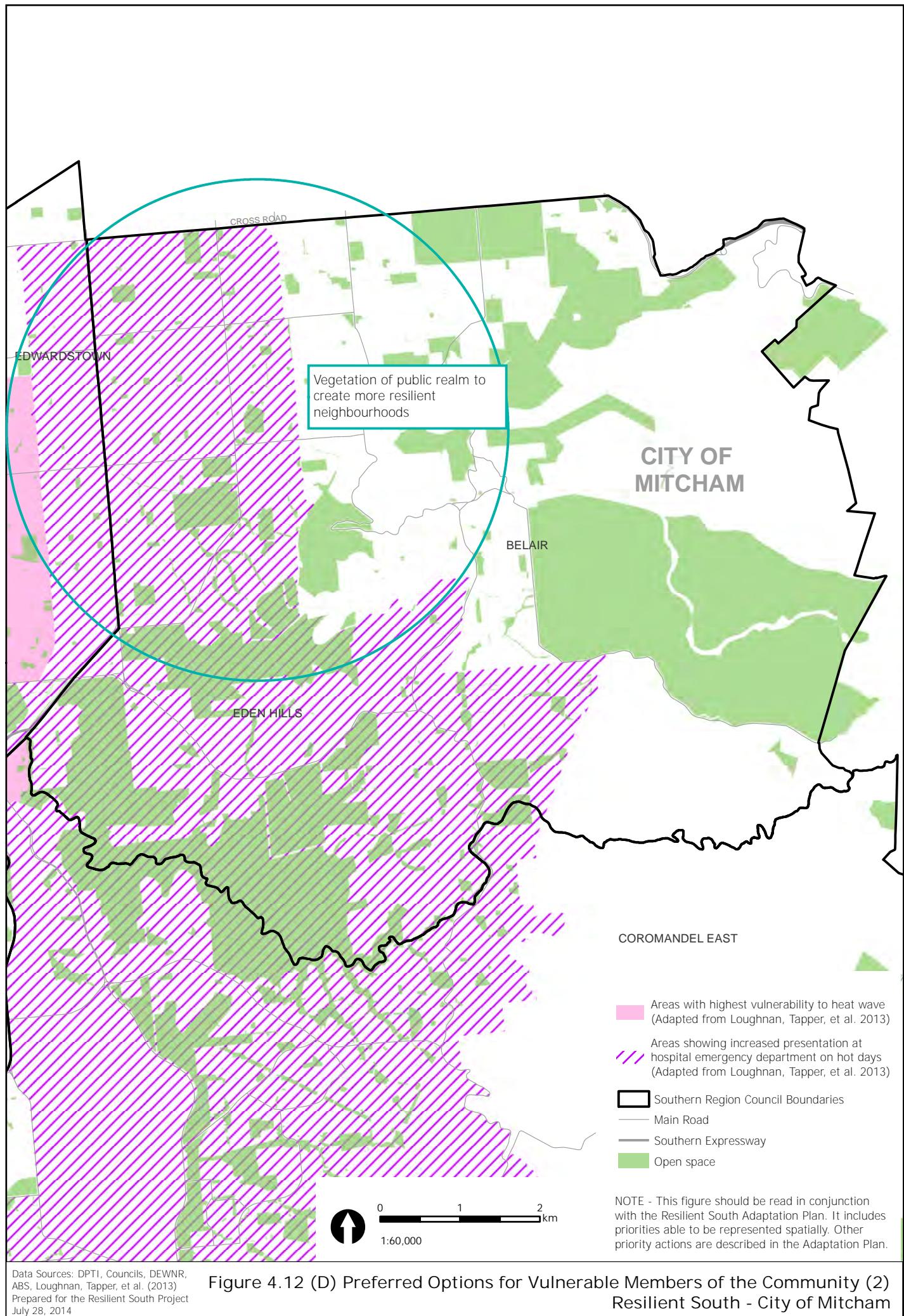












4.9 Emergency services

Key area of decision making

How can we better manage demand for emergency services given more frequent intense rainfall events, more frequent bushfires and heatwaves and increased risk of coastal inundation as a result of sea level rise?

Why is managing the demand for emergency services important?

Emergency services are highly valued in the Southern Region and are essential for the functioning of the community, protecting vulnerable members of the community (e.g. people with existing medical conditions) and protection of the economy of southern metropolitan Adelaide⁵³. The Region is well served by the emergency services sector with SA Ambulance Services, Country Fire Services, Metropolitan Fire Services, SA Police, State Emergency Services (SES), St John Ambulance and Surf Life Saving Clubs located across the area.

Work undertaken by SA Health⁵⁴ found that increased ambulance call-outs, heat-related hospital and emergency presentations and mental and renal health outcomes are of particular concern for the Southern Region during heat waves. These findings tie in with physiological, age-related, behavioral and cognitive factors that are known to contribute to health problems during extreme heat.

How will climate change impact the demand for emergency services?

The IVA found that climate change will increase the demand for emergency services in the Southern Region⁵⁵. This will place pressure on already stretched resources that are often dependent on an aging and declining group of volunteers. This finding is important given that one of the broader aims of the Resilient South Adaptation Planning project is to improve emergency response capabilities relevant to climate change impacts.

Bushfire was the major climate risk identified by Project Champions as having the potential to increase demand for emergency services. Fire risk (measured using the FFDI⁵⁶) is projected to increase in the future with, for example, the number of very high fire risk days increasing by 41% by 2070. High bushfire hazard zones in the Region exist in:

- Areas around Belair National Park;
- The upper parts of the Sturt River (which is the boundary between Mitcham and Onkaparinga);
- Flagstaff Hill;
- The Onkaparinga Gorge, between Clarendon and Mount Bold; and
- Along the Willunga Escarpment.

Another climate factor that will increase demand for emergency services is heatwaves, which will increase significantly in frequency and duration by 2070⁵⁷. While there is some ability to cope with periodic increases in demand for health services during heatwaves (e.g. additional

⁵³ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁵⁴ Resilient South (2014a) *Regional Profile – Resilient South*

⁵⁵ Resilient South (2014d) *IVA Technical Report – Resilient South*

⁵⁶ The Forest Fire Danger Index (FFDI) provides an estimate of fire risk based on factors like temperature, humidity, wind speed, fuel load and slope.

⁵⁷ Resilient South (2014) *Climate Change Scenarios Report – Resilient South*

ambulance staff put on to address increased call outs), demand is likely to exceed the capacity to respond, particularly if the frequency and duration of heatwaves increases.

Increasing intensity of rainfall events may also increase demand for SES services as flooding of low lying areas and alongside watercourses becomes more frequent (see also Section 4.4 for water resource management impacts and adaptation options). A more significant potential flooding risk though will come from rising sea levels and increased coastal inundation. Without adaptation, it can be expected that increased flooding of low lying infrastructure, public realm and open space will occur during storm surge events which will increase the demand for emergency services.

How can we manage the demand for emergency services?

The emergency services pathway (refer Figure 4-13) shows a range of adaptation options, with four being identified as preferred options to be progressed for the Region. All are considered part of current best practice management:

Community connectivity, communication, education, awareness and preparation: Improving community connectivity, communication, education, awareness and preparation provides individuals with greater capacity to manage their own risk and if emergency situations are avoided reduces demand on emergency service providers. This is an appropriate strategy for flood, fire and heatwave risk and can build on existing strategies already adopted by emergency services providers and Local Government. Figure 4-14 identifies areas of higher flood and bushfire risk where education and awareness and community connectivity programs could be targeted.

Development Plan policy: Reviewing and amending Development Plans can provide policies to:

- Restrict development in high risk areas such as ensuring that vulnerable members of the community are not housed in buildings in high risk zone e.g. aged care facilities and schools in bushfire zones; and
- Encourage development with improved resilience (e.g. by including higher floor levels in buildings in areas at flood risk or adoption of improved design guidelines that could reduce the potential urban heat island impacts that will be exacerbated by future heatwaves).

The benefits of changing Development Plan policy will take some time to take effect, with changes only applying to new development, not existing development.

Figure 4-14 shows areas of high bushfire and flood hazard where Development Plan policy review could focus.

Number of trained volunteers: As the demand for emergency services rises, the number of trained volunteers will need to increase. This will require training support for emergency services organisations and strategies to attract more volunteers.

Stormwater management: Further investment in stormwater management will be required to better manage future flood threats due to the impact of increasing stormwater run-off – a consequence of more intense rainfall events and greater run-off being generated from increasing hard surfaces as the number of medium density dwellings increases. This may be a significant issue in the inner southern suburbs. For example, a discussion paper prepared

for Holdfast Bay and Marion councils⁵⁸ found that it is likely that only 15% of the site area in future residential developments will be permeable surfaces given changing lot sizes, compared with 50% under the current situation.

Future investment should include maintenance and upgrade of existing drainage infrastructure and stormwater management infrastructure such as detention/retention basins and consolidation of recent investment in stormwater management across the Region.

Better management of stormwater represents a cross sectoral priority and opportunity for the Region because it can assist with water resources management (see Section 4.5) objectives and maintaining open space and public realm (see Section 4.10) through providing additional water for irrigation.

Summary of preferred options for managing the demand for emergency services

Now

- Improve community connectivity, communication, education, awareness and preparation;
- Review and amend Development Plan policy;
- Increase the number of trained volunteers; and
- Continue to improve stormwater management.

Preparatory work

- Undertake further investigations now to determine the most appropriate location and design requirements for stormwater management infrastructure to cope with a projected increase in flood risk

Figure 4-14 identifies where these preferred options might apply spatially for the Southern Region.

⁵⁸ Jensen Planning and Design (2011) *Discussion Paper: Development Potential within the Catchment*, prepared for Cities of Holdfast Bay and Marion

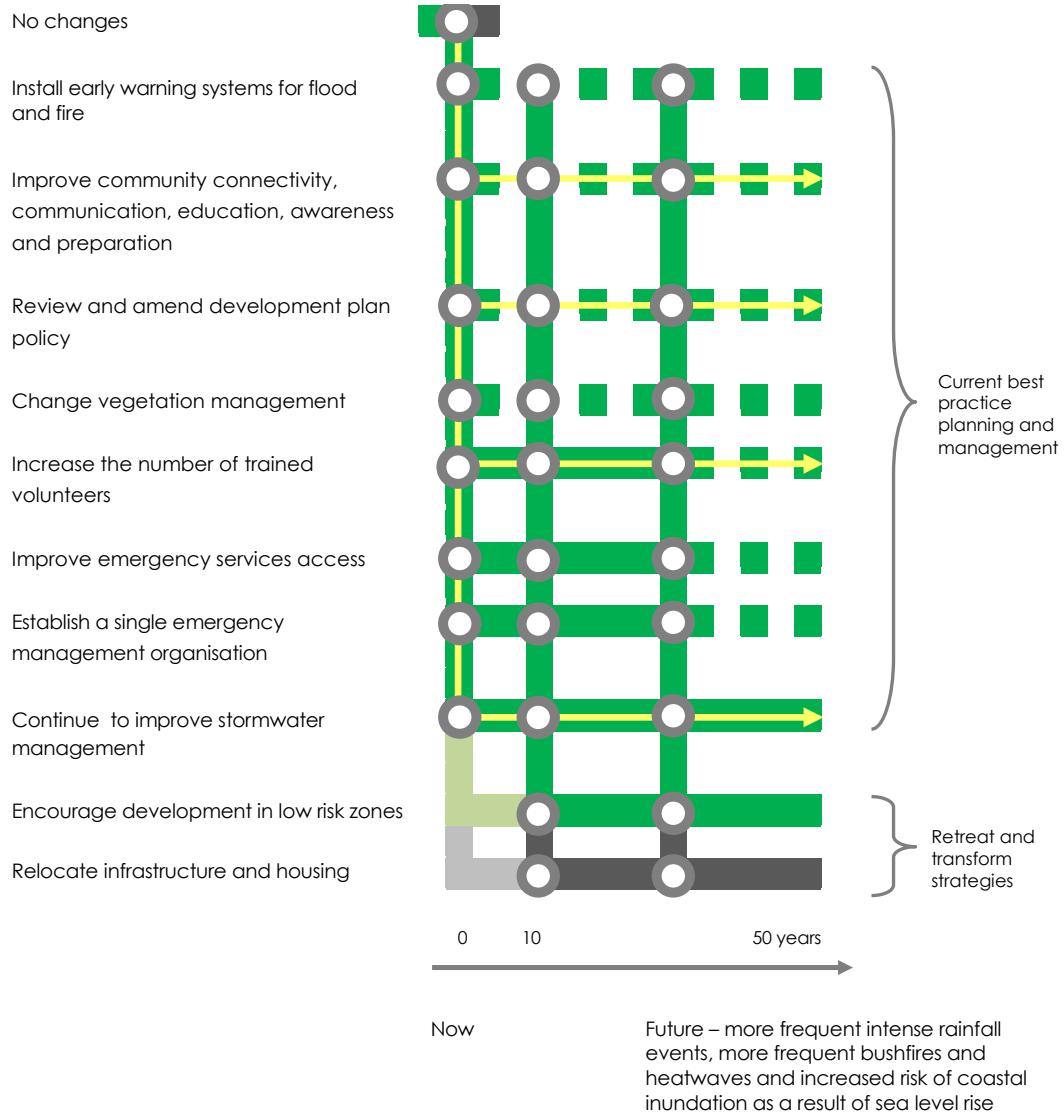
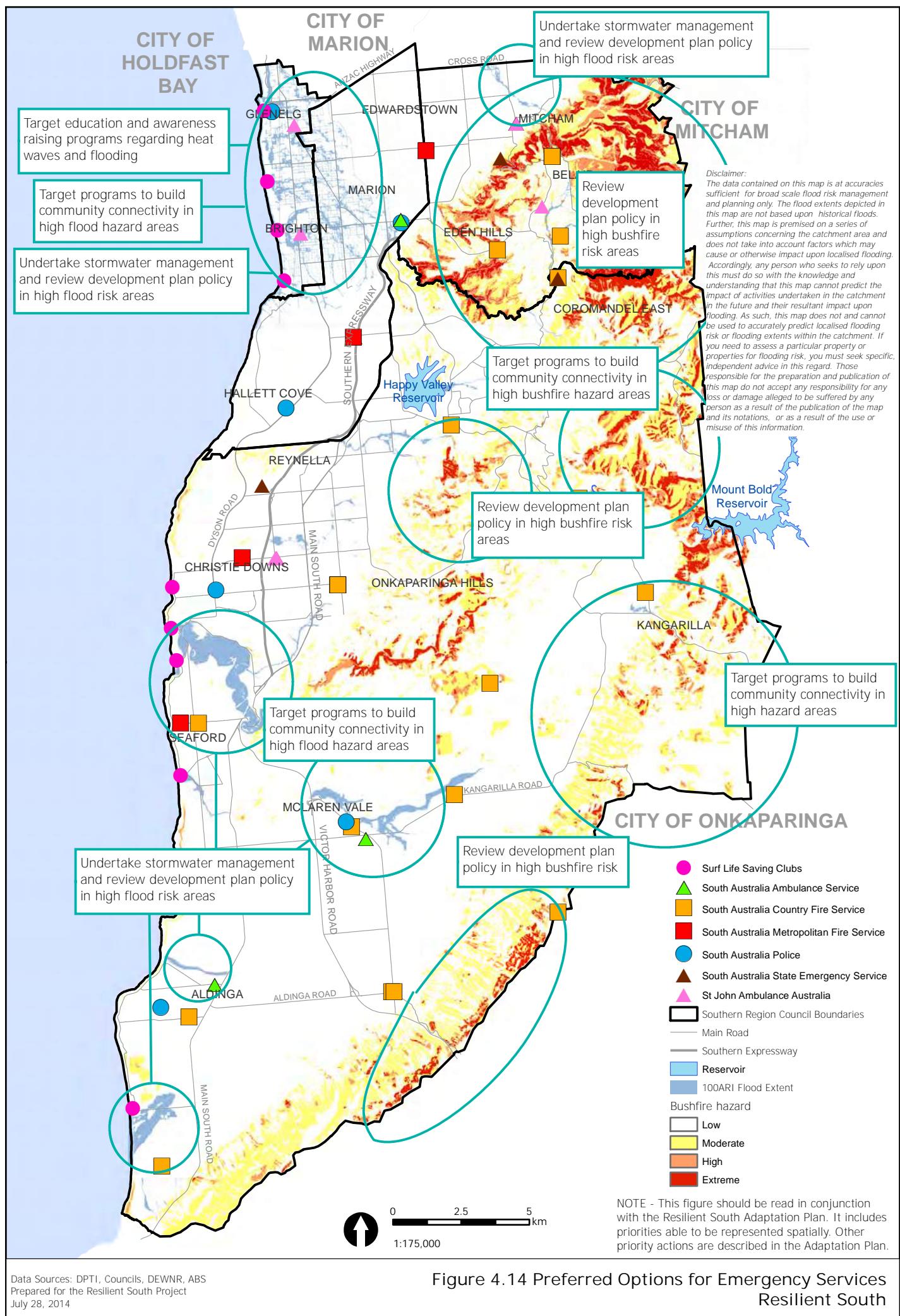


Figure 4-13: Emergency services pathway

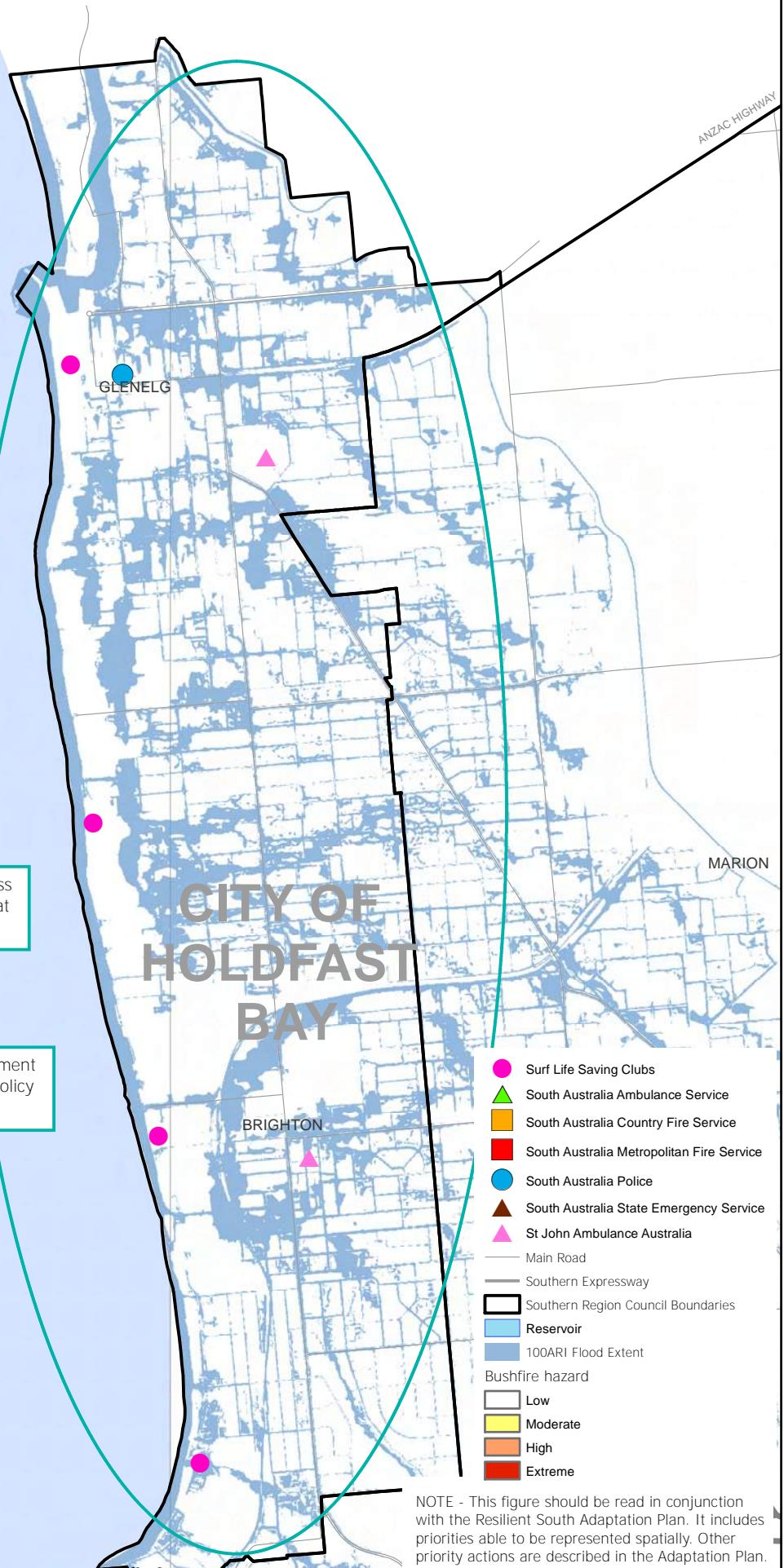
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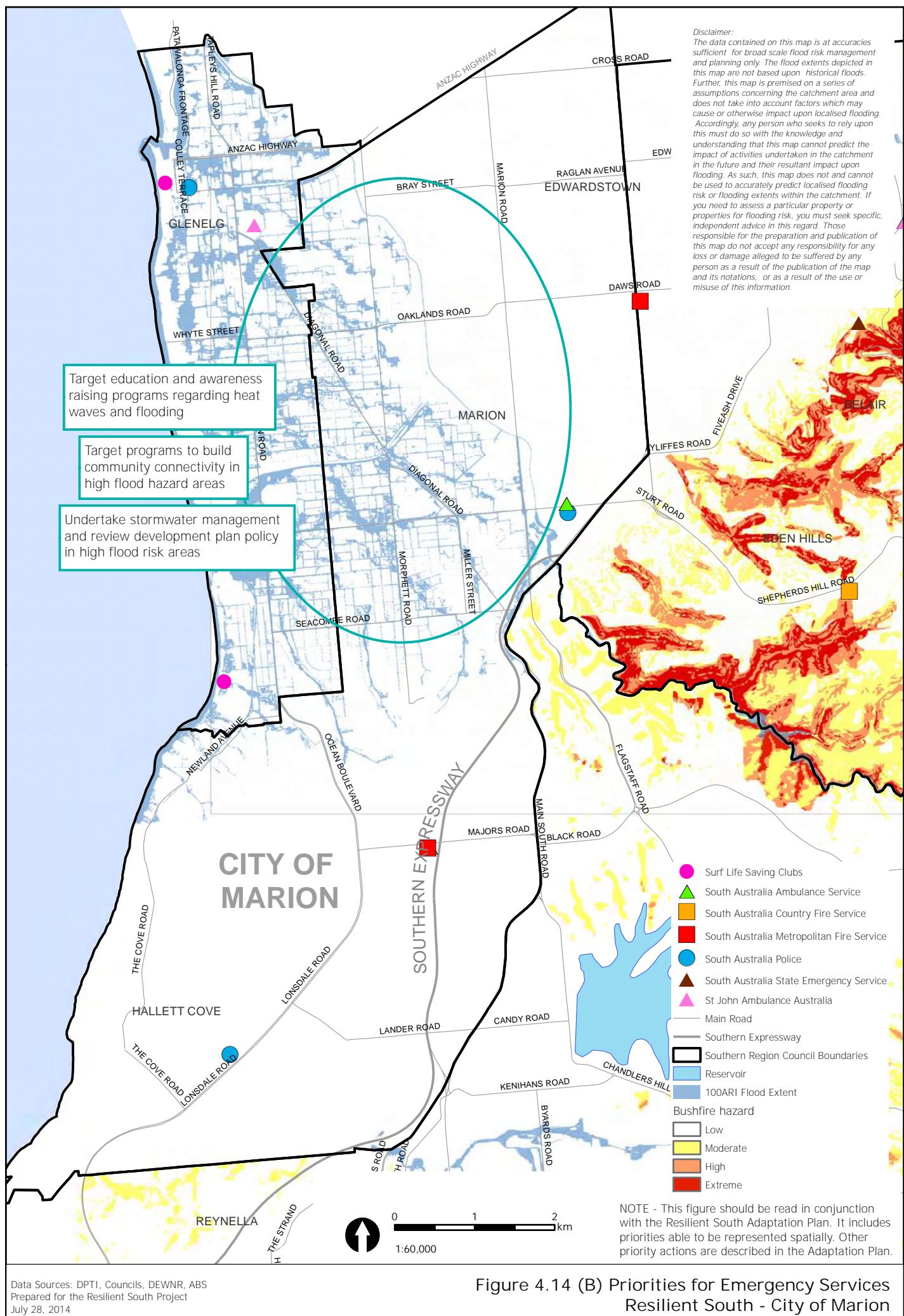
- [Green bar] Time period over which an option can usefully address the key decision area
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- [Green bar with circle] When decision makers may need to choose between different options
- [Yellow arrow] Preferred pathway as identified by Project Champions



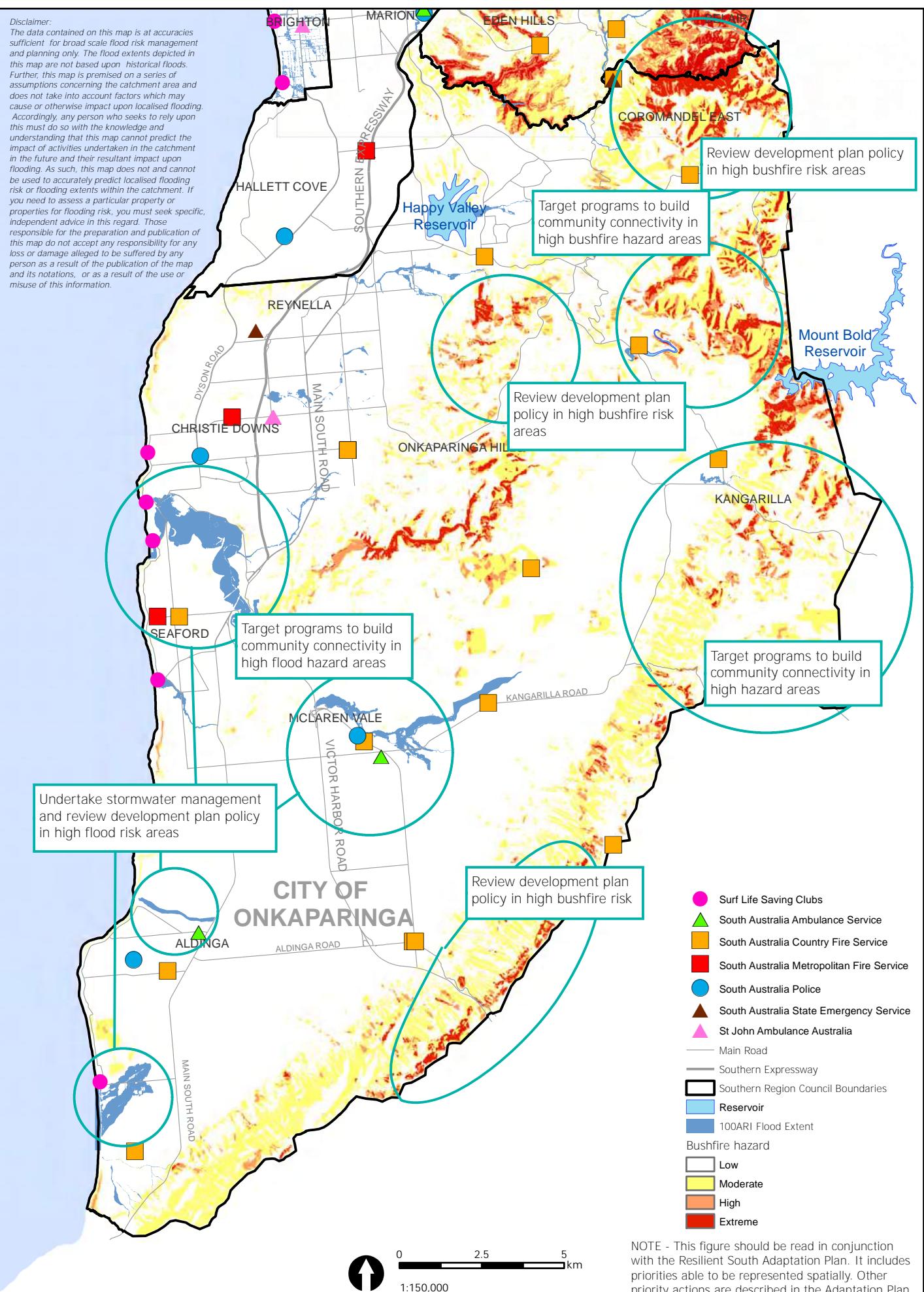
Disclaimer:

The data contained on this map is at accuracies sufficient for broad scale flood risk management and planning only. The flood extents depicted in this map are not based upon historical floods. Further, this map is premised on a series of assumptions concerning the catchment area and does not take into account factors which may cause or otherwise impact upon localised flooding. Accordingly, any person who seeks to rely upon this must do so with the knowledge and understanding that this map cannot predict the impact of activities undertaken in the catchment in the future and their resultant impact upon flooding. As such, this map does not and cannot be used to accurately predict localised flooding risk or flooding extents within the catchment. If you need to assess a particular property or properties for flooding risk, you must seek specific, independent advice in this regard. Those responsible for the preparation and publication of this map do not accept any responsibility for any loss or damage alleged to be suffered by any person as a result of the publication of the map and its notations, or as a result of the use or misuse of this information.

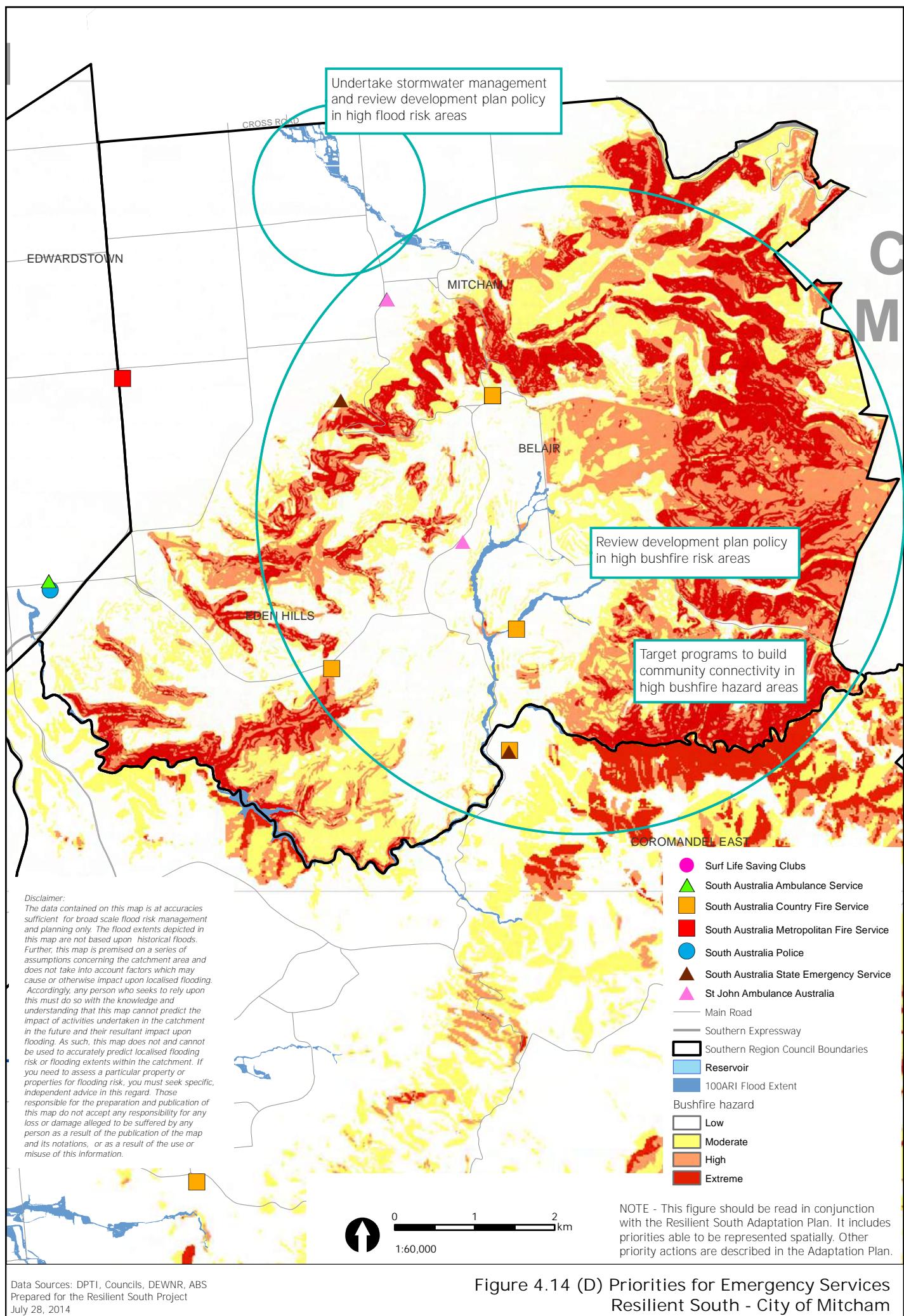




Disclaimer:
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NOTE - This figure should be read in conjunction with the Resilient South Adaptation Plan. It includes priorities able to be represented spatially. Other priority actions are described in the Adaptation Plan.



4.10 Open space and public realm

Key area of decision making

How do we provide, protect and enhance quality, useable open space and public realm in the face of less rainfall, more frequent flash flooding events, higher average temperatures, more frequent bushfires and heatwaves, increased evaporation and greater risk of coastal inundation?

Why is quality, useable open space and public realm important?

Open space and the public realm are highly valued in the Southern Region. Open space and public realm contributes to the amenity, vibrancy and wellbeing of the community⁵⁹ and provides:

- Formal and informal recreation opportunities;
- **Spaces and places for relaxation, community interaction, children's play and health and fitness;**
- Biodiversity hubs and habitat for native fauna and a connection to nature;
- Vegetation which assists with reducing the urban heat island affect; and
- Places for outdoor civic events to be held by Councils.

The Southern region has 8,700 ha of open space including parks and recreational areas. This is a significant proportion of metropolitan Adelaide's open space and includes more than 1,700 local reserves, 470 playgrounds, 34 km of sandy beaches and irrigated open space, and extensive public realm facilities including footpaths, walking and cycling trails.

How will climate change impact quality, useable open space and public realm?

The IVA found that without adaptation climate change will have major impacts on the quality of useable open space and public realm⁶⁰. This will occur at the same time as these facilities come under increasing demand as the region's population increases and urban development densifies.

The amenity and quality of open space assets will be impacted by:

- Reduced water availability

The ability to maintain amenity and playing standards through irrigation of open spaces (including playing fields) will be influenced by increased water costs and access to appropriate water sources. As the ability to irrigate declines, so too will the amenity and quality of open space resulting in reduced use and less opportunities for community members to be active. In turn this could place increased pressure on a smaller number of facilities. However, for some open space, there may be a need to maintain specific playing standards of turf for reasons of liability and permeability. There will also be increased desire to maintain green open space to offset the impacts of the urban heat island effect.

⁵⁹ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁶⁰ Resilient South (2014d) *IVA Technical Report – Resilient South*

- Temporary damage or delays caused by extreme events (heatwave or bushfire), periodically unsuitable climate and/or the longer term desire of users to avoid unfavourable weather (particularly summer heat).

This may alter the time of day spaces are used for outdoor civic events, disrupt sporting calendars, force the rescheduling of events and shorten sporting seasons. It also may create demand for investment by Council in facilities that accommodate changed use patterns or meet expectations of the community such as improving shade over children's playspaces and along walking trails or increased demand for indoor facilities.

Public realm (e.g. cycling and walking paths, streetscapes, street trees, seating and beach access/stairs) will be most at risk where climate hazards cause direct physical damage or impact on the usability of infrastructure, leading to increased maintenance, repair and replacement costs.

How can we respond to the impacts of climate change on the quality and usability of open space and the public realm?

The open space and public realm pathway (refer Figure 4-15) shows two adaptation options identified by Project Champions as preferred options to be progressed for the Region.

Accelerating current best practice

The first preferred option is to encourage change in the way we use and manage public realm and open space. This could work to:

- Change the time of day people recreate or the hours during which outdoor civic events are held;
- Review relevant event guidelines for risk assessment of heatwave and bushfire events;
- Review the way open space is provided and managed regionally (which could include focussing efforts on the provision of a smaller amount of high quality areas); and
- Alter community expectations about standards of infrastructure and experiences provided by open space and public realm.

Protection strategy

The second preferred option is to develop more climate sensitive outdoor infrastructure in preference to developing more indoor recreation infrastructure. This will benefit people wanting to recreate outdoors and assist Councils holding outdoor civic events. Climate sensitive outdoor infrastructure can be designed and constructed to take into account anticipated climate impacts, for example:

- Utilise materials that are more resilient to extreme weather such as extreme heat, wind and rainfall;
- Design and construct footpaths and trails that can cope with extreme rainfall, flooding from storm surge events and heat; and
- Provide shade via vegetation or built structures for playspaces and playgrounds and adjacent to walking and cycling paths.

Guidelines for the design and construction of this type of infrastructure should be developed and incorporated into Asset Management Plans.

Figure 4-16 shows playgrounds and open space located throughout the region. As can be seen, there is a large number of playgrounds and open space areas, and further analysis and prioritisation for shading and other climate sensitive infrastructure measures will be required. Figure 4-16 also shows areas with highest vulnerability to heatwave and increased presentation at hospital emergency departments on hot days. These areas could be targeted for public realm vegetation.

Future decisions

The open space and public realm pathway shows that reassessment of the mix of adaptation options needs to occur within one decade and then again within two decades. This reflects the general uncertainty as to the extent to which climate change will impact open space and public realm in the Region as well as the ability to access water for irrigation from alternative sources.

Summary of preferred options for responding to the impacts of climate change on quality, useable open space and public realm.

Now

- Encourage change in the way we use and manage public realm and open space; and
- New climate sensitive outdoor infrastructure.

Figure 4-16 identifies where these preferred options might apply spatially for the Southern Region.

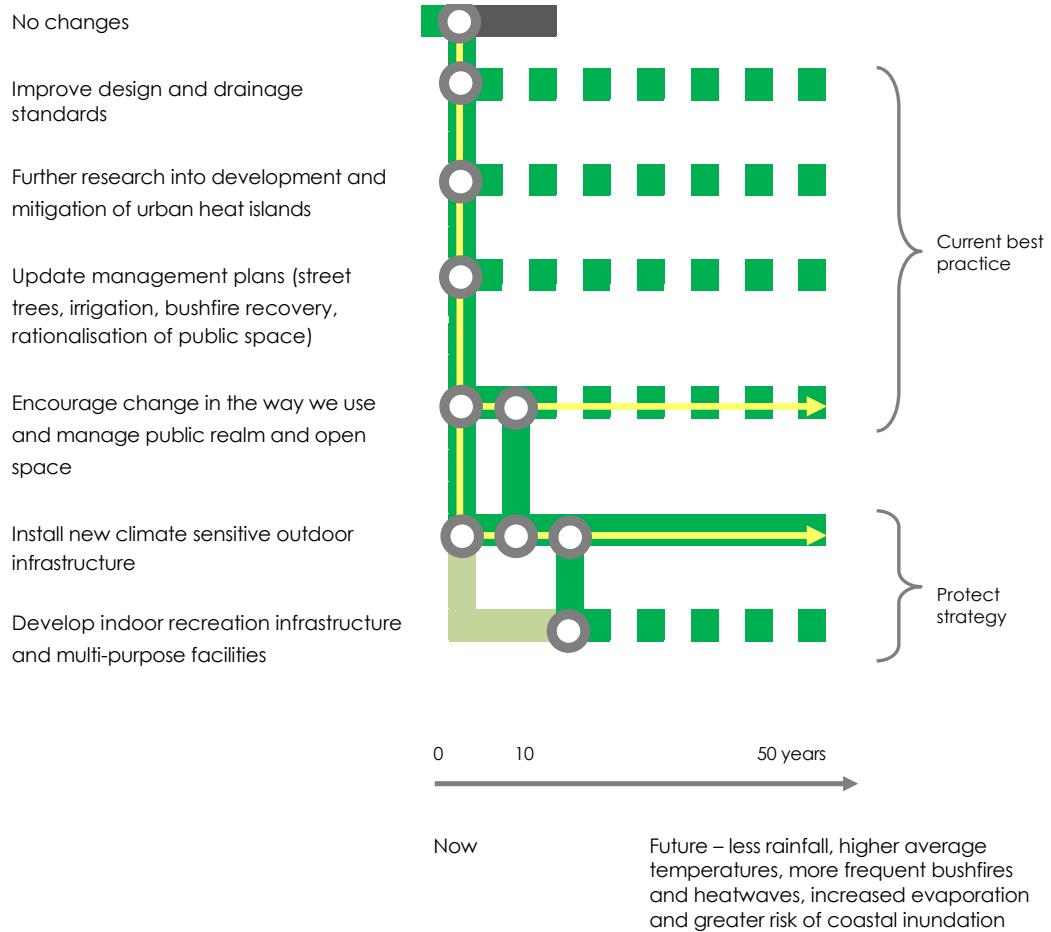
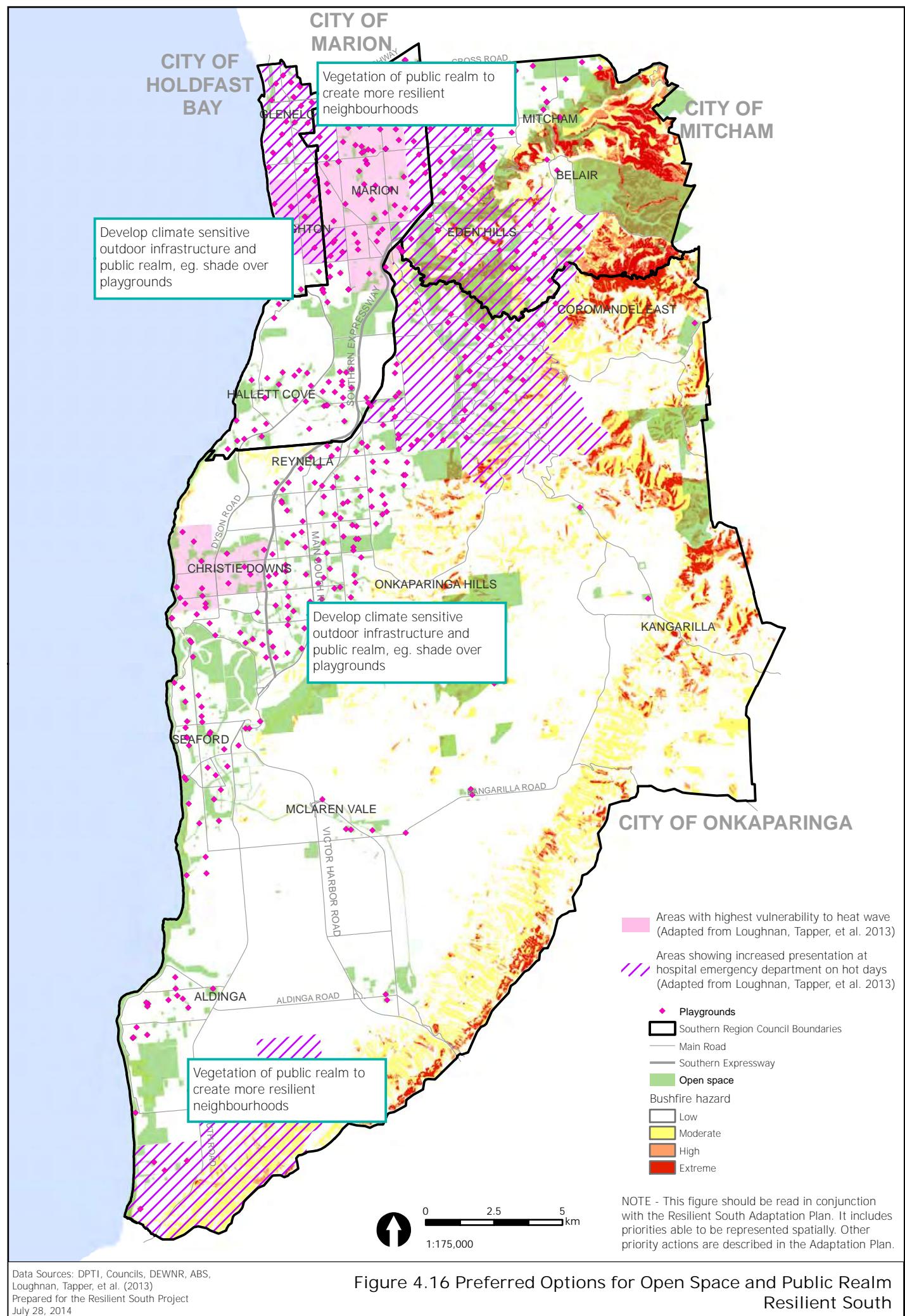
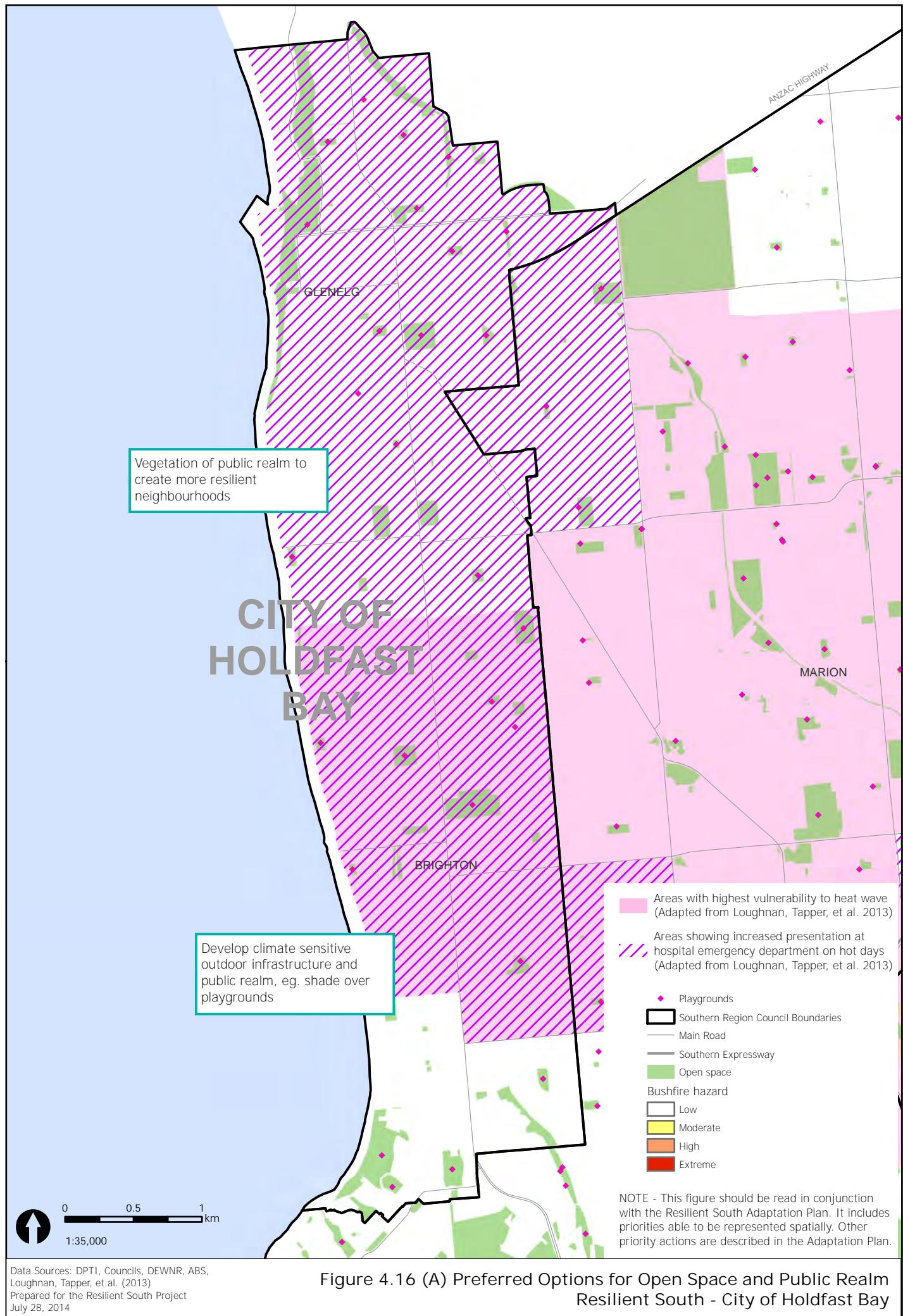


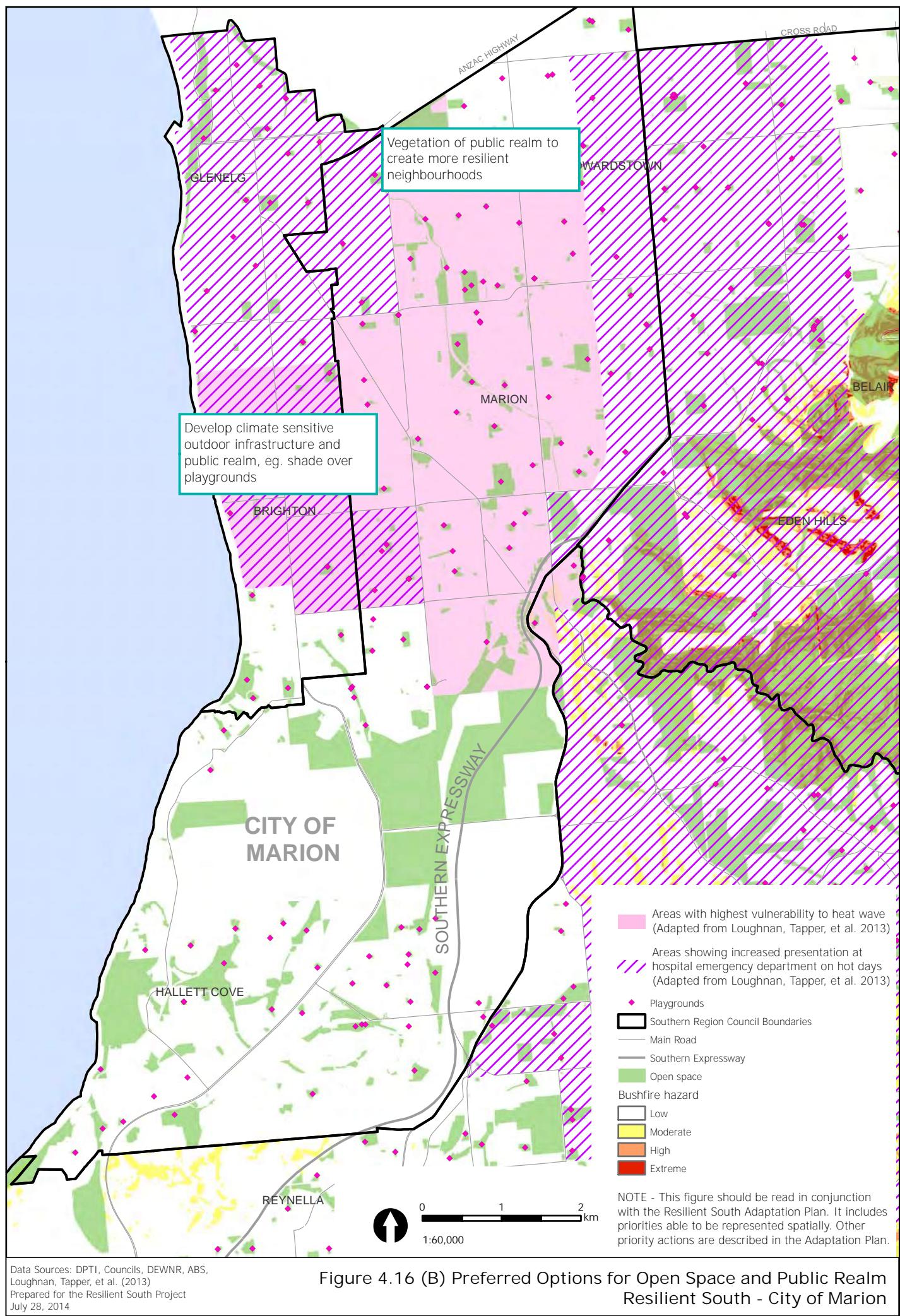
Figure 4-15: Open space and public realm pathway

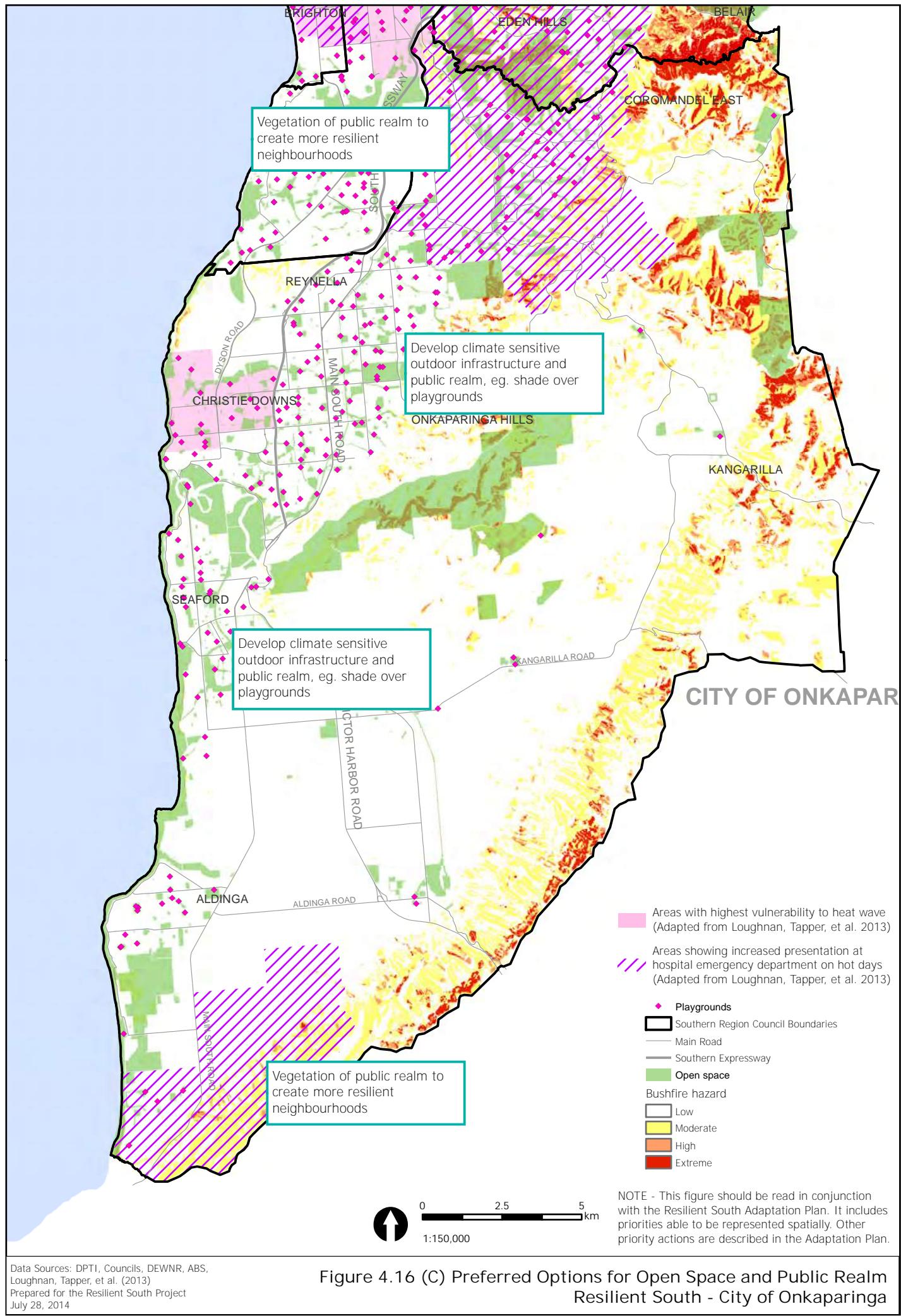
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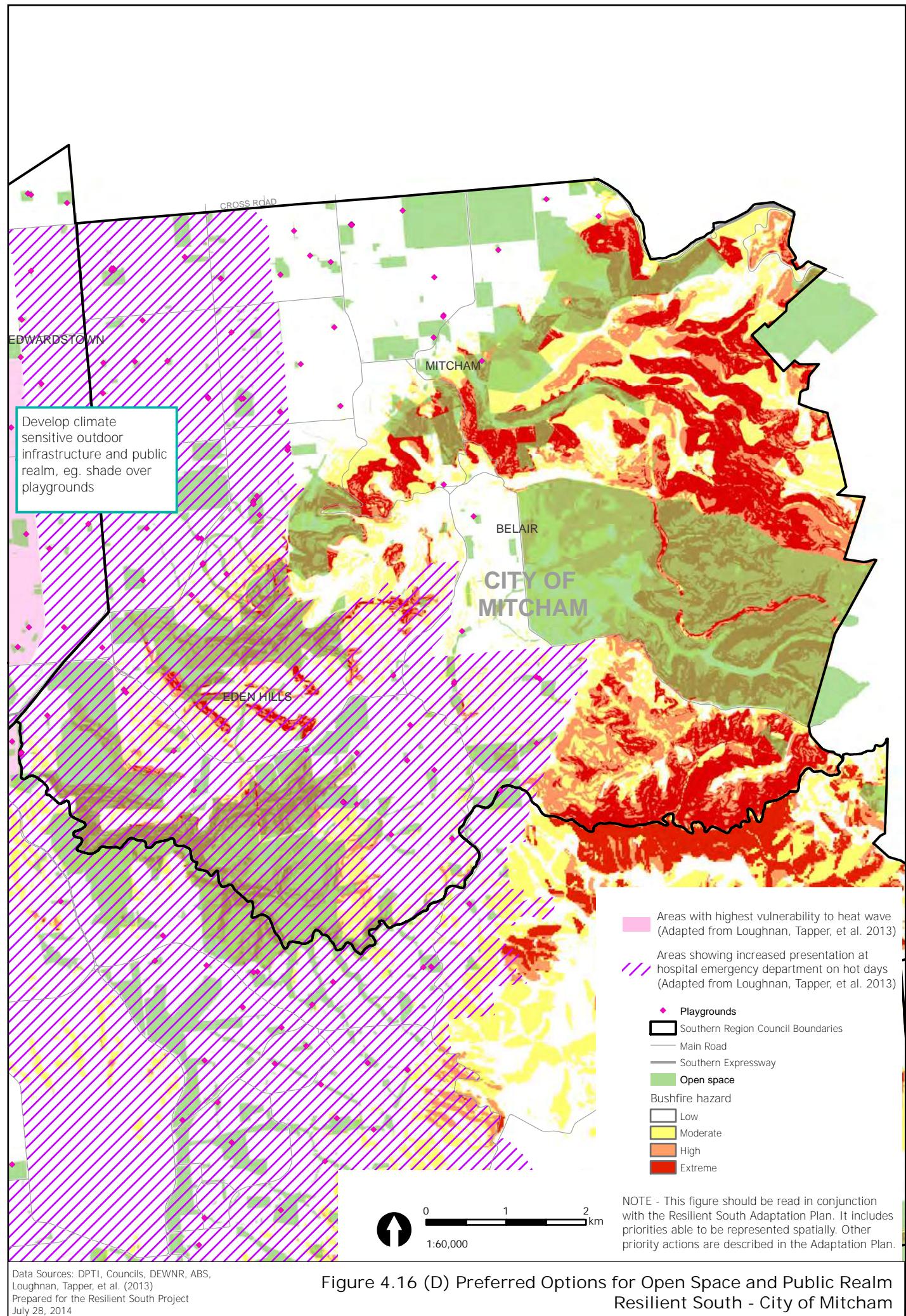
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- [Green bar with grey circle] When decision makers may need to choose between different options
- [Yellow arrow] Preferred pathway as identified by Project Champions











4.11 Essential services

Key area of decision making

How do we maintain the continuity of supply of essential services given more frequent intense rainfall events, potential flooding along the coast from sea level rise and storm surge and more frequent bushfires and heatwaves?

Why is the continuity of supply of essential services important?

Essential services⁶¹ are vital to the Southern Region's economy and underpin a vibrant, productive and healthy community⁶². Responsibility for their provision within the region rests largely with private companies who also provide these services across other parts of the State, for example:

- ElectraNet owns and manages the electricity transmission network;
- SA Power Networks operates the electricity distribution network, delivering electricity to properties from high voltage lines through substations and distribution lines;
- Envestra owns the natural gas distribution network;
- SA Water is responsible for provision of potable water supplies and management of waste water networks; and
- Telecommunications is provided by various organisations including Telstra, Vodafone and Optus as well as the South Australian Government Radio Network.

The operating standards and costing of most essential service providers is determined by independent regulators.

How will climate change impact the continuity of supply of essential services?

The IVA found that climate change could have a negative impact on the delivery of many essential services in the region⁶³. The primary concern was for electricity and telecommunications. Increased loads on the electricity supply network and more frequent power outages were identified as potential impacts of heatwaves. Power outages can occur when electricity supply loads need to be managed across the network but may also be a risk management strategy utilised on high fire risk days. This will be most significant in the hills part of the region within the Mitcham and Onkaparinga Council areas.

There are many flow on impacts of power outages including disruptions to:

- Business operations;
- Traffic lights;
- Schools;
- Shops;
- Food services;
- Hospitals and healthcare services; and
- Public safety.

⁶¹ The focus of Project Champion's discussions which have driven the development of this key decision area and associated pathway map has largely been on electricity and to a lesser extent telecommunications.

⁶² Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁶³ Resilient South (2014d) *IVA Technical Report – Resilient South*

Vulnerable members of the community such as older /frail aged people, people requiring assistance with core activities and economically disadvantaged people can be particularly susceptible to disruption to essential services, for example power outages may prevent access to cooling, cordless phones and other electric appliances (including medical equipment). While much of the potential disruption to essential services could come from heatwaves and bushfire conditions, sea level rise and flooding from storm surge events could also cause direct damage to essential services infrastructure. This in turn will impact on demand for emergency services (discussed further in Section 4.9).

Although most climate change impacts on essential services were considered to be strongly negative, potable water supplies were considered to be less vulnerable than other essential services because of the ability for the desalination plant to continue to produce potable water even during drought times.

How can we maintain the continuity of supply of essential services under the impacts of climate change?

The essential services pathway (refer Figure 4-17) shows that a wide range of adaptation options will be required to respond to the potential impacts of climate change. When considering how best to adapt, all options form part of the preferred pathway. However, this reflects an absence of clear priorities rather than the result of a ranking process. This is not unexpected because the future of continuity of essential services provision remains uncertain at present with the balance between electricity supply from traditional network providers versus distributed systems (e.g. solar PV) currently in flux.

Active management, improved planning and protection

A range of existing options employed by service providers will continue to be important in the near future such as strategic power outages on high fire risk days and management of vegetation near power lines. Figure 4-18 shows the location of high voltage transmission lines and where they traverse areas of high bushfire hazard. Improved planning and protection will also need to continue involving streetscape planning to reduce impacts on essential services infrastructure and strategic protection of key distribution assets from bushfire (refer Figure 4-18).

While some of these activities are part of normal operations, Project Champions indicated that many are at odds with the objectives of their sector and are a potential source of maladaptation. For example:

- Power outages on high fire risk days may reduce bushfire risk but can also impact vulnerable members of the community through preventing access to electricity for air-conditioning, medical equipment and cordless phones on extreme hot weather days; and
- Native vegetation clearance can work at cross purposes with aims to protect and maintain native ecosystems.

Alternate supplies and protection strategies

The major focus of future adaptation for the continuity of supply of essential services will be on alternate supplies and protection options. It is expected that a decision between major options will need to be made within 10 years. Distributed energy through solar PV has already been adopted in a significant way in South Australia and is now a major consideration in the management of power supply and demand for the State. Linked with

further adoption of distributed energy will be whether there is success in developing more advanced and cost effective power storage solutions.

Protection options offer a different solution and focus on increasing the review of the existing distribution system. Options include:

- Increased electricity feeder automation, which allows for real time automated, distribution network management;
- Undergrounding of power cables;
- Upgrading cooling systems for telecommunication exchanges; and
- Installation of backup power supplies.

Summary of preferred options for maintaining the continuity of supply of essential services

Now

- Strategically manage power outages on high fire risk days;
- Manage native vegetation near power lines;
- Conduct streetscape planning that considers impacts on essential services infrastructure;
- Protect key assets from bushfire (e.g. feeders); and
- Increase distributed energy.

Within 10 years

- Increase electricity feeder automation;
- Undergrounding of power cables;
- Upgrade cooling systems for telecommunicates exchanges; and
- Install backup power supplies.

Preliminary work

- Conduct a feasibility study into the costs and benefits of different supply and protection strategies, involving regional organisations, essential services providers and regulators.

Figure 4-18 identifies where these preferred options might apply spatially for the Southern Region.

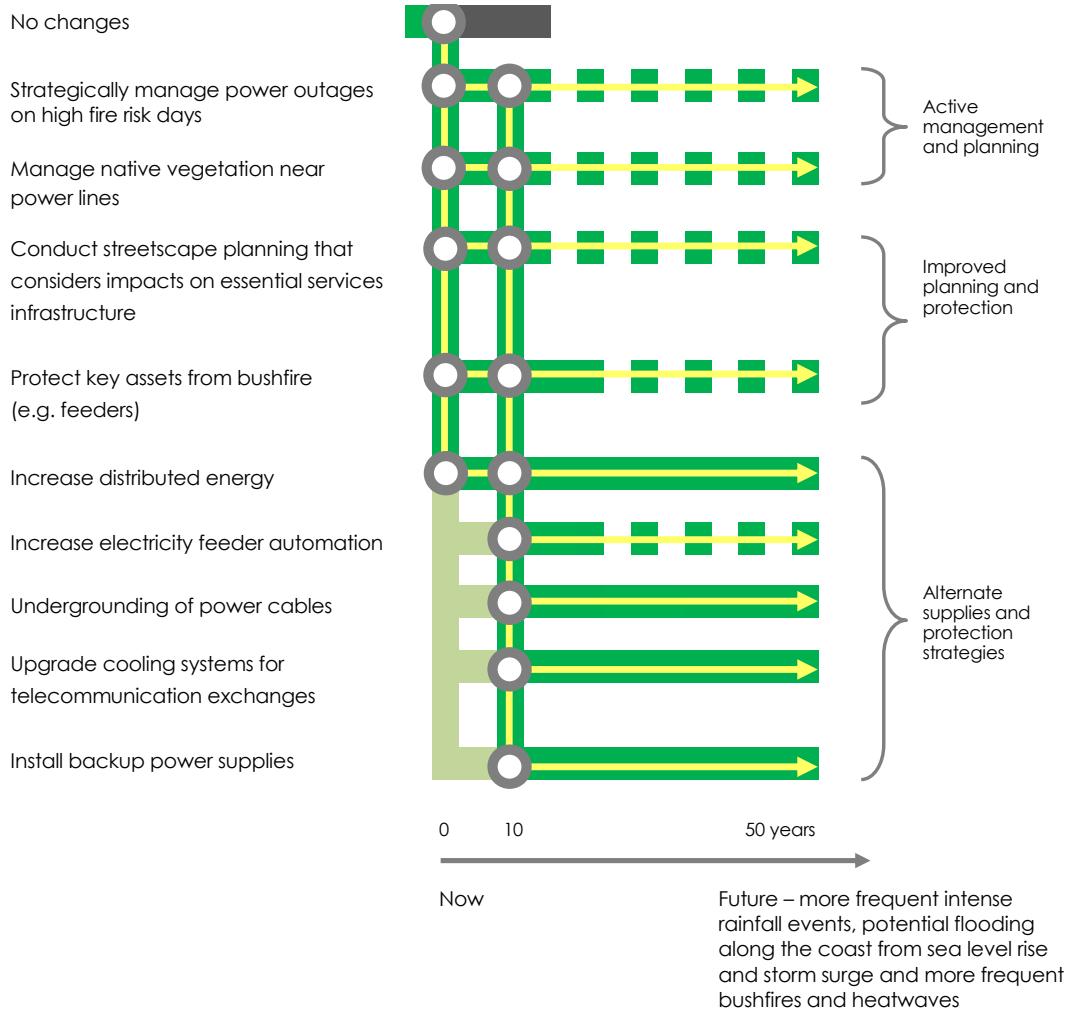
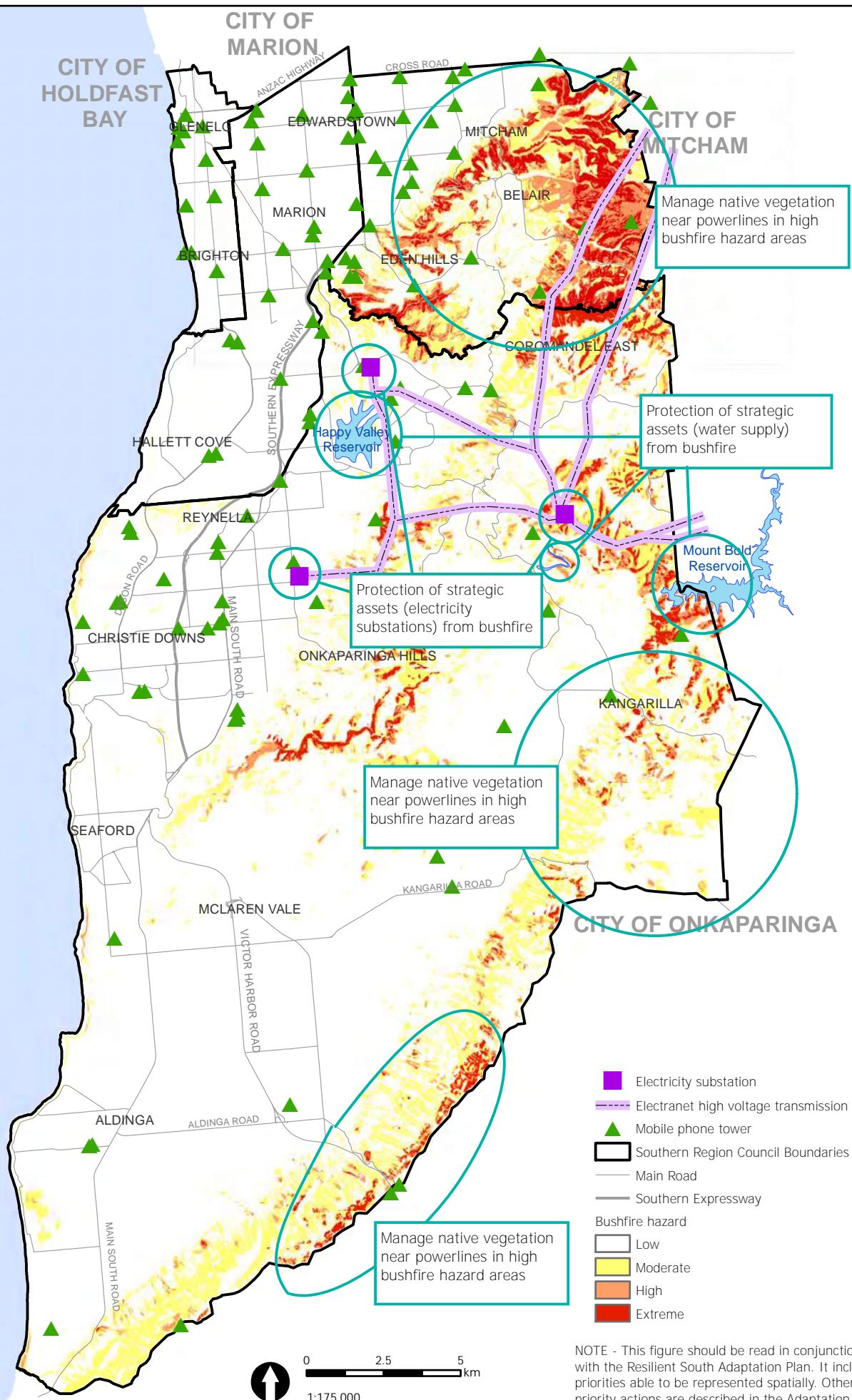


Figure 4-17: Essential services pathway

See Figure 4-1 for an explanation of how to interpret this figure.

- [Green bar] Time period over which an option can usefully address the key decision area
- [Light green bar] Time before an option is implemented during which preparatory work is required
- [Grey bar with dots] An option that contributes to the adaptation solution but only in part
- [Dark grey bar] An option that is not favoured
- [Light grey bar] An option that is not preferred but that would require preparatory work if pursued
- [Bar with circle] When decision makers may need to choose between different options
- [Yellow arrow] Preferred pathway as identified by Project Champions



4.12 Manufacturing and business

Key area of decision making

How do we maintain and increase the viability of the manufacturing and business sector given increasing bushfire hazard, flood events, sea level rise and more frequent heatwaves?

Why is maintaining and increasing the viability of the manufacturing and business sector important?

Manufacturing and business are an important part of the Southern Region's economy. ABS Census data indicates that 80% of people who work in the Region live in the Region, meaning that a high proportion of the population spend the majority of their time in the Region⁶⁴. Retail trade accounts for 16% of jobs in the Region, manufacturing 9% and accommodation and food service 7%.

Manufacturing connects with other industries in the Region such as wine production and the motor vehicle and transport sectors with large manufacturing and light industrial areas located in Lonsdale and Edwardstown. There are a number of major infrastructure projects that have been recently completed (e.g. Seaford rail extension and rail electrification) or that are underway in the Region (e.g. Southern Expressway duplication) that draw on manufacturing services. The business sector relies heavily on retail and trade activity, with major shopping centres at Marion, Glenelg, Mitcham and Colonnades.

While other sectors focus on maintaining or protecting assets and services, the aim of the manufacturing and business sector is continued growth to help build the Region's economy and create new jobs to support a growing population.

How will climate change impact the manufacturing and business sector?

The IVA found that without adaptation climate change could impact on the value of the manufacturing and business sector in the Region⁶⁵. Impacts can occur as a result of:

- *Heatwaves and extreme heat* which can reduce organisational productivity and the cost of doing business such as by increasing the need to change operating hours (e.g. manufacturing facilities with uncooled workshops or working environments). Even where changing operating hours to minimise work during the hottest times of the day is an option, this could raise other issues such as noise impacts on people in neighbouring residential areas;
- *Bushfire* frequency increases, which could impact on the ability for customers to access shopping centres or in direct damage to buildings and infrastructure; and
- *Sea level rise and storm surge effects* combining to periodically inundate low lying areas close to the coast.

How can we respond to the impacts of climate change on the manufacturing and business sector?

The manufacturing and business pathway (refer Figure 4-19) shows a range of adaptation options, however, the majority were considered by Project Champions to only contribute to adaptation and are not a solution in their own right.

⁶⁴ Resilient South (2014a) *Regional Profile – Resilient South*

⁶⁵ Resilient South (2014d) *IVA Technical Report – Resilient South*

Current best practice

The preferred pathway focuses on two adaptation options for immediate implementation. Reviewing and amending Development Plan policy is considered a priority so as to avoid manufacturing and business facilities being located in areas at risk from climate hazards such as bushfire and coastal flooding. Planning and environmental policy could also be reviewed so as to allow more flexible operating hours for businesses in industrial areas.

Business continuity planning through educating and building capacity in the manufacturing and business sector is also an immediate priority and includes providing information systems and websites and targeted programs for home industries and small business to better understand climate impacts on energy, water and emergency services provision. Figure 4-20 shows commercial and industrial zones where education and capacity building programs could be targeted.

Protect strategy

It is expected that as the impacts of climate change start to increase, there will be greater focus on maintaining the continuity of supply of essential services for manufacturing and business, with a particular focus on electricity. This is considered an immediate priority and may include backup power supply options and greater adoption of distributed energy solutions. Business case assessments are required to determine the best combination of options.

Summary of preferred options for maintaining and increasing the viability of the manufacturing and business sector

Now

- Review and amend Development Plan policy;
- Educate and build capacity of the manufacturing and business sector; and
- Improve the continuity of supply of essential services, especially electricity.

Preparatory work

- Conduct business case assessments for options to improve the continuity of supply of essential services.

Figure 4-20 identifies where these preferred options might apply spatially for the Southern Region.

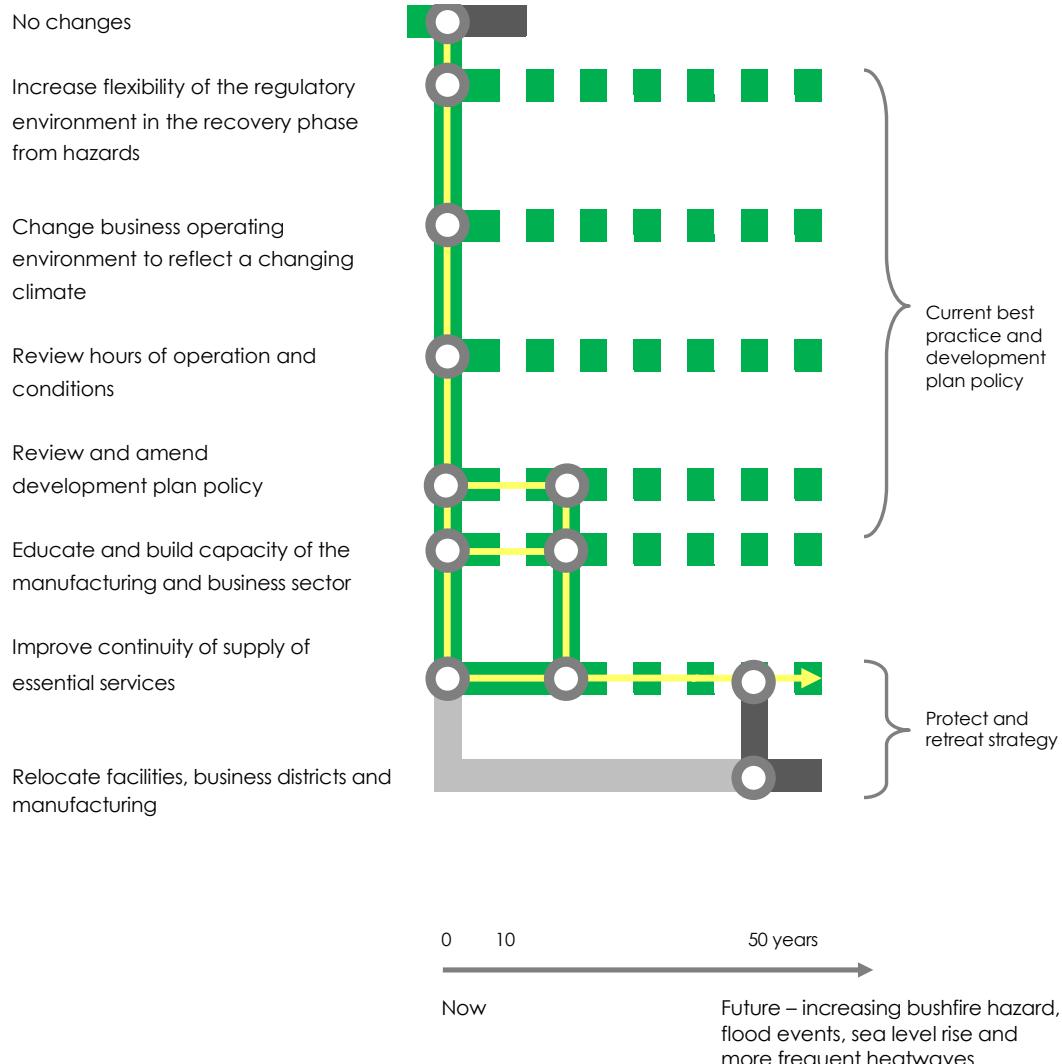
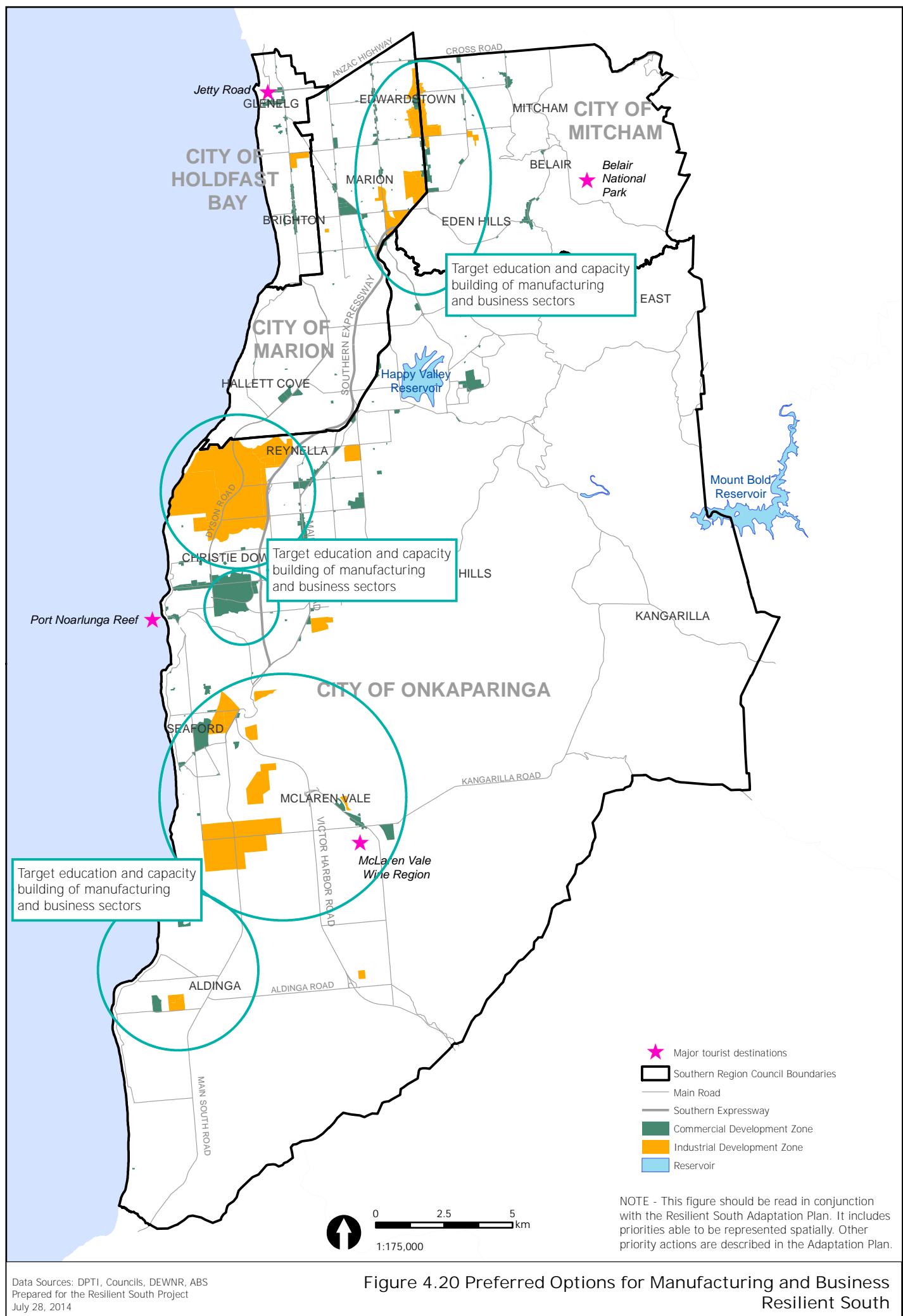


Figure 4-19: Manufacturing and business pathway

See Figure 4-1 for an explanation of how to interpret this figure.

- | | |
|--|--|
| | Time period over which an option can usefully address the key decision area |
| | Time before an option is implemented during which preparatory work is required |
| | An option that contributes to the adaptation solution but only in part |
| | An option that is not favoured |
| | An option that is not preferred but that would require preparatory work if pursued |
| | When decision makers may need to choose between different options |
| | Preferred pathway as identified by Project Champions |



4.13 Viticulture

Key area of decision making

How do we maintain the productivity of local viticulture given a warmer and drier climate with more frequent and intense bushfires?

Why is maintaining the productivity of local viticulture important?

Viticulture is recognised as an important part of the Southern Region's economy⁶⁶. McLaren Vale is the major wine grape growing and wine production area within the Region.

Viticulture is a major contributor to the agriculture, forestry and fishing sector in the region accounting for almost 55% of employment in the sector⁶⁷. It also has flow on benefits to other sectors such as manufacturing and tourism. In addition to being an important part of the Region's economy, the viticulture sector focused on McLaren Vale contributes to the character and aesthetic of the region in the same way as the coast and hills.

How will climate change impact the productivity of local viticulture?

The IVA found that a warmer and drier climate with more frequent and intense bushfires could impact on the productivity of local viticulture⁶⁸ as follows:

- Warmer conditions will change the timing of flowering and harvest;
- Extreme hot weather can result in burning of fruit;
- A drier climate will reduce soil moisture availability requiring greater reliance on irrigation; and
- Warmer nights can affect plant water relations, reducing recovery periods from high daytime temperatures and potentially changing the composition of the fruit.

Some response strategies for dealing with increasing temperatures can create issues in their own right. For example, promoting more canopy cover in the crop to protect berries requires more water to be used and the shading from the plant's increased canopy can result in increased risk of splash effect leading to mildew problems as well as slower ripening times.

Increased bushfire risk is of concern because:

- Bushfires can directly damage vines and wine processing and manufacturing infrastructure. Vineyards located in Clarendon, Blewitt Springs, McLaren Flat, the Range and Sellicks Hill are all located in areas of higher bushfire hazard; and
- Smoke taint can occur as a result of fires in the district in general and can be hard to detect. Increased risk of smoke taint in wine has led to at least one winery interstate establishing operations in a less bush fire prone region.

⁶⁶ Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*

⁶⁷ Resilient South (2014a) *Regional Profile – Resilient South*

⁶⁸ Resilient South (2014d) *IVA Technical Report – Resilient South*

How can we respond to the impacts of climate change on the productivity of local viticulture?

The viticulture pathway (refer Figure 4-21) shows that a range of current best practice options can contribute to adaptation but that in the longer term more transformational strategies will need to be considered. All options described below are part of the preferred pathway.

Current best practice management

Assisting vines to better cope with climate extremes already occurs and will need to continue as part of adaptation for the viticulture sector, focussing on vine canopy management such as sprays and shading to reduce heat impacts and shading to reduce rain damage. Planting cover crops between rows will also continue to be an important option to prevent erosion during more frequent, intense rainfall events. Figure 4-22 shows the locations of vineyards in the Region.

One of the greatest concerns for viticulturists in the Region will be bushfire damage, either directly to vines and infrastructure or indirectly to wine through smoke taint. Bushfire management plans are considered essential and increased adoption is required. Smoke taint testing is a well-established practice and guidelines on how to undertake it can be obtained from the Australian Wine Research Institute website. Figure 4-22 shows the close proximity of vineyards to high bushfire hazard.

Continuous improvement in water management practices has been a feature of the Southern Region in the past and will continue to be important in the future. There needs to be a continued focus on irrigation efficiency to reduce demand for water. However, while this option was favoured by Project Champions it was noted that with current technology there is limited additional opportunity for further irrigation efficiency savings. Figure 4-22 identifies the expansion of use of recycled water for vineyard irrigation.

Protect and transform strategies

Viticulturists have already started to rethink whether current varieties are still appropriate for the Region and new options are understood to have been trialled. This shift to varieties more resilient to higher temperatures and less rainfall in the future will need to continue and be accelerated where possible.

The Region has already done significant work to develop alternate water supplies, such as has been achieved through Willunga Basin Water in McLaren Vale to alleviate pressure on groundwater resources. Within 10 years, it is expected that further identification of alternative irrigation sources to increase supply options will be required.

Summary of preferred options for maintaining the productivity of local viticulture

Now

- Plant cover crops between rows to prevent erosion;
- Improve vine canopy management;
- Develop bushfire management plans;
- Undertake smoke taint testing and mini fermentation;
- Adopt irrigation efficiency measures; and
- Plant varieties more resilient to higher temperatures and less rainfall.

Within 10 years

- Develop alternate irrigation sources.

Figure 4-22 identifies where these preferred options might apply spatially for the Southern Region.

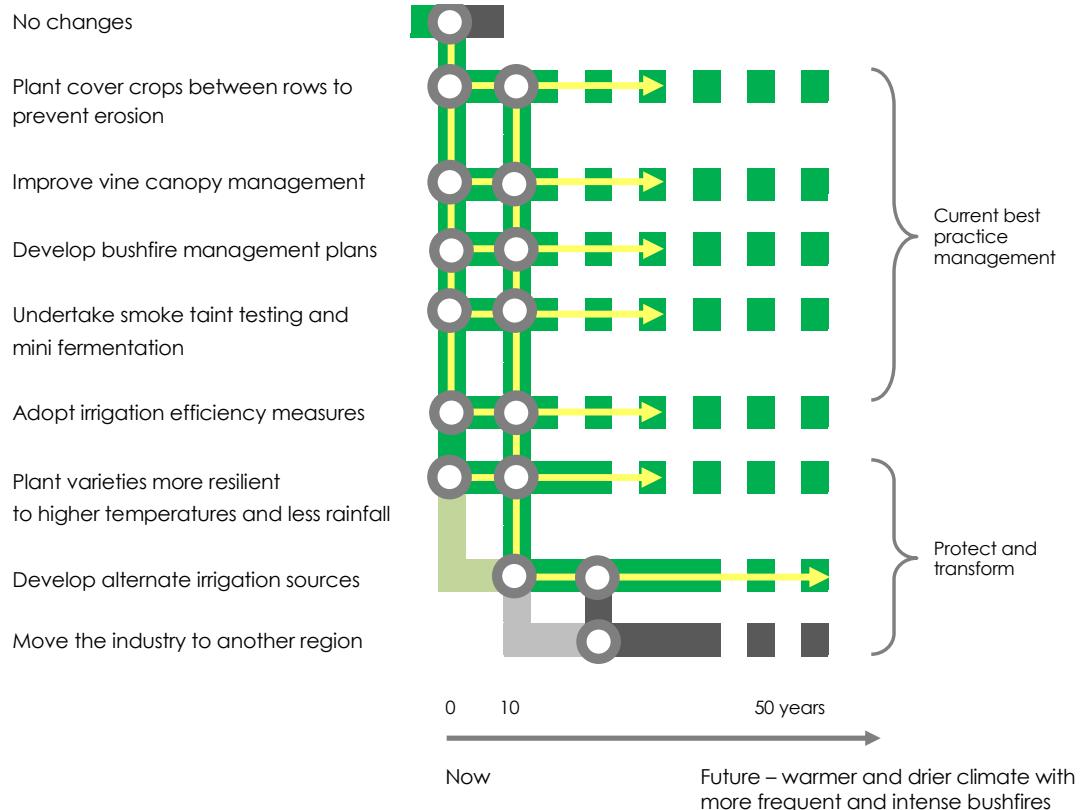
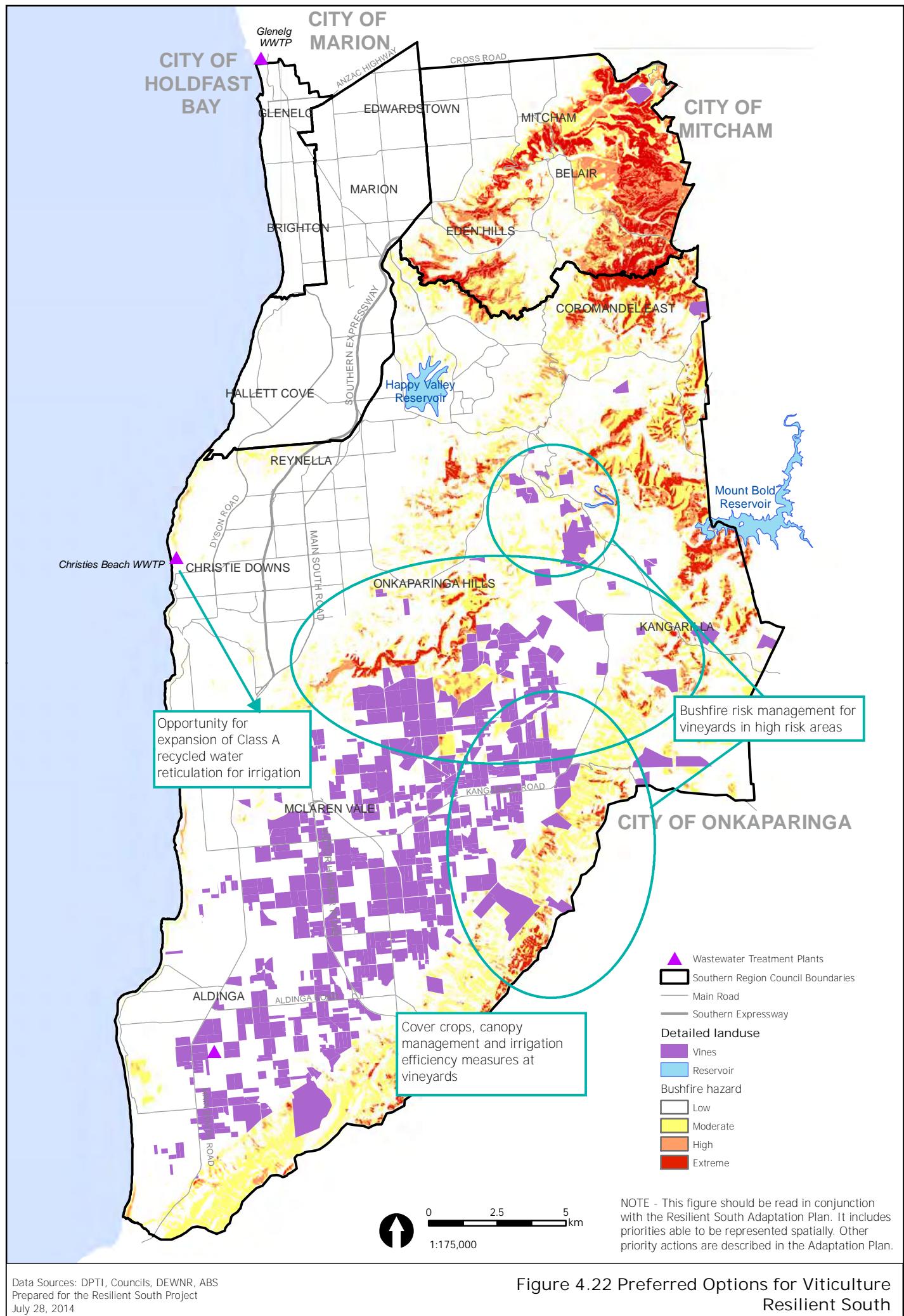


Figure 4-21: Viticulture pathway

See Figure 4-1 for an explanation of how to interpret this figure.

- [Green bar] Time period over which an option can usefully address the key decision area
- [Light green bar] Time before an option is implemented during which preparatory work is required
- [Grey squares] An option that contributes to the adaptation solution but only in part
- [Dark grey bar] An option that is not favoured
- [Light grey bar] An option that is not preferred but that would require preparatory work if pursued
- [Circle with dot] When decision makers may need to choose between different options
- [Yellow arrow] Preferred pathway as identified by Project Champions

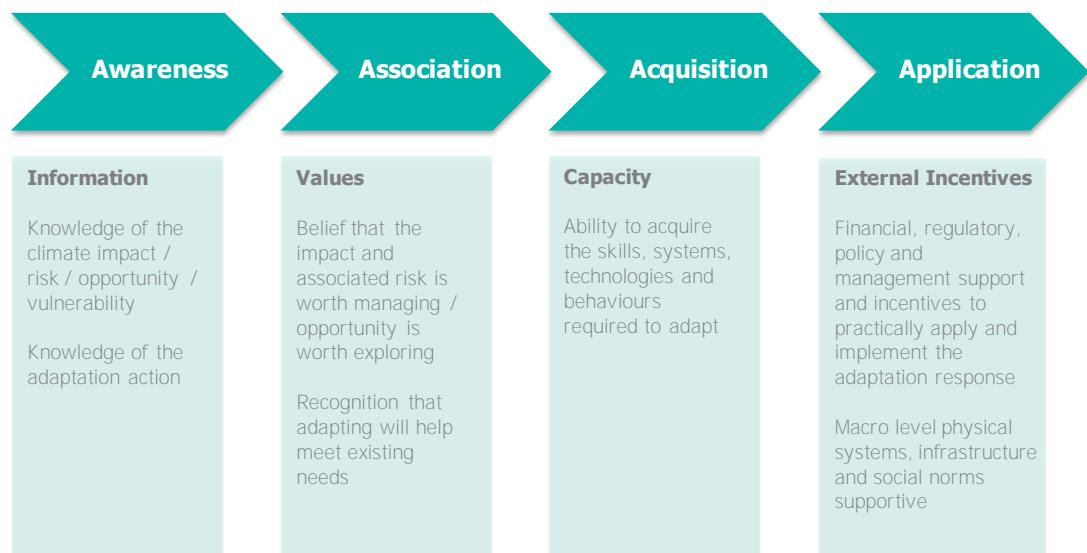


5 Enabling adaptation action

From its inception the Resilient South Adaptation Planning project has sought to integrate insights from the social sciences into the adaptation planning process, and to better understand the social and institutional mechanisms by which more resilient and sustainable systems and practices develop.

This approach was informed throughout the project by the Model of Receptivity – a tool for considering factors influencing willingness and ability to change, that can be applied in the context of climate change adaptation⁶⁹. The Model of Receptivity is shown in Figure 5-1.

Figure 5-1: Model of Receptivity



In the context of the Model of Receptivity, the project involved the following tasks:

- Change research⁷⁰ to better understand how change occurs, what barriers to change exist, and the institutional characteristics, attributes and tools likely to be associated with a high degree of resilience and capacity to adapt; and
- An integrated, participatory approach to all stages of the project based on the notion that people - their values, decisions and behaviour - are central to climate change adaptation and to development of meaningful, practical adaptation measures⁷¹.

Appreciation of the social and institutional aspects of adaptation complements the adaptation pathways for key decision areas set out in the Regional Adaptation Plan (refer Section 4), and importantly, provides insight into how implementation of the Regional Adaptation Plan may be supported.

⁶⁹ Resilient South (2013) *Resilient South Project Background Paper – Transitioning Towards Resilient Futures – Building capacity and commitment to adapt to climate change in the southern Adelaide Region*

⁷⁰ Resilient South (2013b) *Social & Institutional Mechanisms for Transitioning to Resilient Practices*

⁷¹ Resilient South (2014c) *Engagement Feedback Report – Resilient South*, also refer Section 1.2 of the Regional Adaptation Plan

5.1 Understanding adaptive capacity and enabling conditions

The Resilient South Adaptation Planning project has involved research to better understand what institutional characteristics or attributes tend to be associated with adaptive capacity. Most simply, adaptive capacity is the ability to flex, adjust and respond as circumstances change – qualities that are important both for planning for climate change, and for responding to its impacts. Organisations which display attributes associated with greater adaptive capacity are likely to be more resilient to the impacts of climate change over the long term.

The project research identified characteristics of adaptive capacity in organisations, and also gathered stakeholder views during the adaptation planning process about the types of conditions that would support adaptation actions to be realised. Table 5-1 sets out these findings with reference to the Model of Receptivity.

Table 5-1: Adaptive characteristics and enabling conditions identified by the Resilient South Adaptation Planning project and links to the Model of Receptivity

Adaptive characteristics identified through research ⁷²	Enabling conditions for the Regional Adaptation Plan identified by Project Champions ⁷³	Model of Receptivity attributes			
		Awareness	Association	Acquisition	Application
Communication and engagement <ul style="list-style-type: none"> Strong, consistent communication channels Robust relationships with stakeholders Information provision supported by genuine engagement and capacity building processes 	Community engagement Education, awareness and visibility Ownership and recognition Accessible quality information and reliable research Accurate media reporting	✓	✓	✓	✓
People and culture <ul style="list-style-type: none"> Strong leadership A culture that embraces change, openness and diversity Empowerment to act at all levels Flexibility and openness to changing traditional practices as new situations arise 	A shared vision and willingness to change Long term, bi-partisan commitment Political will Leadership of champions and good communicators Broad understanding, buy in, capacity building Collaboration across issues and agencies		✓	✓	✓

⁷² Resilient South (2013b) *Social & Institutional Mechanisms for Transitioning to Resilient Practices*

⁷³ Resilient South (2014c) *Engagement Feedback Report – Resilient South*, also refer Section 1.2 of the Regional Adaptation Plan

Adaptive characteristics identified through research ⁷²	Enabling conditions for the Regional Adaptation Plan identified by Project Champions ⁷³	Model of Receptivity attributes			
		Awareness	Association	Acquisition	Application
Access to resources <ul style="list-style-type: none"> Access to financial and non-financial resources to realise objectives Allocation of financial resources to address long term challenges 	Resources and finance Physical capacity to implement Development of technology			✓	✓
Functional strategic and operational instruments <ul style="list-style-type: none"> Plans, strategies, policies, procedures and legislation to support change Tools function best when a clear strategic vision is well integrated into culture and operations 	Development planning and legislation Practical steps to realise options Mechanisms for implementation, accountability, continuous improvement Supportive policies			✓	✓

5.2 Building adaptive capacity and creating enabling conditions

On the basis of the understanding of adaptive capacity and enabling conditions developed through the project research, 4 key strategies were identified for fostering resilience throughout the Southern Region:

- Build adaptive capacity - ongoing strengthening of adaptive capacity within the Region's institutions, including addressing those barriers to resilient practices within organisations identified in the research;
- Leverage existing values - identify ways in which adaptation options can be aligned with the values of stakeholders in the Region to encourage voluntary adaptation efforts;
- Leverage existing strategic planning tools - make explicit links between adaptation strategies and existing planning tools to embed resilience into organisations from the "head power" documents through to operational plans; and
- Facilitate long term planning – overcome political and practical barriers to plan and allocate resources for the long term future.

The relationship of these strategies to the Model of Receptivity is shown in Figure 5-2. The links between these strategies and implementation of the Adaptation Plan are described below.

Strategy 1: Build adaptive capacity with the Adaptation Plan

The Resilient South Adaptation Planning project has sought to build adaptive capacity throughout development of the Regional Adaptation Plan. There is scope to continue to do

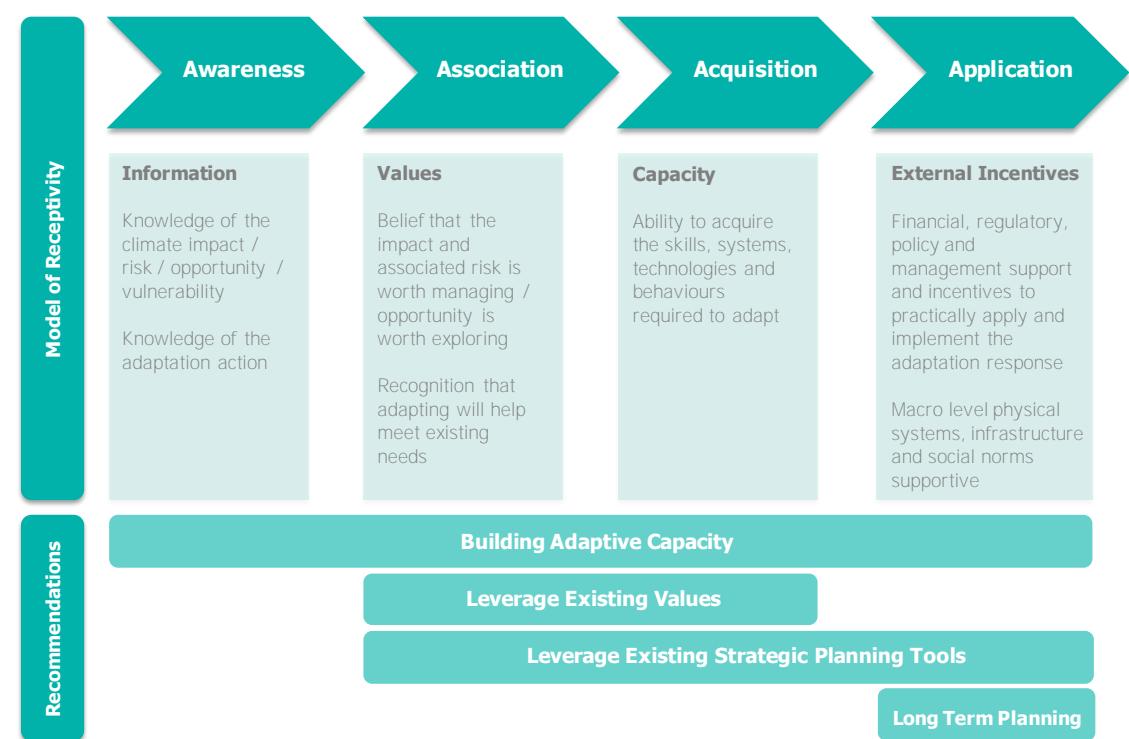
so through the implementation phase, specifically through leadership and support for Regional connections.

Lead with the Adaptation Plan

For social and institutional barriers to adaptation to be overcome, and adaptive thinking to be integrated into everyday practices and decision making in the Region, leadership is required. Similarly, leadership is required to maintain the momentum of the Resilient South Adaptation Planning project into the implementation phase.

The Regional Adaptation Plan itself and the process by which it was developed is a strong basis from which to provide this leadership. The project Councils, with support of existing Project Champions and their organisations are well placed to continue the leadership they have demonstrated in development of the Regional Adaptation Plan. Formalised agreement to support the implementation of the Regional Adaptation Plan is recommended. This approach to the Resilient South Adaptation Planning project to date has proven highly successful in setting the foundation for partnership and collaboration via the Resilient South Heads of Agreement and Southern Region Climate Change Sector Agreement.

Figure 5-2: Strategies for building adaptive capacity and creating enabling conditions and the Model of Receptivity



Support Regional connections

Connectedness, engagement, and partnerships with stakeholders are key elements of resilience and adaptive capacity. It was clear from the Resilient South Adaptation Planning project stakeholder engagement process that many organisations in the Region are already working on these factors as part of realising their current organisational goals, often in partnership with other organisations within the Region and the community.

Feedback from stakeholders involved in the Resilient South Adaptation Planning project identified the opportunity to connect across the Region and across different sectors as one of the most valuable aspects of their participation.

Implementation of the Resilient South Adaptation Plan provides an opportunity to link in with and enhance initiatives and practices already occurring in the Region, as well as to create opportunities for connection to occur around key decision areas.

Strategy 2: Leverage existing values

Values-based engagement with stakeholders has been a critical component of the Resilient South Adaptation Planning, generating interest, enthusiasm, and commitment to the project.

Broader community and stakeholder engagement around climate change and adaptation will be fundamental to successful implementation of the Regional Adaptation Plan as adaptation strategies will affect communities and individuals in various ways.

The importance of awareness-raising within the community was identified by stakeholders from the first round of workshops through to the last in which enabling conditions were discussed, as was the notion of connecting adaptation messages with values and established behaviours.

Strategy 3: Leverage existing strategic planning tools

Research and engagement through the Resilient South Adaptation Planning project emphasised the significant role plans and strategies have in shaping priorities, behaviour and decision making within organisations throughout the Region and across sectors.

There are existing strengths to build on in this area, given the range and number of plans in place and existing triggers to influence action and decision making.

Developing mechanisms to link the Regional Adaptation Plan with other relevant plans in meaningful ways is likely to be a complex and ongoing task, and is likely to be related to ongoing engagement and connection with key sectors in the Region (refer Strategy 1: Build adaptive capacity with the Adaptation Plan and Section 7 regarding implementation of the Regional Adaptation Plan).

Strategy 4: Facilitate long term planning

An ability to plan and allocate resources for the long term future can be inhibited by a political environment focused on the immediate and short term, uncertainty surrounding future resource availability (for example what funding might be available from other levels of government), and statutory time limits on terms of political office and the effect of documents.

Effective implementation of the adaptation pathways, and in particular their resourcing, will require a commitment to planning for the relatively distant future.

The City of Onkaparinga's Climate Change Response Fund is an example of an organisation taking specific measures to address the resourcing of long term and perhaps uncertain challenges.

Actions to progress these 4 strategies are set out in Table 5-2.

Table 5-2: Actions to progress strategies for building adaptive capacity and creating enabling conditions

Actions	Strategies			
	1 Build adaptive capacity	2 Leverage existing values	3 Leverage existing strategic planning tools	4 Facilitate long term planning
1. Recognition of the Adaptation Plan in Councils' and other organisations' Strategic Plans	√		√	
2. An "Adaptation Roadshow" - taking the Plan to organisations within the Region and seeking support and involvement to implement the adaptation pathways	√	√		
3. Develop targeted programs linked to adaptation priorities that: <ul style="list-style-type: none"> - Connect to sector values - Share planning processes, tools and insights - Inspire, encourage and support adaptation 	√	√		
4. Promote the implementation of specific reward and recognition mechanisms for effective change efforts, e.g. the Resilient South Awards	√	√		
5. Tailor communications associated with the Adaptation Plan to connect and appeal to stakeholders' existing values	√	√		
6. Maintain connections and host sector-based forums to inform implementation decisions	√			
7. Investigate broader adoption of City of Onkaparinga's Climate Change Response Fund or like				√

6 Preferred options for adaptation in the Southern Region

Through the IVA and development of adaptation pathways, 57 preferred options across 10 key decision areas have been identified to enable the Southern Region to build resilience and adapt to the impacts of climate change (refer Table 6-1).

Adaptation Action Plan

The preferred options identified in Table 6-1 are brought together within the Resilient South Regional Climate Change Adaptation Action Plan contained in Appendix B.

For each preferred option this Action Plan summarises:

- Key actions to progress implementation of the option;
- Timing for implementation;
- Lead responsibility for initiating and/or driving implementation;
- Others to be involved in implementation; and
- Linkages with other preferred options that may benefit from a coordinated approach to implementation.

It is intended that this Action Plan be used by organisations and individuals across the Southern Region to guide adaptation action, and where required be further developed and refined as new information becomes available or as monitoring and review occurs.

Table 6-1 Preferred options for adaptation in the Southern Region

Key decision area	Preferred option
Coastal management	Coordinated planning and monitoring
	Inform and educate the community and encourage behaviour change
	Review and amend Development Plan policy
	Develop soft structural options
	Construct hard structural options like storm tide barriers or sea walls
Water resources management	Ongoing research to inform adaptation and management
	Educate communities
	Calibrate water resource plans, policy and legislation
	Review and amend Development Plan policy with a focus on water security
	Improve flood management and riparian rehabilitation
	Continued adoption of water sensitive urban design
	Increase domestic and industrial capture of rainwater

Key decision area	Preferred option
	Greater water recycling and waste water re-use
	Increased managed aquifer storage
Natural landscapes	Monitoring and research to undertake situation appraisal and review (hills, plains and hillsface, coastal) Review and amend Development Plan policy (hills, plains and hillsface, coastal) Address current and emerging threats (hills, plains and hillsface, coastal) Maintain habitat values in non-conservation areas (hills, plains and hillsface, coastal) Protect and improve refugia (plains and hillsface) Move species and ecosystems and implement ecosystem engineering (coastal and estuarine).
Marine biodiversity	Research Address marine biodiversity in water management plans Develop marine pest plant and animal management plan Reduce non-climate change threats to marine biodiversity
Vulnerable members of the community	Support for service systems Develop emergency management plans Education, awareness raising, cultural change and building social connectivity Provide essential services subsidies Continue to develop technology for emergency situations Establish emergency response centres and provide assisted transport Develop and maintain vegetated public realm Construct climate sensitive developments
Emergency services	Improve community connectivity, communication, education, awareness and preparation Review and amend development plan policy Increase the number of trained volunteers Continue to improve stormwater management
Open space and public realm	Encourage change in the way we use and manage public realm and open space Install new climate sensitive outdoor infrastructure (cycling, walking, outdoor recreation, tree shades, shading of playgrounds)
Essential services	Strategically manage power outages on high fire risk days Manage native vegetation near power lines Conduct streetscape planning that considers impacts on essential services infrastructure

Key decision area	Preferred option
	Protect key assets from bushfire (eg feeders)
	Increase distributed energy
	Increase electricity feeder automation
	Undergrounding of power cables
	Upgrade cooling systems for telecommunication exchanges
	Install backup power supplies
Manufacturing and business	Review and amend Development Plan policy
	Educate and build capacity of the manufacturing and business sector
	Improve the continuity of supply of essential services, especially electricity
Viticulture	Plant cover crops between rows to prevent erosion
	Improve vine canopy management
	Develop bushfire management plans
	Undertake smoke taint testing/mini fermentation
	Adopt irrigation efficiency measures
	Develop alternative irrigation sources
	Plant varieties more resilient to higher temperatures and less rainfall

6.1 Relevance of preferred adaptation options to domains and sectors

The key preferred adaptation options identified for the Southern Region relate to multiple sectors and domains⁷⁴ reflecting the regional nature of the Regional Adaptation Plan and the involvement of a broad range of stakeholders. This aspect is important as Resilient South is a regional project that aims to deliver a Regional Climate Change Adaptation Plan that guides action on aspects that are important to the Region.

Appendix C shows the relevance of preferred options to domains and sectors. This analysis shows for example, that '**increased domestic and industrial capture of rainwater**' is relevant to multiple sectors including water resources (e.g. rainwater harvesting for reuse, thereby reducing reliance on other sources such as the River Murray), community health and individual wellbeing (e.g. potential savings on water costs for domestic households through capture and reuse of rainwater), energy and water (e.g. alternative sources of water), infrastructure and urban areas (e.g. creation of impervious areas and generation of runoff to be captured and managed), and manufacturing and services (e.g. provide opportunities to increase capture of rainwater).

Understanding the relevance of some preferred options across sectors will be important in progressing the options in an efficient and coordinated way.

⁷⁴ The Adaptation Planning project has viewed the Region and its stakeholders through the framework of three domains and 13 sectors. Refer List of acronyms/glossary of terms for further detail.

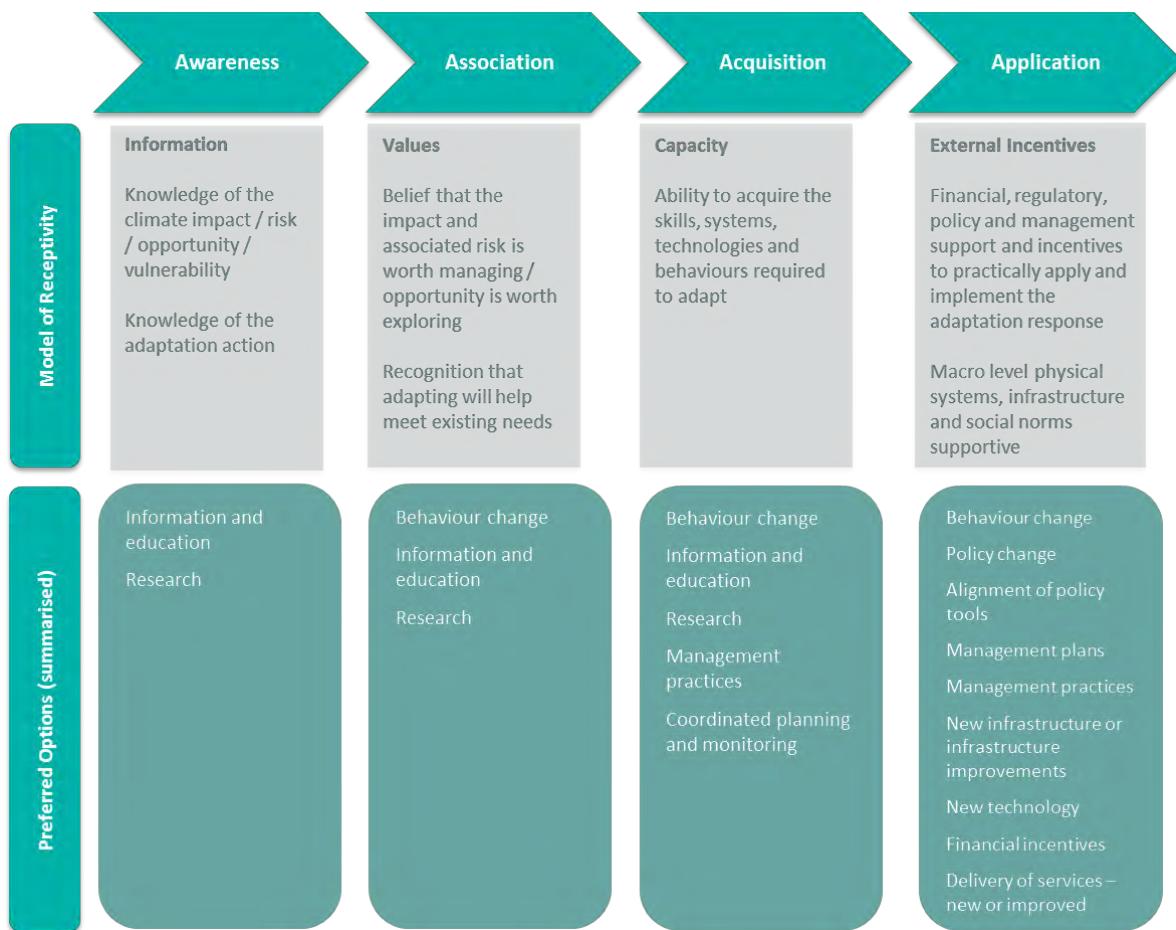
6.2 Preferred options and the Model of Receptivity

The preferred options (and associated actions) forming the Regional Adaptation Plan can be linked to the Model of Receptivity.

To simplify presentation of these links, the 57 preferred options have been summarised into 12 preferred option types (refer Appendix D), set out in Figure 6-1 in relation to the Model of Receptivity. Some preferred options fall into more than one type.

As may be expected of options for adaptation action, most relate to the Application part of the receptivity model.

Figure 6-1 Summary of priority options and the Model of Receptivity



Enabling conditions to support implementation

Creating the conditions to support adaptation action is as important as identifying the actions themselves. The Resilient South Adaptation Planning project has sought to identify enabling conditions which can assist with creating the type of environment that will support adaptation actions to be realised. Based on the research undertaken for Resilient South, enabling conditions include:

- Leading with the Regional Adaptation Plan;
- Supporting regional connections;
- Engaging with values;
- Linking the Regional Adaptation Plan with existing plans; and
- Fostering a long term view.

Section 5 provides more details regarding enabling conditions and ways to progress their creation.

6.3 Monitoring and evaluating implementation of the Regional Adaptation Plan

This Regional Adaptation Plan presents preferred options for adaptation based on information available at the time of its development and local knowledge and input from Project Champions who participated in the project.

It is recommended that this Adaptation Plan to be periodically evaluated, consistent with an adaptive management approach. This will provide the opportunity to consider new information on climate change projections and impacts and to account for changes in adaptive capacity in the Southern Region. Other regions such as the Eyre Peninsula and the South Australian Murray Darling Basin have established a review period of two to three years for their Adaptation Plans. The Southern Region may choose to follow suit, or alternatively, every four to five years to coordinate with the typical release of IPCC reporting.

Developing a Monitoring and Evaluation Framework to underpin this Adaptation Plan will help determine what successful adaptation will look like in the Region. This is an emerging focus for climate change planning in Australia. A recently published Proposed National Adaptation Assessment Framework⁷⁵ was developed by the Australian Government to assist with evaluation and outlines a process and set of national indicators that are also useful at a regional scale.

The Framework is due for completion in 2014 and asks three broad questions that can be adapted for the Southern Region:

1. What drivers in society and the economy would promote good adaptation?
2. What activities would we expect to see now if the Southern Region is adapting well?
3. What outcomes do we expect to see from good adaptation?

⁷⁵ Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (2013) *Climate Adaptation Outlook: A Proposed National Adaptation Assessment Framework*

It is recommended that a Monitoring and Evaluation Framework be developed to support adaptation in the Southern Region and underpin implementation of this Plan, building where relevant on the National Framework.

In developing the Monitoring and Evaluation Framework it will be important to identify both lead and lag indicators. For example, a lead indicator may show trends in exposure to future climate extremes whereas a lag indicator could be the effect of climate hazards on, for example, land prices⁷⁶. Indicators will be required for all key areas of decision making identified throughout the Plan.

Indicators will also need to be identified that can inform major decision points identified in pathways, such as the need to construct hard structural barriers to protect natural and built assets along the coast (see Section 4.4).

6.4 Resilience and opportunities for the Southern Region

The Resilient South Adaptation Planning project has shown that climate change will impact the Southern Region in different ways. As identified by the IVA process, there are a number of indicators which have higher vulnerability to the impacts of climate change relative to others, and these more vulnerable aspects have been the focus of this Regional Adaptation Plan. The IVA process however also identified a number of assets, services or characteristics that have lower vulnerability.

This lower vulnerability could be the result of a combination of one or more reasons, including that the indicator being assessed had lower exposure scores, lower sensitivity scores or higher adaptive capacity scores. An indicator can receive a lower vulnerability score if it is resilient to the climate change variable being assessed or if it has high adaptive capacity. However, if the indicator being considered may benefit from a given climate impact (i.e. an opportunity), this can also be reflected by assigning a low sensitivity score or high adaptive capacity score. Hence, low vulnerability could be as a result of either resilience or an opportunity.

Resilience

The following indicators were identified as having low vulnerability scores as a result of high resilience to future climate change:

- Demand for emergency evacuation centres and facilities – Adaptive capacity was rated as very high because most people will stay with family and friends in case of an emergency and capability already exists to rapidly establish evacuation centres if required;
- GRP from retail trade – Sensitivity was low to moderate and adaptive capacity very high. The very high adaptive capacity was because shopping hours could be altered in response to most extreme events and air-conditioning installed in the case of responding to heatwaves. There was also a view from workshop participants that consumers would just choose to shop on a different day, especially for essential items;
- Costs of waste management – This indicator scored an average vulnerability below the threshold because one of the two variables scored (increased rainfall intensity) was not

⁷⁶ Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (2013) *Climate Adaptation Outlook: A Proposed National Adaptation Assessment Framework*

seen as having a significant impact on the costs of waste management because there are existing arrangements to manage waste which means adaptive capacity is high;

- GRP from education and training; Ability to access educational and lifelong learning facilities – Education and training could be impacted periodically by extreme events that reduce attendance rates, but workshop participants were of the view that classes could be delivered at alternate times or delivered online and so adaptive capacity was high;
- Delivery of potable water – Adaptive capacity was rated as high because the treatment of water could be adjusted, or alternate supplies could be sourced, especially from outside the Region e.g. desalination plant; and
- Groundwater quality and quantity McLaren Vale PWA – Adaptive capacity is considered to be high because of access to additional water through the Willunga Basin Water reclaimed water scheme.

Future climate change adaptation planning processes for the Southern Region could consider how to further build on these areas of resilience or how to promote them as a way of encouraging people to invest and live in the Region.

Opportunities

The following opportunities for the Southern Region as a result of climate change were identified:

- Tourism - Tourism was assessed through the IVA using the following indicators:
 - Tourist accommodation occupancy rates
 - GRP from tourism (Accommodation and food services)

Workshop participants were of the view that based on current experience, any increase in average temperatures was likely to benefit tourism especially in coastal areas through increased visitation to beaches and associated retail outlets and accommodation providers.

- People choosing to live or work in the Region - Workshop participants recognised that while the Southern Region of Adelaide will become warmer in the future, its average temperatures will still be more moderate than areas for example in the north of Adelaide. As such, the Southern Region may become a more popular part of metropolitan Adelaide in which to live and work.

Opportunities presented by adaptation to climate change

In addition to the above opportunities presented by climate change, a number of the preferred options identified in relation to the key decision areas present opportunities in themselves. For example, the capture and reuse of stormwater provides an opportunity to collect and use water from an alternative water source and reduce reliance on other water sources such as the River Murray. This option also presents an opportunity for open space and public realm by providing irrigation to maintain and/or enhance their quality. In the next steps of the project when the identification of priority preferred adaptation options for implementation is undertaken, consideration could be given to options that present opportunities in addition to adapting to climate change.

7 Next steps for implementing the Adaptation Plan

This Regional Adaptation Plan and the actions it proposes are for the consideration of the Southern Region. The Cities of Holdfast Bay, Marion, Mitcham and Onkaparinga are seeking to maintain existing and develop new partnerships with other governments, local business and industry, and non-government organisations to implement the Adaptation Plan and together increase the resilience of our community.

To progress the implementation of the Regional Adaptation Plan over the next 12 months a number of key steps are anticipated including:

- Working with stakeholders (including different sectors, Elected Members, Resilient South Adaptation Planning Project Champions) to identify regional and locally specific priority adaptation options from the 57 preferred options identified by the Adaptation Plan (the map server is a useful tool that can assist with this process).

In particular, it is acknowledged that further engagement is required with local Kaurna people and the business and manufacturing, viticulture and marine biodiversity sectors;

- Reviewing and renewing partnerships with the South Australian and Australian Governments;
- Reflecting on learnings of the Resilient South project and sharing these with other Councils and industry peers;
- Maintaining existing governance arrangements, including the Resilient South Project Heads of Agreement and the Resilient South Project Sector Agreement; and
- Establishing a framework to monitor and evaluate the implementation of the Adaptation Plan.

8 References

- Chiew, F.H., and T. A. McMahon (2002) *'Modelling the impacts of climate change on Australian streamflow'*, *Hydrological Processes*, vol. 16, pp. 1235–1245.
- CSIRO and Bureau of Meteorology (2014) *State of the Climate 2014*, http://www.bom.gov.au/state-of-the-climate/documents/state-of-the-climate-2014_low-res.pdf?ref=button
- Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education (2013). *Climate Adaptation Outlook: A Proposed National Adaptation Assessment Framework*. Commonwealth of Australia.
- Environment Protection Authority (2013) *Adelaide Coastal Water Quality Improvement Plan*
- Government of South Australia (2010) *The 30-Year Plan for Greater Adelaide*
- Haasnoot, M., Kwakkel, J. H., Walker, W. E., and ter Maat, J. (2013). Dynamic adaptive policy pathways: A method for crafting robust decisions for a deeply uncertain world. *Global Environmental Change*. Volume 23: 485–498.
<http://dx.doi.org/10.1016/j.gloenvcha.2012.12.006>)
- Haasnoot, M., Middelkoop, H., Offermans, A., Beek, E., and Deursen, W. (2012). Exploring pathways for sustainable water management in river deltas in a changing environment. *Climatic Change*. Volume 115: 795- 819. (<http://dx.doi.org/10.1007/s10584-012-0444-2>).
- Intergovernmental Panel on Climate Change (2013) Fifth Assessment Report (AR5)
- Jeffrey, P. & Seaton, R.A.F. (2003/04) *A conceptual model of 'receptivity' applied to design and deployment of water policy mechanisms*, *Environmental Sciences*, Vol. 1, No. 3, pp.277-300.
- Jensen Planning and Design (2011) *Discussion Paper: Development Potential within the Catchment. Prepared for Cities of Holdfast Bay and Marion*
- Loughnan, M., N. Tapper, et al. (2013) *A spatial vulnerability analysis of urban populations during extreme heat events in Australian capital cities*, Gold Coast Queensland, National Climate Change Adaptation Research Facility.
- Resilient South (2014) *Climate Change Scenarios Report – Resilient South*, prepared by SKM as part of 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.
- Resilient South (2014a) *Regional Profile – Resilient South*, prepared by URPS for the Cities of Onkaparinga, Holdfast Bay, Marion and Mitcham in association with the Government of South Australia and the Australian Government.

Resilient South (2014b) *Climate Change Risks, Opportunities and Vulnerabilities in the Southern Region*, prepared by URPS and Seed Consulting Services as part of 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.

Resilient South (2014c) *Engagement Feedback Report – Resilient South*, prepared by URPS as part of 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.

Resilient South (2014d) *IVA Technical Report – Resilient South*, prepared by URPS and Seed Consulting Services as part of 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.

Resilient South (2013) *Resilient South Project Background Paper – Transitioning Towards Resilient Futures – Building capacity and commitment to adapt to climate change in the southern Adelaide Region*, prepared by Nina Keath for the Cities of Onkaparinga, Holdfast Bay, Marion and Mitcham in Association with the Government of South Australia and the Australian Government.

Resilient South (2013a) *Stage 1 Stakeholder Engagement Report – Resilient South*, prepared by URPS as part of 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

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

Wise, R. M., Fazey, I., Stafford Smith, M., Park, S. E., Eakin, H. C., Archer, Van Garderen, E. R. M., and Campbell, B. (2014). Reconceptualising adaptation to climate change as part of pathways of change and response. *Global Environmental Change* (on-line) (<http://www.sciencedirect.com/science/article/pii/S095937801300232X>.)

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9 Appendices

Appendix A: Organisations that participated in Resilient South

Organisations that participated in Resilient South

Participation in Resilient South Adaptation Planning project may have occurred via one or more of the following activities throughout the project:

- Receptivity Survey;
- Key informant interview;
- Values workshop;
- Integrated Vulnerability Assessment workshop;
- Adaptation options identification and assessment workshop;
- Adaptation pathways workshop;
- One on one meetings/conversations;
- Elected Member briefings, workshops, regional forums;
- Newsletters.

The following table lists organisations involved in at least 1 workshop or one-on-one discussion across the Resilient South Adaptation Planning project Stages 1, 2 and 3. As shown, some organisations participated in the project across multiple domains.

Participating Organisation/Domain	Environment and Natural Resources Domain	Social and Community Domain	Economy and Infrastructure Domain
Adelaide & Mount Lofty Ranges Natural Resources Management Board	X		
Australian Water Association	X		
Alano Water	X		
Blackwood/Belair District Community Association	X	X	
Business SA			X
City of Holdfast Bay	X	X	X
City of Marion	X	X	X
City of Mitcham	X	X	X
City of Onkaparinga	X	X	X
Comace			X
Community Housing Council of SA		X	
Department for Environment, Water and Natural Resources	X		

Participating Organisation/Domain	Environment and Natural Resources Domain	Social and Community Domain	Economy and Infrastructure Domain
(multiple departments)			
Department for Environment, Water and Natural Resources Adelaide & Mount Lofty Ranges Region	X		
Department of Further Education, Employment, Science and Technology		X	X
Department of Planning, Transport and Infrastructure			X
East Waste			X
Flinders University	X	X	X
Friends of Glenthorne Farm	X		
Friends of the Lower Field River	X		
Friends of Marino Conservation Park	X		
Goodstart Early Learning		X	
Home Grain Bakery Aldinga			X
Housing Industry Association SA			X
Hydramet SA Pty Ltd	X		X
Local Government Association of SA		X	
McLaren Vale Business Association			X
McLaren Vale Grape, Wine & Tourism Association			X
McLaren Vale Water Allocation Plan Committee	X		
Mental Health Coalition of SA		X	
Metro South State Emergency Service		X	
Nano Water	X		X
Noarlunga Health		X	
Office for the Ageing – SA Health		X	
Office for Recreation and Sport		X	
Office for the Southern Suburbs			X
Peter Newland - consultant	X		X
Property Council of Australia (SA)			X

Participating Organisation/Domain	Environment and Natural Resources Domain	Social and Community Domain	Economy and Infrastructure Domain
SA Fire and Emergency Services Commission		X	
SA Tourism Commission			X
SA Water			X
Seaview Downs Primary School		X	
South Australian Council for Social Services		X	
Southern Adelaide Economic Development Board			X
Southern Region Waste Resource Authority			X
Southern Success Business Enterprise Centre			X
Stormwater Industry Association	X		
Surf Life Saving SA (including multiple clubs)		X	
Renewal SA			X
TAFE SA		X	
Trees for Life	X		
Trility Pty Ltd			X
University of Adelaide	X	X	
University of South Australia – Davis Unaipon College of Indigenous Education and Research		X	
Water Industry Alliance	X		X
Water Utilities	X		X
Weed Management Society of South Australia	X		
Zero Waste SA			X

Appendix B: Resilient South Adaptation Action Plan

Resilient South Regional Climate Change Adaptation Action Plan

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead This role could include one or more of the following: <ul style="list-style-type: none"> - Initiation of the preferred action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring and evaluation 	Suggested partner/s This role could include one or more of the following: <ul style="list-style-type: none"> - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring and evaluation 	Linkages with other preferred options I.e. the preferred option is: <ul style="list-style-type: none"> - the same as or similar to another preferred option from a different key decision area; or - the action to implement the preferred option is the same or similar to another from a different key decision area and therefore would benefit from coordinated implementation
Coastal management (CM)						
CM1	Coordinated planning and monitoring	Now	Develop a monitoring strategy to inform decision making regarding the timing for construction of hard structural barriers.	Metropolitan Seaside Councils Committee	Bureau of Meteorology (BOM) Coast Protection Board	-
CM2	Inform and educate the community and encourage behaviour change	Now	Implement education initiatives which focus on raising awareness and understanding of periodic hazards such as flooding from storm surge and how to prepare for and recover from extreme events.	All levels of government	Zone Emergency Management Committee (ZEMC) Department of Environment, Water & Natural Resources (DEWNR) Department of Education and Child Development (DECD) Non-government organisations	WRM2 VMC3 EMS1 MB2 OSPR1
CM3	Review and amend Development Plan policy	Now	Develop a scope for a regional Development Plan review and amendment to address climate change considerations relating to coastal areas in the Southern Region. Areas of focus to include: <ul style="list-style-type: none"> - Revising existing policy based on an assessment of hazards and promoting development in appropriate locations and conversely restricting/preventing development occurring in high risk areas; and - Policy that responds to anticipated climate impacts (e.g. sea level rise, storm surge/coastal inundation). 	Department for Transport, Planning & Infrastructure (DPTI)	Resilient South Councils DEWNR	WRM4 EMS2 MB1 NL2
CM4	Develop soft structural options	Now	Enhance existing dune care programs through the provision of additional resources (financial, support for volunteers or community groups).	Metropolitan Seaside Councils Committee	DEWNR, Natural Resources Adelaide & Mount Lofty Ranges (AMLR) Community groups	-
CM5	Construct hard structural options like storm tide barriers or sea walls	20 to 30 years	Preparatory work includes: <ul style="list-style-type: none"> - Working with other metropolitan coastal Councils outside of the Southern region to establish a coordinated approach to implementation of hard structural options; - Undertaking more detailed investigations into locations identified for hard structural options; and - Establishing points along the coast (e.g. on jetties and/or boat ramps) to monitor the progress of sea level rise. 	Coast Protection Board Metropolitan Seaside Councils Committee	DPTI	-

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead This role could include one or more of the following: <ul style="list-style-type: none"> - Initiation of the preferred action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring and evaluation 	Suggested partner/s This role could include one or more of the following: <ul style="list-style-type: none"> - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring and evaluation 	Linkages with other preferred options I.e. the preferred option is: <ul style="list-style-type: none"> - the same as or similar to another preferred option from a different key decision area; or - the action to implement the preferred option is the same or similar to another from a different key decision area and therefore would benefit from coordinated implementation
Water resources management (WRM)						
WRM1	Ongoing research to inform adaptation and management	Now	Undertake research to better understand the changing nature of rainfall events, soil movement impacts, interactions at the coast such as salt water intrusion and ground water recharge.	DEWNR	Resilient South Councils Stormwater Management Authority (SMA) Goyder Institute BOM	-
WRM2	Educate communities	Now	Implement education initiatives which focus on reducing potable water use. Utilise a range of methods/techniques for educating/communicating/raising awareness including social media, engagement with special interest groups and State-wide advertising campaigns.	Resilient South Councils	SA Water DEWNR, Natural Resources AMLR	CM2 VMC3 EMS1 MB2 OSPR1
WRM3	Calibrate water resource plans, policy and legislation	Now	Integrate new research into water planning activities (e.g. water allocation planning, stormwater management plans etc.).	DEWNR, Natural Resources AMLR Resilient South Councils	SAFECOM	MBIO2
WRM4	Review and amend Development Plan policy with a focus on water security	Now	Develop a scope for a regional Development Plan review and amendment to address climate change considerations relating to water security in the Southern Region.	DPTI	Resilient South Councils Department of Environment, Water & Natural Resources (DEWNR)	CM3 EMS2 MB1 NL2
WRM5	Improve flood management and riparian rehabilitation	Now	Implement Stormwater Management Plans. Enhance existing riparian rehabilitation activities across the region. Undertake riparian rehabilitation for high priority areas. These priority riparian areas include those located on public land (particularly in the hills) and have biodiversity and water quality benefits.	Resilient South Councils DEWNR, Natural Resources AMLR SMA	SAFECOM Community Groups ZEMC	EMS4
WRM6	Continued adoption of water sensitive urban design	Now	Accelerate implementation of WSUD.	Resilient South Councils Developers	DEWNR	OSPR2 WRM6 VMC7
WRM7	Increased domestic and industrial capture of rainwater	Within 10 years	This priority option aims to address major water supply issues. Preparatory work that can start now includes: <ul style="list-style-type: none"> - Determining the best mix of water supply options (e.g. capture and reuse and/or recycled water and waste water reuse, and/or managed aquifer recharge). Targeted monitoring of supply and demand to inform when a decision about additional investment will be required.	Resilient South Councils	SA WATER Major industry/industrial developers DEWNR, Natural Resources AMLR	WRM8 WRM9
WRM8	Greater water recycling and waste water re-use	Within 10 years	As for domestic and industrial capture of rainwater above.	Resilient South Councils SA Water	DEWNR, Natural Resources AMLR Environment Protection Authority (EPA) SA Health	WRM7 WRM9

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead This role could include one or more of the following: <ul style="list-style-type: none"> - Initiation of the preferred action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring and evaluation 	Suggested partner/s This role could include one or more of the following: <ul style="list-style-type: none"> - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring and evaluation 	Linkages with other preferred options I.e. the preferred option is: <ul style="list-style-type: none"> - the same as or similar to another preferred option from a different key decision area; or - the action to implement the preferred option is the same or similar to another from a different key decision area and therefore would benefit from coordinated implementation
WRM9	Increased managed aquifer storage	Within 10 years	As for domestic and industrial capture of rainwater above.	Resilient South Councils SA Water	DEWNR, Natural Resources AMLR	WRM7 WRM8
Natural landscapes (NL)						
NL1	Monitoring and research to undertake situation appraisal and review (hills, plains and hillsface, coastal)	Now	Work with research institutions to develop a monitoring and evaluation framework for climate adapted natural resources management in the region	DEWNR-Natural Resources AMLR	Research institutions	-
NL2	Review and amend Development Plan policy (hills, plains and hillsface, coastal)	Now	Develop a scope for a regional Development Plan review and amendment to address climate change considerations relating to natural landscapes in the Southern Region.	DPTI	Department of Environment, Water & Natural Resources (DEWNR) Resilient South Councils	CM3 EMS2 MB1 WRM4
NL3	Address current and emerging threats (hills, plains and hillsface, coastal)	Now	Conduct an assessment of existing and emerging threats to consider how they will be impacted by climate change paying particular attention to differences that may exist across the three natural landscape types.	DEWNR-Natural Resources AMLR	Resilient South Councils	-
NL4	Maintain habitat values in non-conservation areas (hills, plains and hillsface, coastal)	Now	Identify priority habitat values in non-conservation areas and develop strategies for their maintenance, focusing on potential different actions required across the three natural landscape types.	DEWNR-Natural Resources AMLR	Resilient South Councils	-
NL5	Protect and improve refugia (plains and hillsface)	Now	Identify potential refuge areas and identify actions to protect and improve them. This could include protecting isolated patches of native vegetation, providing additional buffers and managing parts of the environment that provide refuge during climatic extremes.	DEWNR-Natural Resources AMLR	Resilient South Councils	-
NL6	Move species and ecosystems and implement ecosystem engineering (coastal and estuarine).	Within 20-30 years	Preparatory work: Commence work with Department of Environment, Water and Natural Resources (DEWNR), Natural Resources Management (NRM) organisations, the South Australian museum, research institutions and the Royal Zoological Society of South Australia to undertake a risk and vulnerability assessment to identify those species that cannot adapt and the implications of losing them in the region.	DEWNR-Natural Resources AMLR	South Australian museum Research institutions Royal Zoological Society of South Australia Councils	-
Marine biodiversity (MBIO)						
MBIO1	Research	Now	Undertake research focusing on the sensitivity and adaptive capacity of key marine species (e.g. seagrasses and kelp) to climate change impacts. Research to include investigating the effects of individual stressors (e.g. increased temperatures) and multiple stressors (e.g. increased temperature and intensity of rainfall).	Research institutions	DEWNR, Natural Resources AMLR Resilient South Councils	-

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead This role could include one or more of the following: <ul style="list-style-type: none"> - Initiation of the preferred action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring and evaluation 	Suggested partner/s This role could include one or more of the following: <ul style="list-style-type: none"> - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring and evaluation 	Linkages with other preferred options I.e. the preferred option is: <ul style="list-style-type: none"> - the same as or similar to another preferred option from a different key decision area; or - the action to implement the preferred option is the same or similar to another from a different key decision area and therefore would benefit from coordinated implementation
MBIO2	Address marine biodiversity in water management plans	Now	Consider marine biodiversity in the preparation of Water Quality Improvement Plans and Stormwater Management Plans.	DEWNR, Natural Resources AMLR Resilient South Councils	-	WRM3
MBIO3	Develop marine pest plant and animal management plan	Now	Initiate the preparation of marine pest plant and animal management plans.	DEWNR, Natural Resources AMLR	Research institutions	-
MBIO4	Reduce non-climate change threats to marine biodiversity	Now	Reduce stormwater and wastewater discharges to the Gulf. Manage the potential spread of pest plant and animal species.	SA WATER DEWNR, Natural Resources AMLR Resilient South Councils	EPA DECD	WRM3 WRM5 EMS4
Vulnerable members of the community (VMC)						
VMC1	Support for service systems (to assist the young, elderly/frail aged and those reliant on assistance for core activities)	Now	Undertake a review of how future climate hazards will impact non-government organisation (NGO) service delivery in the social services sector.	South Australian Council of Social Service (SACOSS) DHA	NGOs Resilient South Councils	-
VMC2	Develop emergency management plans	Now	Undertake emergency management planning focusing on facilities that are housing or caring for vulnerable members of the community (e.g. aged care facilities).	SAFECOM Service providers	Resilient South Councils	-
VMC3	Education, awareness raising, cultural change and building social connectivity	Now	Implement education initiatives which focus on: <ul style="list-style-type: none"> - Raising awareness and understanding of periodic hazards such as bushfire, flooding and heatwaves and how to prepare for and recover from extreme events; and - Promoting individual health and well being. Undertake/support initiatives which contribute to building social connectivity including: <ul style="list-style-type: none"> - Developing a culture of civic leadership and community action; - Increasing and broadening general participation in social activities and civic processes; and - Encouraging partnerships and collaboration to enhance formal and informal support networks. 	Resilient South Councils	DHA Country Fire Service ZEMC DEWNR, Natural Resources AMLR DECD NGOs	CM2 WRM2 EMS1 MB2 OSPR1
VMC4	Provide essential services subsidies	Now	Investigate opportunities to progress the provision of essential services subsidies (e.g. to offset the full cost of electricity) to support people on low incomes to use air-conditioners or other cooling strategies during heatwave.	State Government Resilient South Councils	Essential services providers	-
VMC5	Continue to develop technology for emergency situations	Now	Utilise and expand existing technology for emergency situations such as existing services like the Red Cross Telecross service.	Australian Red Cross	SAFECOM ZEMC	-

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead This role could include one or more of the following: <ul style="list-style-type: none"> - Initiation of the preferred action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring and evaluation 	Suggested partner/s This role could include one or more of the following: <ul style="list-style-type: none"> - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring and evaluation 	Linkages with other preferred options I.e. the preferred option is: <ul style="list-style-type: none"> - the same as or similar to another preferred option from a different key decision area; or - the action to implement the preferred option is the same or similar to another from a different key decision area and therefore would benefit from coordinated implementation
VMC6	Establish emergency response centres and provide assisted transport	Now	Identify locations for emergency response centres and opportunities to provide assisted transport via the ZEMP for the Southern region.	SAFECOM	Resilient South Councils	-
VMC7	Develop and maintain vegetated public realm	Now	Prioritise the vegetation of public realm as a way to reduce the impacts of the urban heat island effect, and contribute to the health and wellbeing of communities. Develop guidelines for the planting and maintenance of species that are low water use and require minimal maintenance. Identify priority locations for vegetating the public realm (e.g. low income areas, areas currently low vegetation, areas of high vulnerability due to heat).	Resilient South Councils	DEWNR (State owned public land)	OSPR2 WRM6
VMC8	Construct climate sensitive developments	Within 10 years	Preparatory work: Investigate ways to support adoption of climate sensitive development e.g. formalised arrangement (e.g. via partnership, Memorandum of Understanding or Heads of Agreement) between key developers and Resilient South Councils to encourage climate resilient development.	Resilient South Councils Key developers	Urban Development Institute of Australia (UDIA) Property Council Housing Industry Association (JIA) Renewal SA DPTI	-
Emergency services (EMS)						
EMS1	Improve community connectivity, communication, education, awareness and preparation	Now	Implement education initiatives which focus on: <ul style="list-style-type: none"> - Raising awareness and understanding of periodic hazards such as bushfire, flooding and heatwaves and how to prepare for and recover from extreme events Utilise a range of methods/techniques for educating/communicating/raising awareness including social media, engagement with special interest groups and State-wide advertising campaigns. Undertake/support initiatives which contribute to building social connectivity including: <ul style="list-style-type: none"> - Developing a culture of civic leadership and community action; and - Increasing and broadening general participation in social activities and civic processes. Encouraging partnerships and collaboration to enhance formal and informal support networks.	Resilient South Councils	Department for Health & Ageing (DHA) Country Fire Service ZEMC DECD NGOs	CM2 WRM2 VMC3 MB2 OSPR1
EMS2	Review and amend Development Plan policy	Now	Develop a scope for a regional Development Plan review and amendment to address climate change considerations across the Resilient South Councils' areas relating to emergency management : Areas of focus to include: <ul style="list-style-type: none"> - Revising existing policy based on an assessment of hazards and promoting development in appropriate locations and conversely restricting/preventing development occurring in high risk areas; and - Policy that responds to anticipated climate impacts (e.g. bushfire, flooding). 	DPTI	Resilient South Councils DEWNR	CM3 WRM4 MB1 NL2

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead This role could include one or more of the following: <ul style="list-style-type: none"> - Initiation of the preferred action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring and evaluation 	Suggested partner/s This role could include one or more of the following: <ul style="list-style-type: none"> - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring and evaluation 	Linkages with other preferred options I.e. the preferred option is: <ul style="list-style-type: none"> - the same as or similar to another preferred option from a different key decision area; or - the action to implement the preferred option is the same or similar to another from a different key decision area and therefore would benefit from coordinated implementation
EMS3	Increase the number of trained volunteers	Now	Develop and implement strategies to attract more volunteers to emergency services organisations. Provide training support for emergency services organisations.	SAFECOM	Resilient South Councils Community Groups	-
EMS4	Continue to improve stormwater management	Now	Implement Stormwater Management Plans. Undertake further investigations now to determine the most appropriate location and design requirements for stormwater management infrastructure to cope with a projected increase in flood risk.	Resilient South Councils DEWNR, Natural Resources AMLR SMA	SMA SAFECOM Community Groups ZEMC	WRM5
Open space and public realm (OSPR)						
OSPR1	Encourage change in the way we use and manage public realm and open space	Now	Raise awareness regarding: <ul style="list-style-type: none"> - Managing the impacts of climate change on personal health and wellbeing (e.g. change time of day spaces are used to reduce dehydration from extreme heat); and - The impacts of climate change on infrastructure and experiences provided by open space and public realm. Prepare a regional framework to guide the management of open space across the region. This framework would assist the Councils to focus efforts on the provision of high quality open space areas as this ability to deliver current standards of open space diminishes across the region due to reduced water availability, resources etc.	Resilient South Councils	DEWNR (State owned public land)	CM2 WRM2 VMC3 EMS1 MB2
OSPR2	Install new climate sensitive outdoor infrastructure (cycling, walking, outdoor recreation, tree shades, shading of playgrounds)	Now	Develop guidelines for the design and construction of climate sensitive outdoor infrastructure. Climate sensitive outdoor infrastructure is infrastructure designed and constructed to take into account anticipated climate impacts, and could involve: <ul style="list-style-type: none"> - Utilising materials that are more resilient to extreme weather such as extreme heat, wind and rainfall; - Designing and constructing footpaths and trails that can cope with extreme rainfall, flooding from storm surge events and heat; and - Providing shade via vegetation or built structures for playspaces and playgrounds and adjacent to walking and cycling paths. Incorporate the development and maintenance of climate sensitive outdoor infrastructure into relevant Council plans and policies such as Asset Management Plans, Playground Strategies, Open Space and Public Realm Strategies, Procurement Policies etc. Identify priorities for implementing climate sensitive infrastructure across the region (e.g. playgrounds for installation of shade).	Resilient South Councils	State Government	WRM6 VMC7
Essential services (ES)						

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead <i>This role could include one or more of the following:</i>	Suggested partner/s <i>This role could include one or more of the following:</i>	Linkages with other preferred options <i>I.e. the preferred option is:</i> <ul style="list-style-type: none">- the same as or similar to another preferred option from a different key decision area; or- the action to implement the preferred option is the same or similar to another from a different key decision area and therefore would benefit from coordinated implementation
ES1	Strategically manage power outages on high fire risk days	Now	Implement power outages on high fire risk days.	Essential services providers	-	-
ES2	Manage native vegetation near power lines	Now	Manage native vegetation near power lines.	Essential services providers	-	VMC7 ES3
ES3	Conduct streetscape planning that considers impacts on essential services infrastructure	Now	Design and construct streetscapes which take into account essential services (e.g. species selection for planting under/near power lines).	Resilient South Councils	Essential services providers	VMC7 ES2
ES4	Protect key assets from bushfire (eg feeders)	Now	Identify key assets which are at risk to bushfire and implement protection measures (e.g. clearance of native vegetation).	Essential services providers	-	-
ES5	Increase distributed energy	Now	Further adoption of distributed energy across the region.	Industrial and domestic users	Essential service providers	-
ES6	Increase electricity feeder automation	Within 10 years	Preparatory work: Conduct a feasibility study into the costs and benefits of different supply and protection strategies, involving regional organisations, essential services providers and regulators.	Essential service providers	-	ES7 ES8 ES9
ES7	Undergrounding of power cables	Within 10 years	Preparatory work: Conduct a feasibility study into the costs and benefits of different supply and protection strategies, involving regional organisations, essential services providers and regulators.	Essential service providers	Resilient South Councils State Government	ES6 ES8 ES9
ES8	Upgrade cooling systems for telecommunication exchanges	Within 10 years	Preparatory work: Conduct a feasibility study into the costs and benefits of different supply and protection strategies, involving regional organisations, essential services providers and regulators.	Essential service providers	-	ES6 ES7 ES9
ES9	Install backup power supplies	Within 10 years	Preparatory work: Conduct a feasibility study into the costs and benefits of different supply and protection strategies, involving regional organisations, essential services providers and regulators.	Industrial/business/ major users	Essential service providers Resilient South Councils RDA	ES6 ES7 ES8
Manufacturing and business (MB)						
MB1	Review and amend Development Plan policy	Now	Develop a scope for a regional Development Plan review and amendment to address climate change considerations across the Resilient South Councils' areas. Specific areas for focus include: <ul style="list-style-type: none">- Revising existing policy based on an assessment of hazards and promoting development in appropriate locations and conversely restricting/preventing development occurring in high risk areas (e.g. bushfire, flooding, coastal inundation); and- Reviewing policy to allow more flexible operating hours for manufacturing and business activities.	DPTI	Resilient South Councils Manufacturing and business	CM3 WRM4 EMS2 NL2

	Preferred option	Pathway timing	Actions to implement preferred option	Suggested lead <i>This role could include one or more of the following:</i>	Suggested partner/s <i>This role could include one or more of the following:</i>	Linkages with other preferred options <i>I.e. the preferred option is:</i>
				<ul style="list-style-type: none"> - Initiation of the preferred action - Coordination with partners - Implementation - Funding or in kind support - Advocacy - Monitoring and evaluation 	<ul style="list-style-type: none"> - Implementation - Funding or in kind support - Advocacy - Participation - Monitoring and evaluation 	<p>I.e. the preferred option is:</p> <ul style="list-style-type: none"> - the same as or similar to another preferred option from a different key decision area; or - the action to implement the preferred option is the same or similar to another from a different key decision area <p>and therefore would benefit from coordinated implementation</p>
MB2	Educate and build capacity of the manufacturing and business sector	Now	<p>Implement education and capacity building initiatives which focus on the manufacturing and business sector including:</p> <ul style="list-style-type: none"> - Information systems; - Websites; - Energy efficiency and backup; - Water use and efficiency; and - Emergency management planning. <p>Utilise a range of methods/techniques for educating/communicating/raising awareness including social media, engagement with special interest groups and State-wide advertising campaigns.</p>	Resilient South Councils	<p>Department of Manufacturing, Innovation, Trade, Resources & Energy (DMITRE)</p> <p>Country Fire Service</p> <p>ZEMC</p>	CM2 WRM2 VMC3 EMS1 OSPR1
MB3	Improve the continuity of supply of essential services, especially electricity	Within 20 years	<p>Preparatory work</p> <p>Conduct business case assessments to determine the best combination of options to improve the continuity of supply of essential services. This may include back up power supply options and greater adoption of distributed energy solutions.</p>	Industrial users	<p>Essential service providers</p> <p>Regional Development Australia</p>	ES5 ES6 ES7 ES9
Viticulture (V)						
V1	Plant cover crops between rows to prevent erosion	Now	Cover crops between rows to prevent erosion.	Viticulture	-	-
V2	Improve vine canopy management	Now	Implement vine canopy management.	Viticulture	-	-
V3	Develop bushfire management plans	Now	Prepare bushfire risk management plans.	Viticulture	-	-
V4	Undertake smoke taint testing/mini fermentation	Now	Undertake smoke taint testing/mini fermentation.	Viticulture	-	-
V5	Adopt irrigation efficiency measures	Now	Implement irrigation efficiency measures.	Viticulture	-	-
V6	Plant varieties more resilient to higher temperatures and less rainfall	Now	Commence work now to determine what varieties are more resilient to higher temperatures and less rainfall and how these will be received by the market.	Viticulture	Research institutions	-
V7	Develop alternative irrigation sources	Within 10 years	Preparatory work: Investigate alternative irrigation sources.	Viticulture	Willunga Basin Water Company	WRM8

Appendix C: Preferred options for adaptation and relevance to multiple sectors

Domain	Key decision areas	Preferred options for adaptation	Domain												
			Environment and natural resources		Social and community		Economy and infrastructure								
			Sector												
Domain	Key decision areas	Preferred options for adaptation	Water resources	Coastal management	Biodiversity	Community health and individual wellbeing	Emergency management	Culture and heritage	Energy and water	Waste	Tourism	Transport	Food and Wine	Infrastructure and urban areas	Manufacturing and services
Environment and natural resources	Coastal management	Coordinated planning and monitoring		✓		✓	✓						✓		
		Inform and educate the community and encourage behaviour change		✓		✓	✓				✓				
		Review and amend Development Plan policy	✓	✓	✓	✓							✓	✓	
		Develop soft structural options		✓	✓	✓									
		Construct hard structural options like storm tide barriers or sea walls		✓		✓	✓						✓		
	Water resources management	Ongoing research to inform adaptation and management	✓	✓	✓										
		Educate communities	✓		✓	✓				✓					
		Calibrate water resource plans, policy and legislation	✓		✓				✓				✓		
		Review and amend Development Plan policy with a focus on water security	✓		✓		✓		✓				✓	✓	
		Improve flood management and riparian rehabilitation	✓		✓	✓	✓	✓					✓		
		Continued adoption of water sensitive urban design	✓	✓	✓	✓							✓	✓	
		Increase domestic and industrial capture of rainwater	✓			✓			✓				✓	✓	
		Greater water recycling and waste water re-use	✓		✓	✓	✓	✓	✓				✓	✓	
		Increased managed aquifer storage	✓						✓				✓	✓	
		Monitoring and research to undertake situation appraisal and review (hills, plains and hillsface, coastal)		✓	✓	✓					✓				
	Natural landscapes	Review and amend Development Plan policy (hills, plains and hillsface, coastal)		✓	✓	✓	✓				✓			✓	
		Address current and emerging threats (hills, plains and hillsface, coastal)		✓	✓	✓					✓				
		Maintain habitat values in non-conservation areas (hills, plains and hillsface, coastal)		✓	✓	✓					✓				
		Protect and improve refugia (plains and hillsface)			✓	✓					✓				
		Move species and ecosystems and implement ecosystem engineering (coastal and estuarine).		✓	✓	✓					✓				
		Research		✓	✓										
	Marine biodiversity	Address marine biodiversity in water management plans	✓		✓										
		Develop marine pest plant and animal management plan			✓										
		Reduce non-climate change threats to marine biodiversity	✓		✓					✓			✓		

Domain	Key decision areas	Preferred options for adaptation	Domain												
			Environment and natural resources		Social and community		Economy and infrastructure								
			Sector												
Domain	Key decision areas	Preferred options for adaptation	Water resources	Coastal management	Biodiversity	Community health and individual wellbeing	Emergency management	Culture and heritage	Energy and water	Waste	Tourism	Transport	Food and Wine	Infrastructure and urban areas	Manufacturing and services
Social and community	Vulnerable members of the community	Support for service systems				✓	✓								
		Develop emergency management plans				✓	✓								
		Education, awareness raising, cultural change and building social connectivity				✓	✓								
		Provide essential services subsidies				✓			✓						
		Continue to develop technology for emergency situations				✓	✓							✓	
		Establish emergency response centres and provide assisted transport				✓	✓					✓			
		Develop and maintain vegetated public realm	✓	✓	✓	✓			✓				✓		
		Construct climate sensitive developments	✓	✓	✓	✓							✓	✓	
Emergency services	Emergency services	Improve community connectivity, communication, education, awareness and preparation				✓	✓								
		Review and amend development plan policy	✓			✓	✓							✓	
		Increase the number of trained volunteers				✓	✓								
		Continue to improve stormwater management	✓	✓					✓				✓		

Domain	Key decision areas	Preferred options for adaptation	Domain									
			Environment and natural resources		Social and community		Economy and infrastructure					
			Sector									
Water resources	Coastal management	Biodiversity	Community health and individual wellbeing	Emergency management	Culture and heritage	Energy and water	Waste	Tourism	Transport	Food and Wine	Infrastructure and urban areas	Manufacturing and services
Economy and infrastructure	Open space and public realm	Encourage change in the way we use and manage public realm and open space	✓	✓							✓	
		Install new climate sensitive outdoor infrastructure (cycling, walking, outdoor recreation, tree shades, shading of playgrounds)	✓	✓	✓						✓	
	Essential services	Strategically manage power outages on high fire risk days			✓			✓				
		Manage native vegetation near power lines			✓	✓		✓				
		Conduct streetscape planning that considers impacts on essential services infrastructure			✓	✓		✓			✓	
		Protect key assets from bushfire (eg feeders)			✓	✓		✓				
		Increase distributed energy					✓				✓	
		Increase electricity feeder automation					✓					
		Undergrounding of power cables					✓				✓	
		Upgrade cooling systems for telecommunication exchanges					✓					
		Install backup power supplies					✓				✓	✓
	Manufacturing and business	Review and amend Development Plan policy			✓	✓						✓
		Educate and build capacity of the manufacturing and business sector			✓							✓
		Improve the continuity of supply of essential services, especially electricity				✓						✓
Agriculture	Viticulture	Plant cover crops between rows to prevent erosion									✓	
		Improve vine canopy management									✓	
		Develop bushfire management plans				✓					✓	
		Undertake smoke taint testing/mini fermentation									✓	
		Adopt irrigation efficiency measures	✓								✓	
		Develop alternative irrigation sources	✓				✓				✓	
		Plant varieties more resilient to higher temperatures and less rainfall									✓	

Appendix D: Adaptive characteristics and enabling conditions as they relate to the preferred options for adaptation

Summary option type	Preferred options
Behaviour change	Inform and educate the community and encourage behaviour change Recycled water and waste water re-use Cultural change and building social connectivity Encourage change in the way we use and manage public realm and open space Strategic power outages on high fire risk days Maintain habitat values in non-conservation areas Climate sensitive development
Coordinated planning and monitoring	Coordinated planning and monitoring (re sea level rise and timing for construction of hard structural barriers) Monitor distribution and abundance patterns of species
Information and education	Inform and educate the community and encourage behaviour change Encourage change in the way we use and manage public realm and open space
Research	Ongoing research to inform adaptation and management Undertake research (e.g. current and future species distribution) Identify future refuge/protected areas (for native ecosystems) Eco system engineering Research (marine biodiversity)
Policy change	Review and amend Development Plan policy Streetscape planning that considers impacts on essential services infrastructure
Alignment of policy tools	Calibrate water resources plans, policy and legislation
Management plans	Emergency management planning Management Plans (for natural landscapes) Bushfire risk management plans (for viticulture) Address marine biodiversity in water management plans Marine pest plant and animal management plan Improved stormwater management Flood management

Summary option type	Preferred options
Management practices	Soft structural options (for coastal areas) Flood management and riparian rehabilitation Improved stormwater management Domestic and industrial capture of rainwater Managed aquifer recharge Develop and maintain vegetated public realm Encourage change in the way we use and manage public realm and open space Active threat management (e.g. pest control, storm water management) Develop methods for large-scale habitat restoration and corridors Species translocations Eco system engineering Manage native vegetation new power lines Strategic protection of key assets from bushfire Cover crops between rows to prevent erosion (viticulture) Vine canopy management Smoke taint testing/mini fermentation Irrigation efficiency measures (for viticulture) Alternative irrigation sources (for viticulture) Alternative grape varieties more resilient to higher temperatures and less rainfall Reduce non-climate change threats to marine biodiversity Continued adoption of water sensitive urban design Maintain habitat values in non-conservation areas Streetscape planning that considers impacts on essential services infrastructure
New infrastructure or infrastructure improvements	Hard structural options like storm tide barriers or sea walls Domestic and industrial capture of rainwater Recycled water and waste water re-use New climate sensitive outdoor infrastructure Distributed energy (e.g. solar PV) Increase electricity feeder automation Underground power cables Upgrade cooling systems for telecommunications exchanges Backup power supplies Continuity of supply of essential services (e.g. backup power, distributed energy) Reduce non-climate change threats to marine biodiversity Continued adoption of water sensitive urban design Climate sensitive development Improved stormwater management
New technology	Technology for emergency situations Increase electricity feeder automation
Financial incentives	Essential services subsidies
Delivery of services – new or improved	Support for service systems Emergency response centres and assisted transport Increase trained volunteers