Australian Government
Department of Climate Change and Energy Efficiency

CLIMATE CHANGE ADAPTATION ACTIONS FOR LOCAL GOVERNMENT

Report by SMEC Australia

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Important notice – please read

This publication is the second update of the original edition of the Climate Change Adaptation Actions for Local Government publication prepared by SMEC Australia and published by the Australian Greenhouse Office, Department of the Environment and Water Resources in 2007.

The views and opinions expressed in this publication are those of the authors and do not necessarily reflect those of the Australian Government.

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1 Introduction

1.1 CLIMATE CHANGE CONTEXT

Preparing Australia for the unavoidable impacts of climate change is imperative. Australia's climate is clearly changing and increasing temperatures, sea level rise, changing rainfall patterns and more frequent and intense extreme climatic events are likely. Many Australian sectors and systems are highly vulnerable to climate change, including the functions and responsibilities of Australian local governments.

This report was developed as part of the Australian Government's support for adaptation to climate change and aims to help to address the need to prepare Australian governments, vulnerable industries, communities and ecosystems to manage the unavoidable consequences of climate change. This report forms part of a suite of tools being developed to assist local governments in identifying and implementing climate change adaptation actions. In particular, this report complements *Climate Change Impacts & Risk Management – A Guide for Business and Government*, released in 2006.

This report has evolved from the understanding that the level of uncertainty of climate change projections makes it difficult for local governments to prioritise their commitment to adaptation. The most effective adaptation to a changing climate appears to require knowledge of both how the climate will change and how the changes will affect the environment, society and the economy. In addition, changes in other key variables, such as technology, personal preferences and social values, will also influence the rate of climate change, our ability to adapt to it and an increased focus on adaptation planning.

The most easily implemented adaptation actions for local governments are those that, regardless of what changes are occurring to Australia's climate, will provide a net benefit to the environment, society and/or the economy. The fact that some degree of benefit or co-benefits will occur irrespective of the scale of climate change, will help lessen the difficulties associated with scientific uncertainty when implementing adaptation actions.

1.2 REPORT OUTLINE

The primary objective of this report is to identify climate change adaptation actions that are applicable to Australia's climatic conditions and climate impact risks as currently predicted (using the Climate Change in Australia Technical Report 2007) and that can be implemented by Australian local governments. In developing these actions, the following six local functions were considered:

- infrastructure and property services
- provision of recreation facilities
- health services
- planning and development approvals
- natural resource management
- water and sewerage services.

The adaptation actions that have been identified during this study are those that provide a net economic, social or environmental benefit no matter what level of climate change occurs. The actions that are identified in this report have been developed through:

a) Literature Review

A review was undertaken of the existing literature and information on climate change adaptation actions available at both the international and domestic level that are relevant to the key responsibilities of local government. A full list of all references is provided at Section 6.

b) Key Informant Interviews

To support the review of relevant information addressing climate change adaptation strategies and the development of possible new strategies, informal discussions were held with a number of relevant stakeholders. During these discussions, stakeholder views were obtained on the possible types of adaptation strategies, existing local government initiatives that were of relevance to climate change adaptation, and recommendations of possible mechanisms for implementation. Consulted organisations are identified at Appendix A.

2 Climate Change Projections

2.1 GLOBAL CLIMATE CHANGE

Over the twentieth century, average air temperatures at the earth's surface increased by approximately 0.74°C (IPCC, 2007). It is very likely that greenhouse gas emissions generated by human activities caused most of the observed increase in globally averaged temperatures since mid-20th century (IPCC, 2007). These temperature increases have also influenced the global hydrological cycle. Precipitation in some regions of the world has increased significantly while more intense and longer droughts have been observed since the 1970s in other regions (IPCC 2007).

Since 1990, the Intergovernmental Panel on Climate Change (IPCC) has provided regular comprehensive scientific assessments of past, present and future climate change with four scientific assessments having being undertaken to date in 1990, 1996, 2001 and 2007.

The most recent assessment by the IPCC in 2007 made the following conclusions and projections about global climate change:

- an increase in the strength of evidence suggesting that most of the global warming that has been observed over the last 50 years can be attributed to human activities
- an average warming of 1.1 to 6.4 °C by 2090-99 relative to 1980-1999 temperatures
- an average sea level rise between 0.18 and 0.59 metres by 2090-99 (these figures do not include the full effects of recent accelerated changes in ice sheet flow)
- increases in the amount of precipitation is very likely in high-latitudes, while decreases are likely in most subtropical land regions and
- extreme climate events – hot extremes, heat waves and heavy rainfall – are very likely to become more frequent.

2.2 CLIMATE CHANGE PROJECTIONS FOR AUSTRALIA

Historical global changes have been mirrored in Australia where average temperatures have increased by about 0.9 °C since 1950 (Climate Change in Australia, 2007). Precipitation in Western Australia and along Australia's east coast has declined steadily since the mid-20th century, while precipitation has increased in the northwest (IPCC, 2007). There has also been an increase in extreme rainfall events throughout Australia, particularly during winter. In summary, projections suggest that:

- the best estimate of annual warming over Australia by 2030 is 1°C (0.7-0.9ºC in coastal areas and 1-1.2ºC inland) and up to 5°C by 2070 (Climate Change in Australia) – this may result in more evaporation and hot days and fewer cold nights
- annual rainfall will generally decrease in south west Western Australia and in the south east of Australia (mainly in winter and spring).

SCENARIOS

Projections for future change are largely determined by the scenario that is used. The Intergovernmental Panel on Climate Change (IPCC) has developed a series of scenarios that represent different development and emission pathways. These scenarios are used in climate models to develop projections of future climate. More on the IPCC scenarios can be found at www.ipcc.ch. For the year 2030 only the A1B scenario is

presented as this period represents the climate change we are already locked in to and there is there is little difference between the model projections for this period. For 2070, the B1, A1B and A1FI scenarios are presented. B1 represents a future where carbon dioxide emissions are successfully stabilised at 550 parts per million. A1B represents a mid way emission scenario while A1FI represents a future where mitigation efforts are limited, emissions remain high and/or the climate's response to emissions is highly sensitive.

TEMPERATURE

It is predicted that by 2030, annual average temperatures will be 1°C higher over most of the Australian continent with the greatest potential for warming to occur in north-west Australia. By 2070 annual average temperatures are projected to have increased by up to 5°C with a best estimate of 3.4°C, under the A1FI scenario, over most of Australia (Climate Change in Australia, 2007). *Figures 1a* and *1b* illustrated projected temperature changes in Australian and *Table 1* summarises these changes.

Figure 1a: Projected changes in Australian temperature by 2030

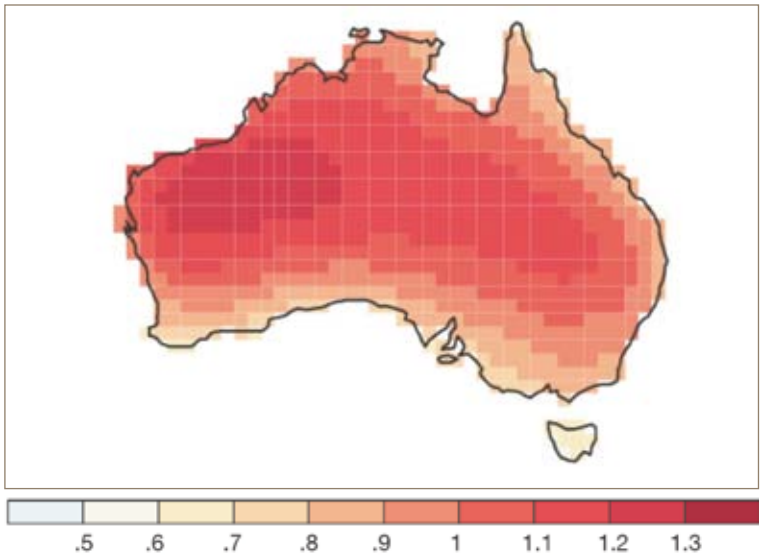


Figure 1a: Best estimate (50th percentile) of the annual change in average temperature (°C) over land by 2030 for the A1B emission scenario. Source: Climate Change in Australia – Technical Report 2007

Figure 1b: Projected changes in Australian temperature by 2070 under the B1, A1B and A1FI scenario

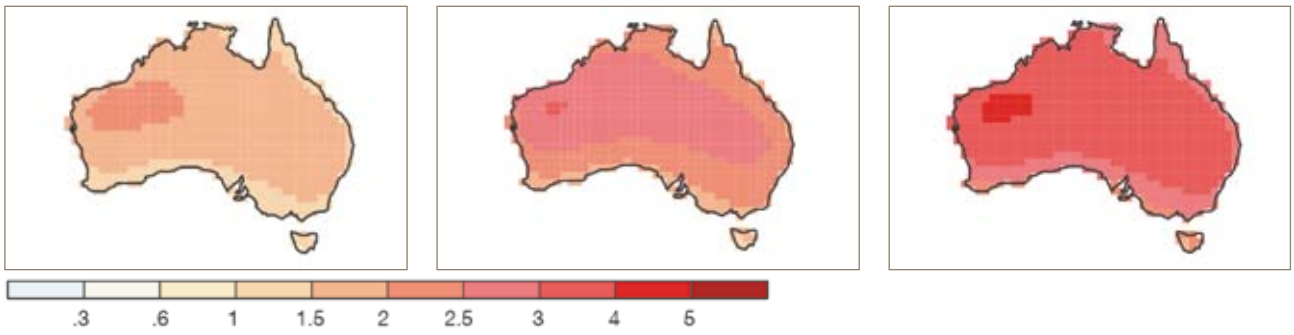


Figure 1b: Best estimate (50th percentile) of projected change of annual mean temperature (°C) for 2070 under the B1, A1B and A1FI scenarios. Source: Climate Change in Australia – Technical Report 2007

Increases in average temperature can lead to large changes in the occurrence of extremely hot or cold days and night with the average number of hot days and nights to increase across most of Australia.

Future changes in variability of daily temperature extremes are relatively small, with the increases in average minimum and maximum temperature determining the change in the extremes.

Table 1: Summary of Temperature Changes

YEAR	PROJECTED TEMPERATURE INCREASE	REGIONAL AND TEMPORAL VARIATION
2030	1°C (range 0.7 to 1.2°C)	The greatest warming is expected in the north west of Australia. In-land areas are expected to warm more than coastal areas. Warming is expected to be greatest in the spring.
2070	1 to 2.5°C (best estimate 1.8°C) under the B1 (low emission scenario) 2.2 to 5°C (best estimate 3.4°C) under A1FI (high emission scenario)	

RAINFALL

The regional variation of average annual rainfall is expected to change across Australia, with a tendency to decreased rainfall across much of southern and eastern Australia and little change in the north. In combination with increased evaporation (see below), changed rainfall patterns are expected to result in reduced stream flow across most of the country. Most models simulate an increase in extreme daily rainfall leading to more frequent heavy rainfall events. The extent of average projected seasonal and annual changes in Australian rainfall for 2030 and 2070 relative to 1990 are represented in *Figure 2a* and *2b*.

Figure 2a: Projected changes to Australian rainfall by 2030

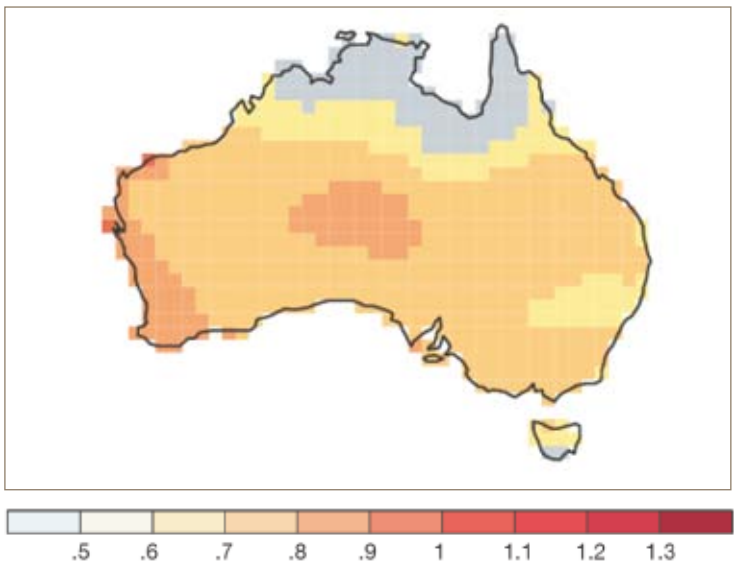


Figure 2a: Best estimate (50th percentile) of the annual projected change of Australian precipitation by 2030 under the A1B scenario as a percentage of 1961-1990 values.

Source: Climate Change in Australia – Technical Report 2007

Figure 2b: Projected changes to Australian rainfall by 2070 under the B1, A1B and A1FI scenarios

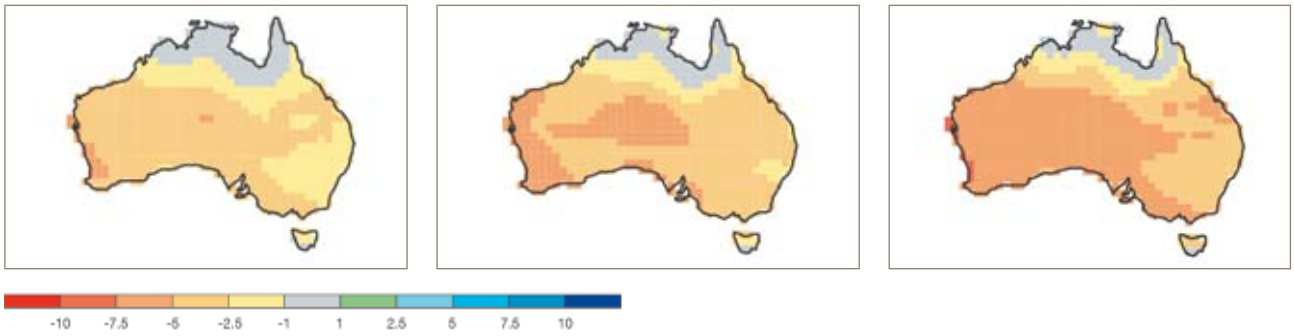


Figure 2b: Best estimate (50th percentile) of percentage change in annual precipitation for 2070 under the B1, A1B and A1FI scenario. Source: Climate Change in Australia – Technical Report 2007

EVAPORATION

Evaporation is likely to increase due to higher temperatures with increases expected in all seasons ranging from 0-6% increases in 2030 (best estimate 2%) to best estimates of 3-6% by 2070 in the south and west and 6-10% in the north and east.

Figure 3: Projected changes to Australian evaporation in 2070 under the B1, A1B and A1FI scenarios

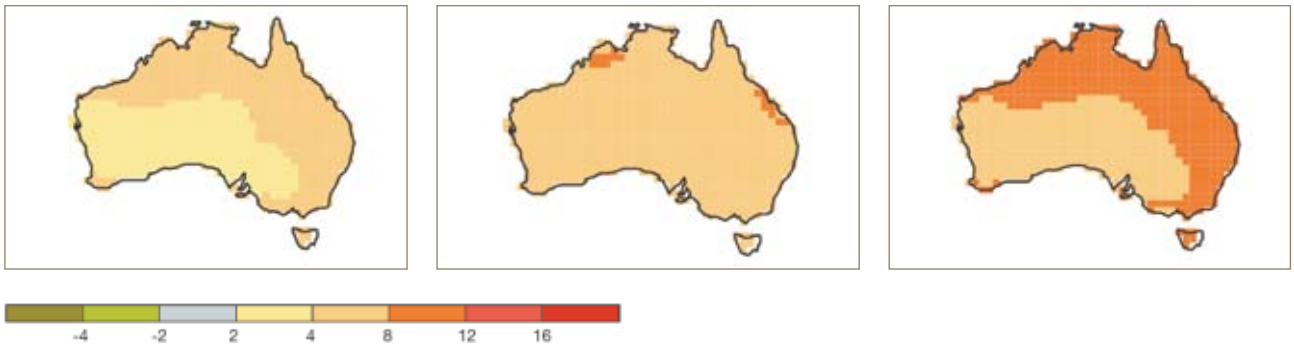


Figure 3: Median (50th percentile) changes in annual potential evapotranspiration in 2070 relative to 1990 under the B1, A1B and A1FI scenario. Source: Climate Change in Australia – Technical Report 2007

The overall pattern shows a decrease in moisture balance nationally and therefore greater moisture stress across much of Australia with average decreases in moisture balance expected to range from 15 to 160mm by 2030 and 40 to 500mm by 2070.

SEA LEVEL RISE

Mean sea level rise is expected to increase with local and regional variations due to land-sea movements and changes to ocean currents. The anticipated extent of sea level rise is estimated to be18 to 76 cm by 2100 including contributions from ice sheet dynamics (IPCC 2007). However higher levels cannot be ruled out with recent research suggesting 1 m is a plausible estimate (Rahmstorf 2007, Pfeffer 2008). Shoreline retreat can be 50 – 200 times the vertical sea level rise, depending on coastal geomorphology.

WEATHER EXTREMES

Projections of future weather extremes associated with climate change are difficult to make, however there are indications of changes to the intensity and frequency of extreme weather events including heatwaves, droughts and severe storms. It is very likely that hot days, warm nights and heatwaves have already become more frequent, and are project to become even more so.

Higher average temperatures have likely exacerbated recent droughts, with a 1°C increase in temperature resulting in up to a 15% reduction in runoff. The occurrences of droughts over Australia are projected to increase, especially in south west Western Australia where a link between the drying trend and human induced warming is already strong.

There is strong evidence that heavy rainfall events will become more frequent as temperatures increase. For example, the intensity of the 1-in-20 year daily rainfall event may increase by up to 10% in parts of South Australia by the year 2030, by 5 to 50% in some NSW regions by the year 2050, 5 to 70% by the year 2050 in Victoria and up to 30% by the year 2040 in south-east Queensland and northern NSW (Hennessy et. al., 2005).

An increase in the intensity of tropical cyclones is still uncertain and depends largely on determining if intensity is related to absolute sea surface temperature (with strong increases expected) or sea surface temperature relative to other oceans (were little increase is expected).

FIRE

In a study based in south-east Australia, an area projected to become hotter and drier under climate change, CSIRO found that at most sites an increase in fire-weather risk is likely in 2020 and 2050. Changes in the frequencies of extreme Forest Fire Danger Index days are generally largest inland and vary from an increase of 10 to 40 % in 2020, to an increase between 20 to 120 % in 2050 (Hennessy et. al. 2006).

The expected levels of climate change in Australia presented here are based on projections presented in the Intergovernmental Panel on Climate Change Fourth Assessment Report 2007 and the *Climate Change in Australia Technical Report* (CSIRO, 2007). The fire weather projections are from *Climate change impacts on fire-weather in south-east Australia* (Hennessy et. al. 2006).

2.3 CLIMATE CHANGE IMPACTS AND REGIONAL VULNERABILITY

A summary of the predicted direct impacts of climate change and any anticipated regional vulnerability to these particular impacts is presented at *Table 2*. This summary is based on the information in *Climate Change – An Australian Guide to the Science and Potential Impacts* (Pittock 2003). A more detailed discussion of all impacts on Australia associated with climate change is available at www.climatechange.gov.au. The anticipated flow-on impacts associated with climate change that are specifically relevant to the operations and responsibilities of local government are addressed in Section 3 of this report.

Table 2: Summary of Climate Change Impacts on Australia

CLIMATE VARIABLE	POTENTIAL IMPACT	VUNERABLE COMMUNITIES
Temperature	• Increased risk and incidence of bushfires – the number of days of very high and extreme fire danger increasing across the country. • Increase in extreme weather events such as floods and drought. • Impacts on ecosystems.	• Generally an increase in fire danger throughout Australia. • Settlements, industry and infrastructure vulnerable to adverse effects of weather. • Changes in biodiversity across Australia. • Loss of coastal wetlands.
Changes to rainfall patterns and evaporation rates	• Increase in the likelihood and severity of drought and increased evaporation from water storages. • Decrease in annual surface water run-off. • Possible reductions in mean flows of rivers. • Heavy rainfall events may be more extreme and frequent possibly leading to riverine flooding and erosion of river banks. • Increased risk, incidence and severity of bushfires.	• Adelaide and south-west Western Australia considered the most vulnerable metropolitan areas. • Drier inland areas more vulnerable to water shortages during the annual dry season. • A decrease of up to 20% is anticipated in south-east Australia. • A -10% to +10% change possible in Tasmania. • Stream flow in northern Australia may increase if summer rainfall increases. • Northern Territory particularly susceptible to inland flooding. • Generally an increase in fire danger throughout Australia.
Sea level rise	• Increased vulnerability to coastal erosion. • Inundation of coastal lowlands. • Impacts on coastal habitats due to changes in tidal inundation. • Increased risk of damage to coastal infrastructure. • Reductions in water quality in coastal rivers. • Saltwater intrusion of estuaries and aquifers.	• Coastal settlements of Queensland. • Low islands of the Torres Strait. • New South Wales coasts. • Especially under storm tides in Port Philip, Western Port and Gippsland Lakes. • Floodplains of northern Australia. • Riverine environments.
Extreme weather events	• Potential increased frequency and intensity of tropical cyclones associated with the occurrence of oceanic storm surges, gales and flooding rains. • Projected rises in average sea level contributing to more extreme storm surges. • Increased risk, incidence and severity of bushfires.	• Potential increased frequency and intensity of tropical cyclones affecting northern Western Australia and Northern Territory. • More intense precipitation events very likely over many areas. • Flooding of coastal wetlands. • Increased potential for freshwater wetlands to turn saline. • Loss of infrastructure in northern Australia. • Generally an increase in fire danger throughout Australia.

Source – Adapted from Pittock (2003)

3 Local Government and Climate Change

3.1 INTRODUCTION

Local government's response to climate change requires a dual approach:

- management and reduction of greenhouse gas emissions (mitigation)
- making adjustments to existing activities and practices so that vulnerability to potential impacts associated with climate change can be reduced or opportunities realised (adaptation).

These two activities are complementary rather than exclusive and should be considered simultaneously.

Local governments are undertaking a high number of greenhouse gas management and reduction activities.

Investment in greenhouse gas management initiatives since the inception of the Cities for Climate Protection program in 1998/99 is reported at over $100 million, with more than 5 million tonnes of CO2e emissions being abated during the same period (CCP, 2005).

Some of the activities currently undertaken by local governments also have the additional benefit of assisting local communities to cope with, or adapt to, the impacts of climate change through the management of natural hazards and regulation of activities with environmental effects. Some existing examples of these adaptation activities include the encouragement of water sensitive urban design, flood plain mapping activities, increasing the availability of shade provision and protection, and mosquito control programs.

This section provides an overview of how the functions of local government in Australia may be affected by a changing climate unless there is a continued focus on the implementation of adaptation measures. Potential adaptation measures for local government are identified at Section 4.

3.2 CLIMATE CHANGE IMPACTS ON LOCAL GOVERNMENT FUNCTIONS

The effects of climate change will have direct and indirect implications for local governments. Aside from any regional variations in impacts across parts of Australia, there will also be differences in the extent to which these impacts are specifically felt by the communities of a local government area. For example, the demographic make up of a local government area could increase vulnerability to health impacts with older people, low-income groups, and remote and Aboriginal communities potentially more sensitive to impacts such as heat stress and disease. To set the context for identification of relevant adaptation strategies, anticipated climate change impacts on, and implications for, the responsibilities and services of local government have been summarised in *Table 3*.

Table 3: Potential Impacts of Climate Change on Local Government Functions

ASSETS/SERVICE DELIVERY	POSSIBLE CLIMATE CHANGE IMPACTS
Infrastructure and property services	
Road/pavement construction and maintenance	• Changes in rates of deterioration – faster deterioration in wetter areas but potentially slower deterioration in areas where rainfall decreases. Deterioration may also result from higher temperatures and increased solar radiation. • Inundation of surface and/or underground roads in coastal areas, potentially resulting in destruction. • Changes in frequency of interruption of road traffic from extreme weather events and emergency transport routes disrupted.
Stormwater/drainage	• More intense rainfall resulting in inflow and infiltration into wastewater networks. • Exceedance of existing flood defences. • Exceedance of drainage capacity. • Reduction in drainage capacity due to sea level rise and storm surge. • Changes in mean and peak stream and river flows. • Lower levels of rainfall, reducing pressure on stormwater systems.
Buildings	• Changes in building heating/cooling costs (can be either negative or positive). • Increased risk of damage from bushfires. • Changes in frequency of wind, rain, hail, flood, storm events and damage, potentially resulting in destruction. • Cyclone damage and destruction due to changes in wind intensity. • Higher rates of building deterioration and associated maintenance costs.
Coastal infrastructure	• Increased coastal erosion and inundation. • Increased frequency, or permanent inundation of, coastal infrastructure and utilities, e.g. water, sewerage, gas, telecommunications, electricity, transportation. • Destruction, damage and disturbance to council-managed marinas and boat ramps. • Increased erosion and/or exceedance of seawalls, jetties and other coastal defences.
Recreational facilities	
Provision and use of recreational facilities	• Impacts on coastal recreational infrastructure. • Loss of existing public space in coastal areas. • Impacts on tourism/recreation activities along the coast. • Increased costs associated with operation and maintenance costs of public amenities/recreational sites due to storm damage.
Maintenance of recreational facilities	• Reduced water quality and quantity resulting in less watering/irrigation of open space and sports grounds and closure of ovals. • Limited water for swimming pools, etc. • Beach closures, e.g. due to E.coli levels after storms.

ASSETS/SERVICE DELIVERY	POSSIBLE CLIMATE CHANGE IMPACTS
Health services	
Community/workplace health	• Milder winters improving communities' comfort levels. • Increase in geographical range and seasonality of vector-borne diseases and the possibility for an expansion of receptive zones. • High temperatures increasing incidence of food and water-borne diseases. • Risk of increased cryptosporidium infections during open water swimming in summer. • Health impacts due to exposure to extreme weather, e.g. heatwaves. • Extreme rainfall events transporting contaminants into waterways and drinking water supplies. • Increased pressure on drinking water supplies. • An increase in injuries due to increased intensity of extreme events, e.g. storm surge and coastal flooding in coastal regions of Australia due to changes in sea level rise and human settlement expansion into coastal catchments.
Emergency/bushfire management	• Increased emergency response and recovery operations. • Risks to public safety and tourism and longer term impacts on regional economies.
Planning and development approvals	
Planning policy and developments	• Inappropriate location of urban expansion areas. • Increased uncertainty in long-term land-use planning and infrastructure design, i.e. location of future developments, suitability of infrastructure designs to cope with changing climate, etc. • Cost of retrofitting of systems. • Loss of private property and community assets. • Increase in insurance costs. • Increased pressure on disaster management and response resources. • Early retirement of capital infrastructure.
Natural resource management	
Coastal management	• Increased coastal erosion and inundation. • Loss of private property/community assets. • Loss of beach width. • Changes to wetlands due to sea level rise, shoreline erosion and saltwater intrusion.
Weed/pest management	• Changes in distribution of invasive species due to changes in climate and associated loss of biodiversity and changes to bushfire intensity.
Biodiversity	• Shifts in distributions of plant and animal species. • Increased risk of population and species extinctions. • Reduced ecosystem resilience to stress. • Increased ecosystem and species heat stress. • Increased pressure on dunal systems. • Changes to mangrove habitats due to salt water intrusion. • Increases in ecological disturbances.

ASSETS/SERVICE DELIVERY	POSSIBLE CLIMATE CHANGE IMPACTS
Water and sewerage services	
Stormwater/sewerage	• Inundation of storm water and sewerage systems. • Increased peak flows. • Changes in groundwater levels. • Changes in flood plains. • Reduced dry weather sewerage flows. • Reduced/unreliability of power supply for sewage pumping and treatment if existing electricity suppliers cannot maintain pace with long term changes in climate.
Wastewater	• Changes in intensity of rainfall events impacting inflow and infiltration to wastewater network. • Potential for blockages and dry weather overflows during dry spells.
Water supply	• Changes in mean and peak stream and river flows. • Uncertain water availability. • Insufficient water supply in some areas. • Increased potential for water contamination. • Salination of surface and groundwater supplies. • Changes in availability of groundwater available for irrigation.

3.3 REGULATORY FRAMEWORK FOR CLIMATE CHANGE ADAPTATION

REGULATORY FRAMEWORK APPLYING TO LOCAL GOVERNMENT

The role of local government to protect the community has been described as:

"Local government provides for the health, safety and welfare of its community and if a council cannot show that it has taken preventative action against any threat to the health, safety and welfare of its community, it faces the possibility of liability costs – costs which can be reduced if a council identifies the threats to its community and implements appropriate strategies to prevent these threats" (Local Government Association of Tasmania, 2004).

It has been documented that the two areas where liability related to climate change may arise are compensation or common law negligence due to a breach of the duty of care (Planning Institute of Australia, 2004).

Reduced risk of costs associated with possible liability could be considered an additional economic benefit of the implementation of adaptation measures. Also, if climate change was included as part of local government's overall risk management regime to mainstream its management, then this would see adaptation actions undertaken during day to day operations and inclusion in local emergency or risk management plans.

The nature of the relationship between each local government and their community means that local government has the ability to play a role of educator and encourage awareness within their communities, and to promote sustainable development.

REGULATORY POWERS OF LOCAL GOVERNMENT

Within each Australian state and territory, the Local Government Act is the principal statute governing councils in each jurisdiction. With respect to the regulatory powers that are available at the local government level to influence the uptake of adaptation to climate change within their jurisdiction, over the years, legislative reforms have resulted in an expansion of the general competence powers, increasing the flexibility of councils to respond more comprehensively to local needs.

Local government bodies in Australian jurisdictions have now been given the authority to "provide generally for the good government of their local government area" with local government now having roles in governance, advocacy, service delivery, planning and community development, and regulation. This has been viewed as conferring on local government the powers of general competence, or the power to take action in any area not expressly precluded by other legislation (National Office of Local Government, 2004).

Councils typically have the power to make and enforce by-laws in certain circumstances and to enforce compliance with the requirements of their Local Government Act and other relevant Acts. For example, Section 3 of the Western Australian Local Government Act 1995 states that:

"A local government may make local laws under this Act prescribing all matters that are required or permitted to be prescribed by a local law, or are necessary or convenient to be so prescribed, for it to perform any of its functions under this Act."

Of the local government regulatory powers which govern additional statutory responsibilities, planning systems provide particularly comprehensive regulatory powers as they typically comprise legislation, regulation, policies, guidelines and initiatives related to planning, natural resource management and environmental protection (Hullick, 2002).

MUTUAL AND SHARED OBLIGATIONS

Stakeholder consultation during the preparation of this report highlighted that local government's climate change obligations may be shared, implemented or defined by other agencies and authorities in other levels of government. These relationships can be complex and differ depending on both the state or territory where the local government is located and the particular local government function being considered. For example, the types of health services undertaken by local government and their relationship with state health agencies vary between jurisdictions. Understanding these relationships is essential to adaptation planning and may require investigation at a regional level.

4 Adaptation Options

The purpose of this report is to identify climate change adaptation actions for local government that produce benefits other than those that are strictly tied to climate change and in particular provide a net economic, social or environmental benefit no matter what level of climate change occurs.

The climate change adaptation actions can be categorised under the general themes presented at Section 4.1. Section 4.2 provides a framework for how local governments can identify the appropriate adaptation responses for their potential level of risk. Sections 4.3 to 4.9 identify potential climate change adaptation options for each local government sector.

4.1 GENERAL THEMES OF ADAPTATION ACTIONS

POLICY

- Undertake a risk assessment for the local government area to identify the most significant areas of risk and to establish priorities
- Incorporate potential climate change adaptation actions into strategic planning where appropriate.

NEW BUILDINGS AND INFRASTRUCTURE

- Where practicable, adopt climate sensitive building design that considers local cooling and heating requirements e.g. inclusion of natural ventilation cooling, consideration of building orientation and low energy consumption
- Design buildings to allow for consideration of future climate change impacts and incorporation of future adaptation (noting that the Building Code of Australia sets minimum standards, and it can be difficult for local governments to justify setting more stringent requirements).

EXISTING BUILDINGS AND INFRASTRUCTURE

- Monitor any changes to the condition in structures so that any modifications/retrofitting occurs on time and prior to failure
- Identify alternative options should the existing buildings and infrastructure be impacted upon in order to maintain services and connections, e.g. to minimise isolation of communities during an adverse storm event that puts the infrastructure at higher risk
- Design retrofitting to a higher standard than the minimum set where possible and practical
- Progressively incorporate higher design standards into asset management plans and rolling capital works programs.

COMMUNITY HEALTH AND RECREATION

- Establish the level of risk to the community of climate change impacts to assist in prioritising potential adaptation actions
- Control planning and activities in areas of high risk
- Encourage building design and public spaces that provide improved levels of thermal comfort and security, e.g. protection during floods or extreme wind.

NATURAL ENVIRONMENT

- Analyse the risks from the initial risk assessment, such as flood liability, storm surge, species extinction security of water supply
- Reduce other external stresses e.g. pollution or development.

4.2 SELECTING THE APPROPRIATE ADAPTATION RESPONSE

There are a number of different frameworks to provide guidance on conducting assessments of climate change impacts and/or adaptation responses. Increasingly, a risk management approach to addressing the potential consequences of climate change is advocated as a means of evaluating decision alternatives in the context of various uncertainties (CSIRO, 2006a).

It has been acknowledged that to identify the appropriate adaptation response, a careful assessment of the risks facing a particular area due to climate change is required. As such the Australian Greenhouse Office (now the Department of Climate Change and Energy Efficiency) released a guide to assist in the integration of climate change impacts into risk management and other strategic planning activities within Australian public and private sector organisations – *Climate Change Impacts and Risk Management – A Guide for Business and Government*. This guide supports users in the:

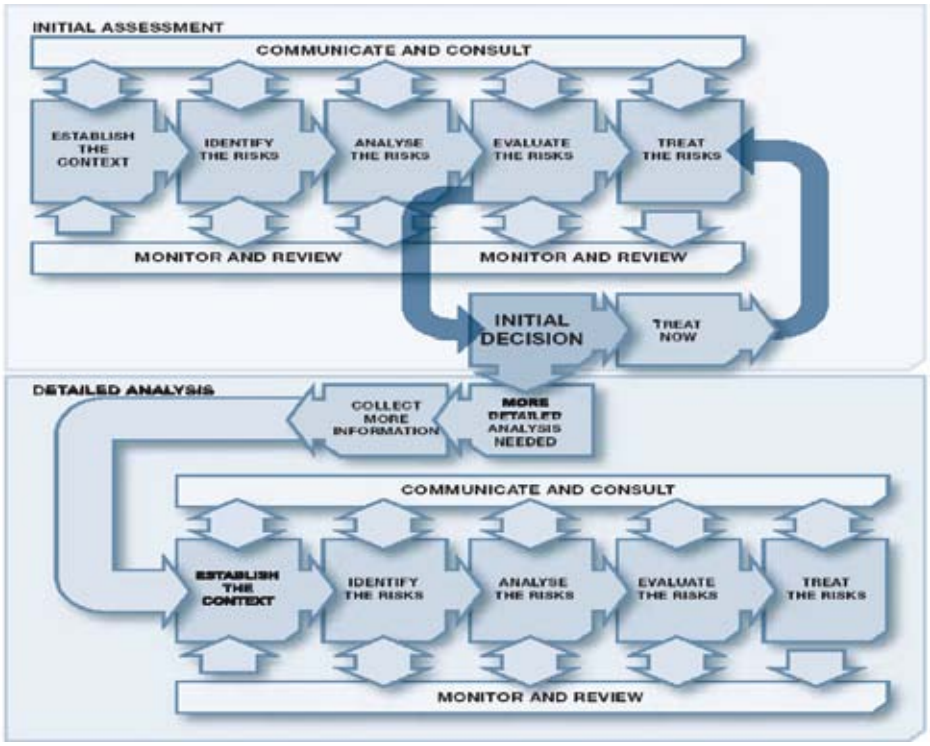
- enumeration of climate change impact related risks
- prioritisation of risks requiring further attention
- establishment of processes to ensure higher priority risks are managed effectively (AGO, 2006).

This framework for the assessment of the risks associated with climate change is based on the *Australian and New Zealand Standard AS/NZS 4360 Risk Management* which prescribes the following steps in the climate change risk management process:

- *Establishment of the context* – through identifying the business to be assessed, its objectives, responsibilities and stakeholders, and the relevant climate scenarios
- *Risk Identification* – by identifying how climate change will impact on each of the above
- *Risk Analysis* – by identifying existing management strategies, the likelihood of each risk, the consequence should this likelihood be realised and the level of resulting risk for each of the above climate change impacts
- *Risk Evaluation* – by ranking risks by severity and identifying those that require additional analysis
- *Risk Treatment* – through the identification and selection of the relevant risk management and/or adaptation options.

Figure 4 below provides an overview of the process that should be followed in the initial assessment and detailed analysis of risks associated with climate change. Further information is available in *Climate Change Impacts and Risk Management – A Guide for Business and Government* available at www.climatechange.gov.au.

Figure 4: Initial risk assessment and detailed analysis



Source – AGO (2006), *Climate Change Impacts and Risk Management – A Guide for Business and Government*.

Consideration of climate change scenarios and the utilisation of a risk assessment and management framework ensures that climate change is considered as early as possible in the decision making process and that the appropriate actions are taken when it is most feasible and sensible to do so rather than being forced into action by a climate change related event.

While the choice of suitable adaptation action will vary depending on the nature of the climate change threat, the sensitivity of the region and its capacity to respond (Engineers Australia, 2004), it is important to remember that the consideration of climate change effects in local government risk assessment and decision-making activities will not always result in an increase in costs or the need for changes to existing operations, particularly where decision-making already considers holistic consequences of actions. It is possible that existing infrastructure and policies will be sufficient to cope with predicted climate change scenarios and related impacts in a particular area (New Zealand Climate Change Office, 2004b).

The following sections identify potential climate change adaptation options for each local government sector. The relevance of the actions identified to the Australian context has been noted as has the anticipated benefits at a broad economic, social and/or environmental level, and a qualitative assessment of potential costs. A qualitative rather than quantitative assessment of adaptation options has been provided as the adaptation option chosen will normally depend on the objectives of the decision-maker and normally involves a trade-off between social, economic and environmental ideals (Kerr and McLeod, 2001), with the associated benefits typically varying substantially between decision-making parties.

4.3 INFRASTRUCTURE AND PROPERTY SERVICES

Table 4 lists the potential adaptation actions relevant to infrastructure and property services. Adaptation for this local government function should exploit the fact that infrastructure is not static and will require refurbishment and replacement on time scales of 25 to 30 years, providing many opportunities to adapt structurally (Engineers Australia, 2004). The costs of adaptation measures can be substantially reduced if these measures are implemented at the stage of upgrade or replacement of existing infrastructure. This is because the costs of designing new buildings to incorporate climate change is in some cases very small whereas the costs of adapting existing infrastructure in the future is potentially large. The implementation of early adaptation strategies in the infrastructure and property services responsibility of local government will ultimately decrease the risk of asset damage and failure in the future which would represent an economic and social cost to councils (UKCIP, 2001).

In the event of new infrastructure, property and building services, adaptation strategies should include the consideration of those elements which are difficult and/or expensive to change during the design life of the building such as location, orientation, thermal mass and structural materials. This is because the costs of retrofitting due to the realisation of anticipated climate impacts in the future can be prohibitive if the appropriate elements are not included in the design phase (Cavan, 2004).

Local governments may have a role in encouraging adaptation in new buildings and in retrofitting actions through motivating and educating the community, setting an example, providing incentives and regulation through approval functions.

The City of Melville has developed sustainable design guidelines which provide a case study showing how planning functions can be used for improving the adaptive capacity of infrastructure and property (Case Study 1). The Western Port Greenhouse Alliance developed adaptation measures for planning in areas affected by coastal inundation or flooding and degradation of beaches and foreshore areas (Case Study 2). The Clarence City Council assessed climate change risks to coastal areas and identified vulnerable areas and adaptation responses (Case Study 3). Port Adelaide-Enfield Council has also undertaken a flood risk study, which will be used to better manage the flood vulnerability of infrastructure and property (Case Study 4).

Case Study 1 – Sustainable Design Guidelines

In recognition of its role as an educator and demonstrator, the City of Melville has engaged in a number of initiatives that target the local community and assist them to adapt to the impacts of climate change. These include:

Sustainable Residential Design Guidelines – These guidelines and associated design checklist and manual have been designed to provide illustrated examples of how to design a dwelling to achieve maximum energy efficiency and water savings for those designing a new dwelling or planning additions. To help make sustainable residential design common practice across the City of Melville, these guidelines have been incorporated in council policy and apply to any significant residential extensions or new home development.

All City of Melville facilities are also subject to the *Sustainable Building Checklist* before their development can proceed.

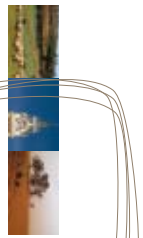
Greywater Reuse Package – Information resources for the selection and installation of greywater reuse systems that take household wastewater and reuse this to irrigate garden areas have been developed and made freely available to the local community to assist householders looking for alternative ways to conserve water.

Additional information on these initiatives is available at www.melville.wa.gov.au or on (08) 9364 0666.

Table 4: Adaptation Actions for Property and Infrastructure Services

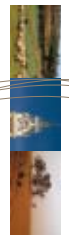
IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Infrastructure development, provision and maintenance				
• All climate change impacts	• Showcase best practice in climate sensitive building design in public buildings.	• Triple bottom line benefit of encouraging sustainable development within the community more generally.	• Economic cost of demonstration technologies and building design.	• Relevant action for construction works managed or approved by local government. • A number of councils already have demonstration sustainable homes.These form an existing mechanism for demonstration of potential measures.
• All climate change impacts	• For infrastructure developments with a lifetime greater than 50 years, design for staged construction to allow future climate change impacts to be taken into account.	• Opportunities to take into account other (non-climate related) improvements to the infrastructure.	• Likely to be a more expensive option, or not technically feasible in some construction projects.	• Relevant for infrastructure design and construction works approved or undertaken by local government. • Relevant guidelines could be included in council specific design manuals, noting that these are often referenced to Australian Design Standards.
• Temperature increases	• Design council buildings to allow for ease of future adaptation, e.g. have the ability for significant amounts of shade to be added or removed from a facade.	• Decreased incidence of heat stress. • Reduced cooling requirements, meaning reduced use of air conditioning.	• Building design costs.	• Relevant for building design and construction works approved or undertaken by local government. • Relevant guidelines could be included in council specific design manuals.
• Temperature/ rainfall changes – seasonal changes in soil wetting and drying and risk of ground subsidence.	• Consider potential for subsidence/ heave in the design of infrastructure foundations.	• Economic and social benefits of infrastructure more resistant to existing risks of heave and subsidence.	• Potential for greater expense in developing resistance in infrastructure foundations.	• Scenarios show changes in rainfall and temperature across Australia. Particularly relevant for local government areas located on clayey soils, or with infrastructure built in water. • Relevant guidelines could be included in council specific design manuals.

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
• Increased rainfall/severe weather events – potential for increased risk of flood disruption and higher risk of flooding for roads located in flood plains or in coastal areas.	• Flood-proof or re-site infrastructure and plan transport routes and roads to avoid disruption by flooding activities. • Increase monitoring and maintenance activities at embankments and bridge piers, and gully emptying activities.	• Social and economic benefits associated with better coping with existing flood events. • Economic benefits of infrastructure maintenance and avoiding rapid degradation.	• Economic costs of flood-proofing and potential economic, environmental and social costs of relocating infrastructure. • Economic costs of more rigorous monitoring and maintenance program.	• Scenarios show that some local government areas are vulnerable to increased flooding events. Local governments play a role in landuse planning. • Relevant to municipalities with scenarios of increased storm activity, and with infrastructure in water environments. • Relevant guidelines could be included in council specific design manuals and asset management plans.
• Increased temperatures – increased risk of bushfires.	• Risk assessment to ensure new infrastructure is not placed in fire-prone areas. • For those where location is not flexible, investigate standards of construction that reduce their sensitivity to bushfire.	• Improved protection of human health and safety and property during bushfires. • Reduced potential for buildings/infrastructure loss and/or damage due to bushfire.	• Potential for unnecessary lock up of available land. • Increased costs associated with use of fire-retardant materials.	• Local governments play a role in land-use, infrastructure development and planning.



IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Building design				
• Increased temperatures/ hot spells – increased demand for comfort cooling in buildings, affecting energy consumption.	• Increase use of insulation in new buildings. • Retrofitting existing buildings with addition of insulation materials and effective and efficient cooling systems. • Reduce lighting and equipment loads to reduce overheating. • Optimise design of cooling systems to provide the best energy efficiency under higher temperature operating loads, i.e. use of passive cooling systems, improved use of thermal properties of building materials, reduce solar heating using recessed windows, roof overhangs and shades. • Promote micropower initiatives.	• Social benefits – comfort affects the health, productivity and general wellbeing of occupants. • Economic and environmental benefits – decreased energy consumption and greenhouse gas emissions.	• Cost of insulation and appropriate building materials. • Capital costs may not be recouped by improved efficiency.	• Scenarios show widespread temperature rise, affecting thermal comfort levels, across Australia. • Local government may have an influence on building research agendas. • Local government may assess cooling systems as part of building approval role. • Local government may encourage retrofitting actions though marketing and incentives and by setting an example with public buildings. • Local government may encourage adaptation in new building design actions through marketing and incentives and by setting an example with public buildings.
• Higher rainfall intensity – creating drainage problems in urban environments.	• Provide education of preventative practices prior to and during extreme events, e.g. clearing gutters and drains. • Minimise hard surfaces, such as pavements. • Include development controls, such as those that promote soft surfaces external to the building footprint.	• Environmental and social benefits of managing runoff from current storm events. • Possibility for use of rainwater for alternative purposes such as garden watering.	• Economic cost of roofing redesign and retrofitting.	• Many local government areas will be susceptible to urban flooding. • Local government may influence roofing design within the community more generally through their role of building approver and setting examples with demonstration houses to demonstrate potential adaptation measures. • Councils could distribute community educative information through rates notices.

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Waste Management				
• Increased rainfall intensity – increased risk of pollution from open site waste disposal.	• Increase community education to reduce waste generation through both sustainable consumption and reducing overall consumption. • Maximise kerbside diversion of material from landfill through provision of high performance collection systems. • Encourage sorting of waste at source for household, commercial and construction wastes and promote composting.	• Environmental and economic benefits associated with less waste production, and increased recycling and resource recovery.	• Economic costs of increased waste reduction and education strategies.	• Hotter temperatures and potential for increased severity of rainfall events predicted for most of Australia. • Local government has responsibility for municipal waste management. • Although not necessarily required by legislation, local government also plays a role in environmental and waste management/ recycling education.



Case Study 2 – Western Port Region – Coastal inundation and flooding

Coastal Inundation, flooding and bushfires have been identified as key longer term climate change risks as part of a major study for the Western Port Region in Victoria. The report, *Impacts of Climate Change on Human Settlements in Western Port Region: An Integrated Assessment*, shows that some 16,500 properties are vulnerable to flood events related to climate change and more than 73,000 people and 34,200 properties are in current bushfire prone areas.

Home to almost half a million people in the five local governments of Bass Coast, Casey, Cardinia, Frankston and the Mornington Peninsular Shire, the Western Port region is expected to increase its population from around 500,000 in 2006 to 650,000 by 2016. The anticipated growth in residential and commercial development, including port development, will increase the scale and risk of communities' exposure to the impacts of climate change.

The two-year study was funded by the Australian Government and co-managed by Marsden Jacob Associates and the Western Port Greenhouse Alliance. The primary objective of the study was to improve understanding of the scientific, economic and social impacts of climate change in order to enhance the capacity and knowledge of local governments and other decision-makers in the region to prepare for and adapt to climate change; and to develop an approach to climate change assessment and adaptation that has transferability to other regions in Australia.

A list of ten priority climate change issues was developed from over 200 risks identified, with most of these related to coastal inundation or flooding due to increased intensity of rainfall.

The issue of uncertainty over planning controls in areas affected by coastal inundation or flooding generated almost 30 adaptation measures, including capacity building to improve decision-makers' understanding of climate change, and the amendment of local planning schemes to include specific provisions on the treatment of sea level rise and storm surge projections in relation to land protection, use and development.

On the issue of loss or degradation of beaches and foreshore areas, adaptation measures recommended in the study included the retention of coastal crown lands in public ownership and that further modelling be undertaken to identify localities most vulnerable to sea level rise, storm surges and inundation now and in the future.

The study recommended the development of a coordinated community information strategy be developed to address the issue of wildfire preparation and response. This strategy is aimed at overcoming the current disconnections between agencies and some aspects of community wildfire information programs.

An important theme running through discussion of all priority issues was the need for community education. Effective response to the impacts of climate change in the region will not be achieved unless communities are fully engaged in all aspects planning for climate change and this is best done at the local level.

The Western Port Greenhouse Alliance (WPGA) is a regional partnership that was established in July 2004 to provide a regional framework for local stakeholders to respond to climate change and work together on greenhouse gas abatement projects. The establishment of the WPGA was made possible through the provision of funds by the Victorian Department of Sustainability and Environment (DSE) under the Victorian Greenhouse Strategy's *Regional Partnerships Program* and has been formed under a Memorandum of Understanding between:

- City of Casey (Alliance host)
- Bass Coast Shire

- Cardinia Shire
- Frankston City Council
- Mornington Peninsula Shire.

The Western Port Greenhouse Alliance is continuing to work with local governments to implement priority adaptation responses. Further information on either the WPGA or its work can be obtained at www.wpga.org.au/. Western Port's report, People, Property and Place**,** Impacts of Climate Change on Human Settlements in the Western Port Region: an Integrated Assessment can be downloaded from http://www.wpga.org.au/ppp.asp.

Western Port

Photo courtesy: Western Port Greenhouse Alliance

Case Study 3 – Clarence City Council – Coastal area risks

The study of climate change impacts on Clarence coastal areas was initiated in response to Council and community concerns about erosion of beaches and clouding events in coastal areas. The purpose of the study was to provide an assessment of climate change risks on coastal areas within Clarence City Council including

- Consultation with community groups, institutions, state government agencies regarding their awareness and response to climate change issues;
- Assessment of 18 localities and infrastructure within Clarence City, which may be vulnerable to coastal hazards, both at present and due to sea level rise and climate change into the future;
- Investigation of adaptive management options in response to present and future coastal hazards; and
- Preparation and execution of a communication plan to inform the community of the findings, initiate discussion about the preferred response and report on community response.

Consultation with community groups revealed that Clarence residents were aware of and concerned about climate change and sea level rise, but the extent to which they may be directly affected was not well understood. A significant theme was a desire to retain beaches in their current state.

The vulnerability assessment identified a number localities and roads at risk now from storm surge – Roches Beach/Lauderdale, Cremorne, Bicheno Street at Clifton Beach, and South Arm Road at South Arm Neck. Clifton Beach, Half Moon Bay, Kangaroo Bay, Bellerive Beach, Rokeby and Droughty Point Road were considered risk areas in the medium term (25-75 years).

Lauderdale Beach Photo courtesy: Clarence City Council

Recommended practical adaptive responses include:

- Planning controls for new development
- Physical works such as seawalls, groynes, dune management or sand nourishment, offshore breakwaters and/or surfing reefs, temporary or permanent flood barriers, reconstruction of public infrastructure above flood level
- Detailed emergency management and evacuation planning with hazard reduction requirements for affected properties
- Providing community education and information to improve awareness and ability to cope
- Ongoing monitoring, analysis and review of findings

The report is providing Clarence City Council with a basis to respond to respond to the impacts of storm surge, erosion, inundation and sea level rise in the short and long term. Council is undertaking a range of work including adding more sand to, and revegetation of, beaches and dune areas, the raising and reinforcement of some roads, the installation of effective sewerage systems and the development of new standards and planning controls. The report can be downloaded from http://www.ccc.tas.gov.au/site/page.cfm?u=807

Case Study 4 – Port Adelaide-Enfield Council – Flood Risk Study

The City of Port Adelaide Enfield, and in particular, the Lefevre Peninsula, has been identified as a key precinct potentially 'at risk' of being impacted by climate change, due to its coastal nature and its history as an 'unnaturally' engineered area.

The Peninsula has a residential population of approximately 28,000 and accommodates key national, state and local infrastructure, major industrial and residential developments, power generation facilities, international harbour facilities and a major new naval manufacturing precinct. The area also contains significant marine and coastal ecosystems, and related environmental and commercial assets, including the Barker Inlet and Port River Estuary.

Its position subjects the area to risk from storm surge and sea level rise which in turn threatens the local coastal ecosystem and coastal developments.. As a result, the Council has initiated and is project-managing a three stage study, the Lefevre Peninsula and Gillman Flood Risk Study. The study includes a risk assessment to identify current and predicted risks and threats to the environment and the community, and the potential long term impacts on vulnerable coastal areas of a range of flood-related issues, including the predicted effects of sea level rise due to climate change. Based on the resulting data, the project will propose an appropriately integrated suite of adaptation strategies that will be socially, economically, and environmentally sustainable.

The project is funded via contributions from the three levels of government – council, the state government via Safecom, and the Australian Government's Natural Disaster Mitigation Program.

The first stage (collection of coastal hydrology data) has been completed with scenarios developed for the next 10, 50 and 100 years. The second stage of the project is identifying the optimal mix of engineering, urban planning, and education strategies required to ensure adequate adaptive management is in place. This project is managed by the Council's Technical Services Department, with reference to a multi-disciplinary steering group, and is the first SA program to incorporate management of sea level rise and climate change related projections in an urban coastal area.

Port Adelaide Photo courtesy: City of Port Adelaide – Enfield

4.4 PROVISION OF RECREATIONAL FACILITIES

There are a number of adaptation action strategies listed in *Table 5* that will provide benefits with respect to local government provision of recreational facilities and services. These also cross over a number of other areas of responsibility including infrastructure, planning, health, and natural resource management. Case Study 5 shows how Ku-ring-gai Council is adapting the management of its recreational facilities to save water.

Case Study 5 – Water reuse and recycling to manage council's recreational facilities

In 2004 Ku-ring-gai Council began a seven year stormwater reuse and water recycling program to reduce its reliance on potable water to irrigate playing fields, public golf courses and public gardens. This program responds to the introduction of water restrictions and climate change modelling that suggests less reliable rainfall and longer inter-rain periods for Sydney.

A total of seven stormwater harvesting projects have been completed, each designed to fit the site and catchment. It is estimated that more than 20 million litres of stormwater will be used to irrigate the ovals each year.

LOCATION	STORMWATER HARVESTING SCHEME	POTENTIAL USE (KL/YEAR)	APPROXIMATE COST ($)*
Barra Brui Oval, St Ives	250,000 L below ground tank Wetland filter treatment	4400	200,000
Edenborough Oval, Lindfield	300,000 L above ground tank with viewing platform and kick wall Sand filter treatment	1600	200,000
Comenarra Oval, Turramurra	250,000 L underground tank Rain garden treatment	3900	300,000
Lindfield Soldiers Memorial Oval, Lindfield	500,000 L above ground tank Gross pollution control trap treatment Subsurface irrigation	2200	200,000
Cliff Oval, Wahroonga	140,000 L below ground tank Pit baskets	1700	170,000
Roseville Chase Oval, Roseville	Joint project with Roseville Golf Club linking to their 23 ML dam with additional 120,000 above ground storage at oval	2500	110,000
Lofberg Oval, West Pymble	400,000 below ground storage Wetland filter treatment	4000	400,000

*Note : cost has not included reconstruction of oval that was also undertaken as part of the capital project

The program has been designed to deliver on a number of objectives that include:

- improved condition of the sporting fields inturn increasing public amenity and safety
- reduction in the number and intensity of peak flow events that discharge to local creeks
- shift towards to a more natural or pre-development flow regime of waterways
- improved water quality in streams that benefit from the treatment stormwater runoff
- more sustainable use of water resources and provision of greater resource security
- adaptation to a change in rainfall distribution and frequency
- demonstration of Council's commitment to sustainability.

Stormwater harvesting tanks at Soldiers Memorial Oval, Lindfield
Photo courtesy: Ku-ring-gai Council

Council has also committed to building a sewer mining plant at each of its two public golf courses, Gordon and North Turramurra. The water recycling plants will provide around 110ML of treated effluent per year.

Funding for these projects has come from Council's capital reserves and Environmental Levy as well as grants from federal and state governments.

Additional information on Ku-ring-gai Council's stormwater harvesting project and other water saving initiatives is available from Council's website (www.kmc.nsw.gov.au) or phone (02) 9424 0745.

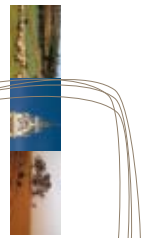
Table 5: Adaptation Actions for Provision of Recreational Facilities

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Shade provision and protection				
• Increased temperatures - heat stress.	• Review/prepare design guidelines for street furniture, shelters and awnings, and infrastructure to provide protection, e.g. development of a shade and sun protection policy. • Conduct shade audits to determine the adequacy of existing shade, whether there is a need for more, if appropriately located and of appropriate size. • Include provision of shade structures in design of new council recreational facilities. • Ensure sufficient shade, either natural or built, is available or planned for when developing new recreational facilities or centres and in any development plans for picnic areas, playgrounds etc.	• Decreased exposure of the community to the sun. • Decreased incidence of heat stress. • Reduced cooling requirements.	• Potential for increased design costs/utilising appropriately qualified staff. • Economic costs of conducting an audit and providing shade material.	• Relevant for the design and construction of works approved by or undertaken by local government. • Local government may develop shade provision policies. These could potentially be amended at a later stage to address climate change. Examples: • UnderCover – Guidelines for Shade Planning and Design (prepared by the SA Cancer Council). • Shade for Everyone - A Practical Guide for Shade Development (SunSmart Victoria).

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Water requirements for recreational facilities/areas				
• Decreased overall rainfall – impacts on watering requirements for turf sports ovals, open spaces, golf courses etc.	• Four main options to consider in reducing irrigation mains water use - i. choosing areas to receive less irrigation ii. efficient irrigation iii. water efficient landscaping iv. using alternative supplies of water such as rainwater tanks, aquifer storage and recovery, greywater and blackwater, reclaimed effluent and groundwater. • Train staff on irrigation system auditing and scheduling. • Develop an irrigation plan to identify and reduce existing irrigation levels where possible. • Water controls and management be tailored for specific council areas.	• More qualified staff. • Decreased water consumption and associated costs. • More aesthetically attractive and hardy recreational areas. • Decreased potential for and risk of injuries, and potential for litigation, on poorly managed turf surfaces.	• Costs associated with assessing feasibility and most appropriate options. • Consultancy costs. • Implementation costs. • Staff training costs.	• Climate change scenarios show hotter and drier weather across Australia. While national parks are generally managed at a state government level, many municipalities provide and maintain natural areas as places of recreation. • In light of decreased overall rainfall and increased water restrictions, the need for greater water efficiency is an area that is already being addressed in a number of Australian councils with general recognition that the use of water in parks and reserves needs to be carefully managed. • Water requirements can be linked with existing local and state government water conservation and efficiency initiatives, e.g. South Australian Local Government Water Conservation Handbook.

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
• Decreased overall rainfall – impacts on watering requirements for open spaces, parks, gardens, etc.	• Use of plants in parks and open spaces that are indigenous to the local council area. • Set aside areas for community gardens to trial plants local to the respective council and their ability to adapt to use in gardens. • Increase mowing heights of lawns to decrease lawn water use and stress. • Increase application of mulches.	• Garden trials provide an opportunity for the local community to inspect and assess various plant types for their own gardens.	• Costs of establishing trials – although these can be offset through the use of existing community volunteer programs.	• Potential linkages to the existing ICLEI Water Campaign.
• Increased temperatures – deterioration of value of existing parks and forests and private gardens for recreational purposes.	• Dedicate additional resources to the provision and maintenance of parks, forests and other green areas. • Provide for increased regular maintenance of park/green space in council management plans and council budgets.	• Environmental benefits associated with preservation of existing natural resources. • Social benefits of provision of high-value recreational areas.	• Economic costs of maintaining natural areas and loss of land for other development purposes.	• While national parks are generally managed at a state government level, many municipalities provide and maintain natural areas as places of recreation. • Local government already allocates land for green space, parks and forests and many have streetscape/ tree plans for their area. These activities may require dedicated and specific planning to be undertaken in the future to account for potential decline in existing park areas.

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Recreational/sporting events				
• Increased temperatures – potential to initiate emergency/health impacts at recreational, tourism and sporting events.	• Adopt heat-emergency contingency plans for recreational/tourism events held within local council area (these plans are generally developed by state/territory governments). • Encourage scheduling recreational and sporting events and activities to avoid the hottest part of the day and at shady locations where possible.	• Social and economic benefits of better preparedness for hot weather-triggered emergencies. • Social and economic benefits of avoiding heat exposure.	• Economic costs of Developing emergency contingency plans. • Economic costs of disrupting existing schedules.	• State governments are responsible for emergency services but local governments are usually first in line for provision of services. • Local governments approve applications for tourism events and can be involved in emergency contingency planning. Many Australian councils already have Events and Festivals Information Kits for prospective event organisers and associated risk assessment guides for such events. • Education for recreational park users such as schools may be provided by local government.



4.5 HEALTH SERVICES

There is evidence to suggest that humans have a capacity for coping with thermal stress, particularly in parts of Australia where the population has experienced natural acclimatisation due to protracted periods of time living in a hot environment (Australian Medical Association 2004). However, without adaptation there is the potential for an increase in temperature-related deaths in some regions, particularly given Australia's ageing population.

For example in January 2009, Victoria experienced extreme temperatures that led to an estimated 374 deaths (Victorian Government Department of Human Services – http://www.health.vic.gov.au/chiefhealthofficer/publications/heatwave.htm). Flood-related deaths and those associated with extreme weather events are also a possibility in a changing climate.

There are a number of climate change impacts that may affect local government provision of health care services. The implementation of adaptation actions must balance the risks of disease against the risk of upsetting people unnecessarily and causing 'warning fatigue' by the time the disease or scenario has eventuated.

Surveillance programs, such as mosquito trapping, may be required and local government capacity to undertake similar eradication programs may also be needed (e.g. the surveillance program that identified the *Aedes aegypti* mosquito at Tennant Creek Northern Territory in February 2004).

In areas currently susceptible to Dengue, there are existing initiatives to eradicate breeding sites and awareness campaigns on such actions as staying inside during the times of days when mosquitoes are biting. These types of actions may be introduced in areas that will become vulnerable to Dengue and other vector-borne diseases as a result of climate change. The City of Mandurah's mosquito control program is presented as Case Study 6.

Any local government adaptation actions relating to health and climate change health risks should be developed in consultation with higher levels of government and with the assistance of existing health programs.

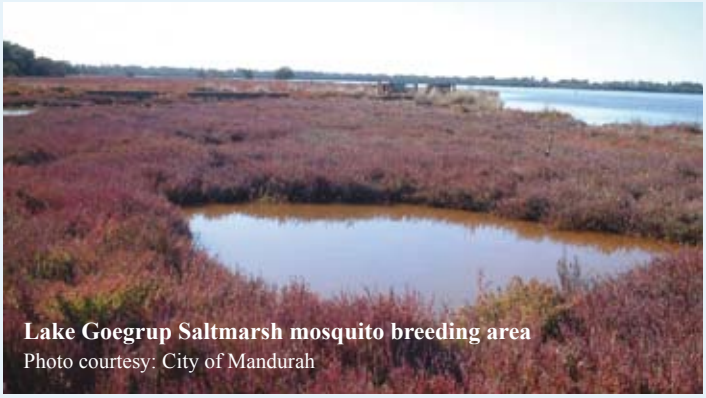
Potential adaptation actions for local government provision of health services are listed in *Table 6*.

Case Study 6 – Mosquito control in the City of Mandurah

The City of Mandurah, 74 kilometres south of Perth, Western Australia, is part of the Peel Region. High numbers of mosquitoes can cause a serious nuisance problem in this region and a number of mosquito species present are also able to transmit Ross River and Barmah Forest virus diseases. These are debilitating illnesses that have symptoms including painful and swollen joints, sore muscles, aching tendons, skin rashes, fever, tiredness, headaches and swollen lymph nodes.

Mosquitoes breed in the saltmarshes that fringe the Peel-Harvey Estuary and its tributaries and it is not uncommon to find over 1000 mosquito larvae per square metre at some sites. To reduce disease, mosquito control is undertaken during the peak disease period (August – April). Because there is approximately six million square metres of saltmarsh, mosquito control is an immense task. The program is undertaken collaboratively by the municipalities of Mandurah, Murray, Rockingham and Waroona and also the WA Department of Health. Currently the program is based on *larviciding*. Aerial larvicide operations attempt to reduce the mosquito population before they emerge as adults. The mosquito-specific larvicide is spread via a helicopter at regular periods (usually fortnightly) throughout the breeding season.

Both the number of mosquitoes and the efficacy of the control program are highly climate sensitive, and the program takes into account that climatic conditions in the region have the potential to increase the risk of mosquito-borne disease and nuisance.



Lake Goegrup Saltmarsh mosquito breeding area
Photo courtesy: City of Mandurah

It is known that warmer weather benefits mosquito breeding. Mosquito activity in the salt marshes is also heavily influenced by tidal activity with high tides providing more expansive breeding sites. The effectiveness of the control program is also affected by tides. If the tides are higher than predicted or increase unexpectedly, then the chemical larvicide used can be diluted and its contact time with larvae shortened. This drastically reduces its effectiveness.

The following climate conditions have been identified as most likely to produce higher than expected tidal levels in the Peel Region:

- local low-pressure systems and the effect of wind
- progression of cyclones down the coast of Western Australia
- the La Niña cycle with associated higher than expected rainfall and tides.

A La Niña cycle was present during the 1999/2000 mosquito season which caused tidal levels to be approximately 300 millimetres higher than expected and brought warmer temperatures. This resulted in a massive increase in mosquito breeding and control was unsuccessful.

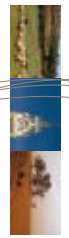
As a result of the control programs, climate vulnerability, and lessons learnt during the 1999/2000 La Niña event, there is ongoing work to develop new techniques for mosquito control. These include runnelling (where small channels are installed in the salt marshes to facilitate tidal movement) and developing new forms of larvicide that will be effective during high-tide events (by requiring shorter contact times with larvae). Both these control techniques are still under development and undergoing trials.

Further information on the Mosquito Control Program can be obtained from the Environmental Health Services division of the City of Mandurah Council on (08) 9550 3746 or at www.mandurah.wa.gov.au.

Table 6: Adaptation Actions for Provision of Health Services

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
All climate change related health impacts.	• Utilise demographic profile and social analysis of council area to assess health vulnerability. • Identify affected communities and needs. • Develop a Public Health Plan that looks at the current health and wellbeing of the communities within the council area and develop Wellbeing Indicators so that the program can be assessed over future years.	• Greater awareness of local constituency and their requirements allowing for more effective targeting of programs and educational campaigns.	• Costs of social analysis.	• Councils already provide a number of health programs designed to protect and promote public health and a number have prepared Public Health Plans as a strategic tool to provide direction and guidance for identified public health issues within their area.
Thermal stress				
• Increased temperatures – possibility for increased sunburn/rise in heat stress to older people, economically disadvantaged groups and vulnerable communities.	• Increase community education on awareness of dangers of sun exposure/ symptoms of heat stress. • Shade audits/provision of more shade in public recreational areas. • Reduce the impact of thermal stress via advice on how to stay cool including the use of portable fans, improved ventilation of homes, public buildings, and other residential institutions and workplaces. • Development of community heat emergency management plans. • Raising awareness of heat-related illness.	• Economic and social benefits of reducing incidents of heat stress, sunburn and skin disease. • Decreased community health costs. • Economic benefits of using ventilation as a cooling strategy (rather than alternative strategies that require electricity).	• Cost of education campaigns. • Shade provision costs. • Economic costs of development of emergency-response plans.	• Many local government areas have ageing and vulnerable communities that are particularly susceptible to heat stress. • Local government could have a role in Awareness campaigns, and also encourage or require provision of shade in public areas. For example existing Cancer Council SunSmart Programs with local government. • Advice should be sought from state and Commonwealth agencies.

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
• Increased temperatures – heat stress likely to increase, and mortality and morbidity rise in hot weather.	• Provide accessible air-conditioned public facilities. • Waive/reduce user fees for swimming pools. • Provision of outdoor drinking facilities.	• Social benefits of improving access to cooling facilities, reducing user fees for facilities, and encouraging use of public areas.	• Economic costs of reducing fees and economic and environmental costs of air-conditioning and installation of drinking fountains.	• Heat stress likely to rise in all regions. Local government able to promote or implement initiatives.
Disease				
• Increased temperatures and changes in rainfall patterns – may affect prevalence of vector-borne diseases.	• Improve alert systems for the possibility of vector-borne disease outbreaks to be developed with advice from state and Commonwealth health agencies.	• Economic, social and environmental benefits of controlling vector-borne disease outbreaks.	• Economic costs of implementing alert systems and community education programs (could be minimised by integrating into existing systems and programs).	• Benefits far more likely from cooperative arrangements on a state and/or national basis.



IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
• Increased temperatures and changes in rainfall patterns – changes in disease patterns.	• Educate residents about disease risks, precautions and symptoms. • Increase council-run immunisation programs to address any increased threats where possible (should be undertaken in liaison with state health programs/agencies).	• Economic, environmental and social benefits for reducing spread of disease.	• Economic costs of education initiatives and increased immunisation services.	• Risks of Ross River Fever, Dengue Fever and diarrhoeal disease are likely to increase in some parts of Australia. While education campaigns might be primarily coordinated through Commonwealth and state governments, local government could play a role in disseminating information within local communities.
• Increased temperatures and changes in rainfall patterns – worsen risk of some vector-borne diseases.	• Surveillance of vector populations, monitoring and reporting of disease incidence. • Control of disease vectors, including elimination of disease vector breeding sites.	• Economic, environmental and social benefits for monitoring and controlling current vector populations.	• Economic costs of monitoring and reporting systems, and elimination of breeding sites.	• The distribution of some vector populations (e.g. mosquitoes and ticks) will be altered by climate change. Local government may have a surveillance role. • National and state government leadership will be required to develop local government capacity to undertake eradication programs, e.g. municipalities in the Peel Region of WA have a current mosquito control program (see Case Study 6).
• Increased temperatures and changes in rainfall patterns – worsen risk of some water-borne diseases.	• Increased monitoring for waterborne diseases (such as E. coli, toxic algae, and viruses).	• Social and economic benefits of improving health impacts of current water-borne disease.	• Economic costs of increased monitoring activities.	• Water quality standards are set at Commonwealth level, but water treatment and monitoring is typically a local government function. • National and state government leadership is required.
• Increased temperatures and changes in rainfall patterns – worsen risk of some water and food-borne diseases particularly at temporary stalls and events.	• Engage in public health education activities (information addressing safer food production and storage processes for local business and communities, food handling guidelines).	• Social and economic benefits of improving health impacts of waterborne and food-borne disease.	• Economic costs of additional education activities.	• Councils already have a legislative duty of care to promote proper standards of public health to ensure that food premises are operated and maintained in a clean and sanitary condition and that food for sale is fit to eat. Advice and guidance on food safety matters generally already available from councils' environmental health departments. • Leadership required from a state and national level.

IMPACT	ADAPTION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Extreme events				
• Extreme weather events	• Review local disaster management plans. • Evaluate bushfire risks. • Improve community disaster preparedness and response systems.	• Social and economic benefits of improved planning and reduced incidents of extreme weather event-related accidents.	• Economic costs of implementation of appropriate systems and associated education activities.	• The Local Grants Scheme under Emergency Management Australia provides grants for local government emergency management and community preparedness activities, protective measures for critical infrastructure and emergency management awareness training.

4.6 PLANNING AND DEVELOPMENT APPROVALS

Potential adaptation actions for local government planning and development approval functions are listed in *Table 7*.

Local government decision-making with regards to planning and development is generally steered by policy and legislation at the state government level. For example, the Queensland Government's *State Planning Policy 1/03 – Mitigating the adverse impacts of flood, bushfire and landslide* guides local government decision-making about development applications in areas subject to natural hazards and requires local government planning schemes to:

- identify hazard-prone areas
- develop appropriate desired environmental outcomes and performance criteria for these areas
- apply appropriate development policies and standards to hazard-prone areas
- identify and manage risks associated with natural disasters.

While planning and development are governed by statutory frameworks established at a state and territory government level, local governments in all Australian jurisdictions prepare a range of legally binding statutory planning instruments such as planning schemes, codes and regulations. There is however substantial variation in the level of authority given to local government to regulate.

Individual local council planning schemes generally place an obligation on councils to consider certain matters when dealing with applications for planning consent. This obligation provides an opportunity for councils to incorporate actions that may serve as a mechanism for local community adaptation to climate change. This includes zoning that restricts development in certain areas and development controls such as building setback, height, design and landscaping requirements.

The Victorian policy requiring that coastal setback distances are calculated by taking into account sea level rise scenarios demonstrates these principles (see Case Study 7). Other examples relate to property infrastructure such as the types of fencing, or building materials that can be used to minimise the risk of damage from bushfire.

Case Study 7 – Victorian Coastal Strategy 2008

In December 2008 the Victorian Government launched the Victorian Coastal Strategy 2008, which presents a long-term integrated planning and management framework for the Victorian coast. It provides policies and actions to plan for and address issues associated with climate change impacts on coastal hazards, such as erosion, storm surges and inundation. The Strategy recognises that significant knowledge gaps remain and identifies actions to undertake a coastal vulnerability assessment to inform future policy, planning and management plans. More specifically, the Strategy outlines the following policies which incorporate climate change in planning:

1. Plan for sea level rise of not less than 0.8 metres by 2100, and allow for the combined effects of tides, storm surges, coastal processes and local conditions, such as topography and geology when assessing risks and impacts associated with climate change. As scientific data becomes available the policy of planning for sea level rise of not less than 0.8 metres by 2100 will be reviewed.
2. Apply the precautionary principle to planning and management decision-making when considering the risks associated with climate change.
3. Prioritise the planning and management responses and adaptation strategies to vulnerable areas, such as protect, redesign, rebuild, elevate, relocate and retreat.
4. Ensure that new development is located and designed so that it can be appropriately protected from climate change's risks and impacts and coastal hazards such as:
    - inundation by storm tides or combined storm tides and stormwater (both river and coastal inundation)
    - geotechnical risk (landslide)
    - coastal erosion
    - sand drift.
5. Avoid development within primary sand dunes and in low-lying coastal areas.
6. Encourage the revegetation of land abutting coastal Crown land using local provenance indigenous species to build the resilience of the coastal environment and to maintain biodiversity.
7. New development that may be at risk from future sea level rise and storm surge events will not be protected by the expenditure of public funds.
8. Ensure that climate change should not be a barrier to investment in minor coastal public infrastructure provided the design-life is within the timeframe of potential impact.
9. Ensure planning and management frameworks are prepared for changes in local conditions as a result of climate change and can respond quickly to the best available current and emerging science.
10. Ensure all plans prepared under the *Coastal Management Act 1995* and strategies relating to the coast, including Coastal Action Plans and management plans consider the most recent scientific information on the impacts of climate change.

Table 7: Adaptation Actions for Planning and Development Approval

IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Increased temperatures, flooding and shoreline erosion				
• Increased temperatures – increased risk of bushfire.	• Identify which areas will be more vulnerable to bushfire. • Encourage new developments, or changes to existing developments, to include improved protection and adaptations to increased bushfire risk (bushfire management strategies are largely available).	• Environmental, social and economic benefits associated with better coping with bushfires and associated damage to public and private infrastructure.	• Development of educational materials.	• Some regions of Australia will be subject to increased intensity of bushfires and some jurisdictions have already prepared relevant planning advice.
• Increased temperatures and reduced rainfall – water a more valuable resource.	• Incorporate polices which ensure that the water resource implications of new developments are assessed. • Promote water sensitive urban design at the plan-making and development assessment stages of the planning process.	• Improved conservation of water. • Decreased water costs.	• Cost of policy development and implementation. • Costs associated with development of educational materials.	• Water sensitive urban design planning is already taking place within a number of local councils. This can be implemented into development assessment criteria.
• Sea level rise, increased storm surge and more intense rainfall – higher risk of flooding/erosion in flood plains or water margins.	• Ensure emergency procedures and equipment are in line with currently available information on local flooding risks.	• Economic and social benefits associated with better preparedness for current flooding regimes.	• Economic costs of updating emergency procedures.	• While state agencies generally have responsibility for emergency services, local government is a stakeholder in emergency preparedness planning.

4.7 NATURAL RESOURCE MANAGEMENT

Potential adaptation actions that local governments could undertake in the natural resource management sector are listed in *Table 8*.

All natural ecosystems are vulnerable to climate change and as identified above, coastal management is one area of natural resource management at a local government level in which climate change impacts have already been integrated into some decision-making. A range of potential adaptation options available for protection of these resources commonly documented includes:

- abandon – allow natural processes to continue unabated
- protect – shield areas from relevant climate change impacts and identified hazards
- adapt – formulate measures that allow continued or extended use of vulnerable land and resources
- retreat – instigate measures to minimise the costs of changing land-use once threatened by coastal hazards and climate change impacts
- do nothing (Rigby and Haward, 2005).

Impacts on the coast are not just restricted to changes in landforms. Changes to wetlands due to sea level rise, shoreline erosion and saltwater intrusion are also important impacts associated with climate change. Other aspects on which climate change could potentially impact include natural coastal habitats, biodiversity and other land resources and these are already vulnerable to risk due to stress from other man-made activities such as pollution and land clearing. The loss of natural habitats and changing land use activities to accommodate continued population growth and urban expansion will continue to place pressure on the natural environment and the specific processes that sustain their ecosystems (Planning Institute of Australia, 2004). The City of Salisbury's development of a large wetland area, as part of a stormwater management strategy, is a good example of where the provision and maintenance of a natural resource area is an adaptation action itself (see Case Study 8).

Parafield Stormwater Harvesting Facility – harvest and treatment of stormwater for reuse

Photo courtesy: City of Salisbury

Case Study 8 – City of Salisbury – Stormwater recycling through wetlands

The City of Salisbury has a commitment to water conservation and management which has resulted in creative, environmentally sensitive projects which decrease reliance on water from the ailing Murray River. Over the past two decades, 68 wetlands have been developed which detain and slow stormwater flows, divert water to ponds and lakes and allow time for natural processes to improve the water quality thus helping protect the downstream ecosystems of streams and coastal areas.

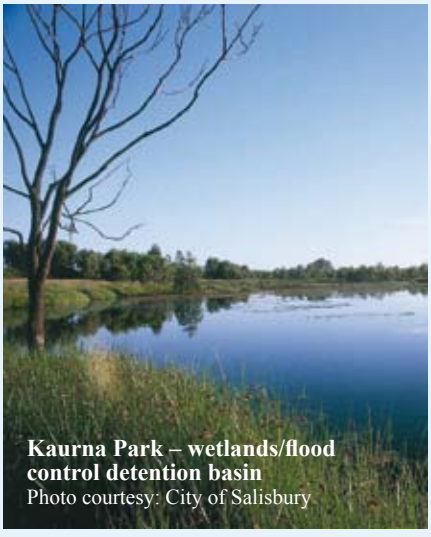
Concerned with the environmental impacts and wastefulness of the traditional water management methods, not to mention the City's huge irrigation costs, the Salisbury Council has developed a sustainable water management strategy to help the City to overcome its reliance on mains water.

Stormwater run-off from the highly developed urban catchment is detained and regulated in a series of flood control dams constructed in the upper reaches of the catchment. These dams, constructed to handle a one in 100 year flood, are used to regulate the flow of water into a series of pipes and open channels which deliver the water to a network of constructed wetlands. The reed beds of the wetlands filter and cleanse the water, removing sediment, suspended matter, nutrients and heavy metals.

The cleansed stormwater is 'harvested' and injected into underground sandy limestone aquifers to provide a buffer storage for the drier months. The cleansed water is recovered and pumped via a dedicated distribution network for irrigation of Council parks and reserves, school sports grounds and increasingly by industrial and commercial users with high water dependency. This process is known as Aquifer Storage and Recovery (ASR) and it was first trialled by the Department of Mines and Energy and Salisbury Council in 1994.

The success of the initial ASR trials led to a significant expansion of the scheme, with the City of Salisbury's ASR network now incorporating a total of 19 injection and recovery sites. The single largest site is the 1100 megalitre/annum Parafield Airport ASR scheme which incorporates a 50 megalitre capacity capture basin, a holding basin with a similar capacity, and a two hectare cleansing reed bed. Combined, Salisbury's nineteen ASR sites will harvest over 8 gigalitres of urban stormwater each year, making it one of the country's largest and most successful stormwater harvesting projects.

One of the key considerations in utilising aquifers for the storage and recovery of stormwater is that of environmental protection - both in terms of protecting the quality of groundwater, and ensuring that the naturally occurring aquifer is not depleted. The storage mechanism is highly regulated by State Authorities including the Environment Protection Authority (EPA) and the Department for Water, Land and Biodiversity Conservation (DWLBC). The EPA issue a licence for each ASR site with a focus on ensuring the quality of the injection water meets quality criteria before injection in order to minimise potential pollution of the aquifer receiving environment. The DWLBC focus is on sustainable management of the overall groundwater resource. In short, the primary consideration for sustainable management and operation of the ASR system is that the amount of water being injected into the Northern Adelaide Plains aquifer must be greater than the amount of water being extracted. This is achieved through the use of a water licensing system which is tied to the amount of water being harvested and injected.



Kaurna Park – wetlands/flood control detention basin
Photo courtesy: City of Salisbury

Buoyed by the outstanding success of the ASR schemes, the City of Salisbury is now focused on taking stormwater harvesting and recycling to the next level - developing and expanding the distribution network to provide high quality recycled water (reWater) throughout the City of Salisbury and beyond.

The greater Adelaide metropolitan area currently consumes some 310 gigalitres of mains water per annum in an average year. Of this, 88 gigalitres is drawn from the Murray River. Needless to say, factors including wide-

spread drought throughout the Murray-Darling Basin, and the ever-increasing emphasis being placed on reducing the nation's reliance on waterways such as the Murray (including plans to increase environmental flows and reduce the total amount of water available for use) all will have a significant impact on Adelaide's future water supply.

With that in mind, the City of Salisbury has proposed the "Waterwise" strategy to potentially harvest over 60 gigalitres of stormwater per annum across Adelaide. Supplemented by increased use of reclaimed water (treated effluent) of up to 50GL/annum and the "insurance policy" provided by the 100GL/annum Desalination plant, the Strategy would bring Adelaide's net demand from the River Murray to 0 ! The strategy would also reduce pressure on the groundwater resource and significantly reduce stormwater run-off (and the associated pollutant load) to the marine environment.

The Waterwise strategy not only proposes to significantly increase the amount of stormwater being harvested, it also incorporates a plan to produce high quality potable (drinking) water supplies by treating the harvested stormwater within the aquifer.

Developed in conjunction with the CSIRO and United Water International, the Aquifer Storage Transfer and Recovery (ASTR) concept differs from the existing ASR schemes. Rather than establishing the injection point and extraction well at the same point in the aquifer, the ASTR project's injection and recovery wells are located significant distances from each other, thereby extending the storage time within the aquifer. Forcing the harvested stormwater to pass through the aquifer for an extended distance prior to recovery, enables the ASTR system to deliver the highly predictable levels of chemical and microbiological contamination attenuation essential for the provision of potable quality water.

To that end, the City of Salisbury has established a major ASTR demonstration project at Parafield Gardens, adjacent to the existing Parafield ASR site. The ASTR project aims to inject an additional 200 megalitres of wetland treated stormwater per year into the brackish aquifer, while recovering water fit for continuous sustainable supply at potable quality.

While the idea of harvesting urban stormwater for processing and recycling into drinking water may appear to some as far-fetched or high-risk, it is important to remember that it is common practice throughout much of Europe. Indeed, in many major European cities the water supply is extracted from aquifers adjoining rivers, using the concept of bank infiltration and using the aquifer as a cleaning mechanism.

While the Salisbury ASTR project will be the first in Australia to utilise aquifer cleansing for potable water, this process has been studied intensely for many years by hydrogeologists, geologists and microbiologists, and the project benefits from a wealth of scientifically-backed research data confirming both the performance and reliability of the process.

Perhaps most importantly, while there can be no doubting the importance of developing additional high quality water supplies, the City of Salisbury also recognises that it is not appropriate to harvest water to the detriment of either the marine or terrestrial environment through which the water runs.

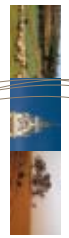
Rather than focusing on the process of recycling water from stormwater flows in isolation, Salisbury's projects have been developed as a component of Council's Integrated Water Cycle Management Plan (IWCMP), which encompasses other important environmental protection and sustainable development issues, including flood protection and environmental flow management. This helps to ensure that harvesting of water from the catchments is achieved in a sustainable manner, and still permits stormwater to flow through the catchment in a manner which emulates, to the extent possible, the catchment prior to urbanization.

It is envisaged that in the long-term, the full development of the Waterwise Strategy will have the potential to supply up to 20% of Adelaide's annual water needs with recycled stormwater. Furthermore, when compared to other alternative supply methods such as additional desalination, the methods used at Salisbury deliver a range of additional benefits, including significantly lower construction costs and lower energy consumption requirements per megalitre of water supplied.

Table 8: Adaptation Actions for Natural Resource Management

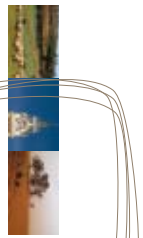
IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Biodiversity management and protection				
• Changed climatic conditions in general – adversely affecting ecological succession.	• Develop a Local Biodiversity Plan as a component of the Local Planning Strategy and Town Planning Scheme. • Implement conservation management plans for local reserves and other local government lands. • Encourage private land conservation, e.g. through incentives.	• Environmental and social benefits of increased amenity, areas of recreation, air pollution control and habitat for wildlife (provided these uses are compatible, some types of recreation may adversely impact on wildlife habitat). • Potential for increased availability of areas for recreation/tourism. • Decreased risk of loss of private and public property and infrastructure.	• Costs associated with mapping and associated staff resources. • Costs associated with additional level of detail in planning/planting costs.	• Local government is responsible for strategic spatial planning, and management of urban vegetation and local government may require reafforestation as a requirement of local government development approvals. • Local government may also undertake reafforestation activities under their own initiative. • Darwin City Council has developed an Environmental Management Plan (EMP) to protect the values of the coastal, urban and rural environments in Darwin. The EMP builds on the City Atlas of Values that presents known environmental, recreational, cultural and land-use values and issues.

IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
• Reduced rainfall and runoff – decreased water supply and associated impacts on urban vegetation.	• During strategic spatial planning, take into account impact of potential reduced water supply on urban vegetation. Trees can result in subsidence risks and location of water bodies relative to urban vegetation may help sustain the vegetation.	• Economic, environmental and social benefits of increased sustainability of urban vegetation and prevention of existing subsidence risks.	• Costs associated with additional level of detail in planning/planting.	• Climate change scenarios show decreased water supply levels across most of Australia. • Local government is responsible for strategic spatial planning, and management of urban vegetation.
• Reduced rainfall and runoff – decreased water supply and associated impacts on urban vegetation.	• Continue to develop roadsides/utility corridors as native vegetation corridors, in consultation with relevant road authorities to ensure road use safety is protected.	• Environmental and social benefits of increased amenity, areas of recreation, air pollution control and habitat for wildlife. • Potential for increased availability of areas for recreation/tourism.	• Costs associated with policy development and/or amendment.	
Coastal management/protection				
• Sea level rise – inundation and erosion of inland areas.	• Implement dune restoration programs as appropriate.	• Environmental and social benefits of restoring the beneficial natural and human use values associated with coastal dunes.	• Economic cost of implementing dune restoration programs.	• Sea level rise is a potential risk to all Australian coastal zones. • Dune restoration programs are an existing feature of many coastal local government areas.
• Sea level rise and increased flooding – potential for erosion in shore zones and impact on vegetation worsening impacts of inundation.	• Protect buffer vegetation in shore zones.	• Environmental benefits of protecting productive ecological zone. Social benefits of maintaining amenity and potential areas of recreation e.g. fishing.	• Economic costs of Protecting vegetation in shore zones.	• Scenarios indicate that many regions of Australia will be vulnerable to shoreline erosion. Maintenance of shoreline vegetation can be a local government activity.



IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Land/park management				
• Increased risk of bushfires.	• Take into account the areas at increased risk of bushfire from climate change in the use of prescribed fire as a tool for managing fuel accumulation (recognising that inappropriate fire regimes can potentially threaten the conservation of biodiversity). • Use of fire adapted vegetation (much of Australian vegetation is fire adapted). • Ensure that 'fire management zones' have been identified. • Ensure that clear objectives and the most suitable forms of fire management and mitigation for each zone have been developed, e.g. identification of assets and collation of information on how fire, and fire mitigation, might affect these assets. (Note – many local governments have already done this)	• Improved bushfire risk management – planning, preparedness, response and recovery. • Decreased potential for risk to human life. • Decreased potential for loss of private and public property. • Decreased costs associated with recovery.	• Increased potential for air pollution and fire related smog, particularly in the Northern Territory where this can already be a problem due to local savannah burning and fire related smog from Indonesia and Malaysia.	

IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Pest/weed management				
• Changed climatic conditions – adverse impacts on ecological succession and creating worsened and new pest and weed problems.	• Develop and implement a pest, weed and invasive species management policy/ strategy that takes into account changed climatic conditions (many local government areas have management policies/ strategies in place). • Promote awareness to local communities of potential weed risks resulting from climate change in the local area (incorporate into existing awareness programs if appropriate). • Revisions to mowing and weed control schedules to take into account changed climatic conditions that affect growth and dispersion.	• Economic and environmental benefits of managing existing weed and pest problems and mitigating against future problems (whether these arise from climate change or not).	• Economic costs of management strategies.	• Pest and weed problems are an existing issue for many local government areas. Local governments may require management strategies as part of development approval, and may also undertake management strategies. • Many Australian councils already have weed management strategies that provide co-ordinated weed control programs and address issues such as: – increasing community awareness of weed issues – encouraging community support for weed management programs – weed hygiene – spread of weeds along road reserves.

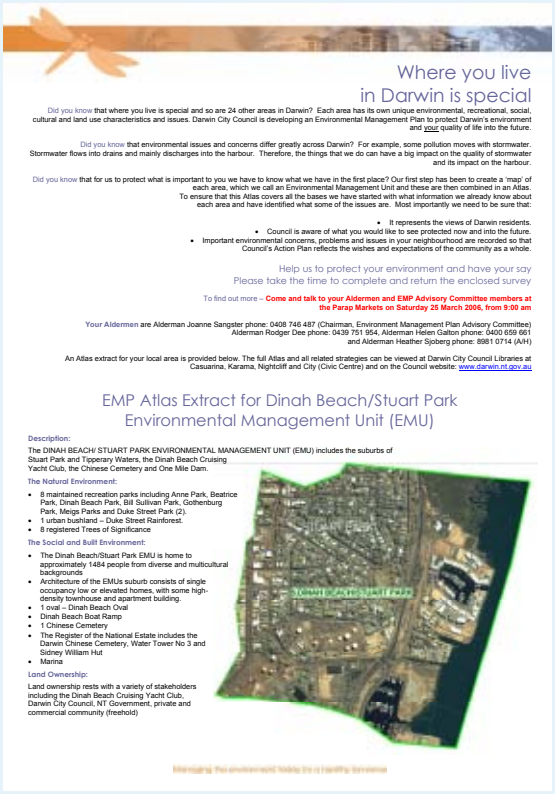


Case Study 9 – Darwin City Council - Climate Change and Environmental Management

Darwin City Council has placed Climate Change and Waste Management at the forefront of its Strategic Directions document "Evolving Darwin - Towards 2020 and beyond".

To support this commitment, Council initiated a 1% Environmental levy in their 2009/10 Budget.

A Senior Policy Officer has been appointed to the Climate Change and Environment Team, to support the development of appropriate policies and procedures, thus ensuring climate change and environmental priorities are effectively addressed in a timely and sustainable manner, across the organisation and within the community.



Where you live in Darwin is special

Did you know that where you live is special and so are 24 other areas in Darwin? Each area has its own unique environmental, recreational, social, cultural and land use characteristics and issues. Darwin City Council is developing an Environmental Management Plan to protect Darwin's environment and your quality of life into the future.

Did you know that environmental issues and concerns differ greatly across Darwin? For example, some pollution moves with stormwater. Stormwater flows into drains and mainly discharges into the harbour. Therefore, the things that we do can have a big impact on the quality of stormwater and its impact on the harbour.

Did you know that for us to protect what is important to you we have to know what we have in the first place? Our first step has been to create a 'map' of each area, which we call an Environmental Management Unit and these are then combined in an Atlas. To ensure that this Atlas covers all the bases we have started with what information we already know about each area and have identified what some of the issues are. Most importantly we need to be sure that:

- It represents the views of Darwin residents.
- Council is aware of what you would like to see protected now and into the future.
- Important environmental concerns, problems and issues in your neighbourhood are recorded so that Council's Action Plan reflects the wishes and expectations of the community as a whole.

Help us to protect your environment and have your say
Please take the time to complete and return the enclosed survey

To find out more – **Come and talk to your Aldermen and EMP Advisory Committee members at the Parap Markets on Saturday 25 March 2006, from 9:00 am**

Your Aldermen are Alderman Joanne Sangster phone: 0408 746 487 (Chairman, Environment Management Plan Advisory Committee) Alderman Rodger Dee phone: 0439 751 954, Alderman Helen Galton phone: 0400 659 661 and Alderman Heather Sjoberg phone: 8981 0714 (A/H)

An Atlas extract for your local area is provided below. The full Atlas and all related strategies can be viewed at Darwin City Council Libraries at Casuarina, Karama, Nightcliff and City (Civic Centre) and on the Council website: www.darwin.nt.gov.au

EMP Atlas Extract for Dinah Beach/Stuart Park Environmental Management Unit (EMU)

Description:

The DINAH BEACH/ STUART PARK ENVIRONMENTAL MANAGEMENT UNIT (EMU) includes the suburbs of Stuart Park and Tipperary Waters, the Dinah Beach Cruising Yacht Club, the Chinese Cemetery and One Mile Dam.

The Natural Environment:

- 8 maintained recreation parks including Anne Park, Beatrice Park, Dinah Beach Park, Bill Sullivan Park, Gothenburg Park, Meigs Parks and Duke Street Park (2).
- 1 urban bushland – Duke Street Rainforest.
- 8 registered Trees of Significance

The Social and Built Environment:

- The Dinah Beach/Stuart Park EMU is home to approximately 1484 people from diverse and multicultural backgrounds
- Architecture of the EMUs suburb consists of single occupancy low or elevated homes, with some high-density townhouse and apartment building.
- 1 oval – Dinah Beach Oval
- Dinah Beach Boat Ramp
- 1 Chinese Cemetery
- The Register of the National Estate includes the Darwin Chinese Cemetery, Water Tower No 3 and Sidney William Hut
- Marina

Land Ownership:

Land ownership rests with a variety of stakeholders including the Dinah Beach Cruising Yacht Club, Darwin City Council, NT Government, private and commercial community (freehold)

Courtesy: Darwin City Council

A Climate Change and Environment Advisory Committee with representatives from community, environmental, indigenous, science, universities, government agencies and the Northern Territory Local Government Association, works with Darwin City Council to provide advice on priorities.

Council endorsed the recommendations from the Advisory Committee and the new "Climate Change and Environment Action Plan 2009-12" establishes a range of task to be undertaken within the categories of Climate Change, Water, Land, Air, Biodiversity, Recycling and Waste Management.

An Environmental Management Plan (EMP) for Darwin was developed in 2006 and the "Climate Change and Environment Action Plan 2009-12" builds on the EMP 'City Atlas of Values' – which divides Darwin into separate Environmental Management Units (EMU's) based on the City's 24 identified hydrological sub-catchment boundaries - thus enabling tasks to be undertaken at a local level.

As an adjoining Coastal Manager with the Australian Government, Northern Territory Government and the Larrakia Nation, Darwin City Council has a strong commitment to enhance, preserve and protect the environment of the Darwin Harbour.

A Coastal Erosion Report undertaken for Council, provided a review of the physical, geological and environmental settings of the low-lying cliffs at two study sites and outlines the major sea and land based processes which are causing enhanced erosion of the coastline.

In taking a leadership role and by working in partnership, Council has initiated discussions and provided seminars to address sea level rise and storm surge issues for the Darwin region. Council is represented on the Darwin Harbour Advisory Committee, along with other committees addressing coastal matters of importance.

Further information about Darwin City Council's "Climate Change and Environment Action Plan Priorities 2009-2012", or to view the Environmental Management Plan and Atlas of Values please visit www.darwin.nt.gov.au or contact the Manager of Climate Change and Environment on (08) 89 300 530.

4.8 WATER AND SEWERAGE SERVICES

A good deal of activity in the provision of water resources has already been undertaken at a local government level to identify and implement actions to serve the purpose of assisting community adaptation to climate change. The continued implementation by local government of water efficiency and demand management initiatives (e.g. rainwater harvesting, water-wise gardens, water efficiency ratings on equipment), will help communities adapt to decreased water availability as a result of climate change.

Commonly identified existing adaptation mechanisms include:

- use of water efficient appliances and hardware
- water efficient urban design and housing standards
- water efficient garden planting and watering
- supplementing supplies with recycled water
- watering restrictions
- appropriate pricing mechanisms
- detection and control of leaks including water pressure management (Brisbane Institute, 2005).

Enhanced community education and engagement will continue to play a role in the adaptation of local government water and sewerage services.

Table 9 identifies adaptation actions relevant to the provision of water and sewerage services by local government. Appropriate strategies have also been identified under other sections, namely recreational facilities, infrastructure and planning. Case Study 10 has also been provided to illustrate existing initiatives in water management that qualify as adaptation actions with additional benefits.

Case Study 10 – City of Melville Sustainable Water Management

Groundwater provides a major source of Western Australian water supply and in particular supplies about 60% of Perth's water. Local governments can also rely on groundwater for activities such as irrigation of parks and gardens and, although the relationship between groundwater and climate change is still uncertain, this resource is potentially threatened with groundwater being lost through increased evaporation rates.

The City of Melville has recognised that good management of groundwater is essential to ensure that growth (i.e. new developments) can still occur, whilst maintaining sustainable yields from the groundwater aquifers into the future. As such, it is a key performance indicator of the City's Strategic Plan to limit groundwater use to 90% of allocated quantity. The City has also been actively developing strategies and procedures that will enable it to practice sustainable water management within its area. One such strategy is that the City has adopted the rationale "if you can't measure it, you can't manage it" and, progressively over the last 10 to 15 years, has been adding meters to its groundwater bores to enable monitoring and sustainable management of groundwater extraction.

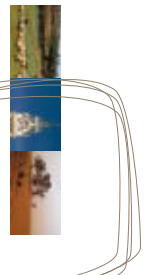
The City has recognised that volumetric-based groundwater monitoring is much more practical and monitoring of these resources is a form of process control, risk management and asset management. Over the coming year, the City of Melville will also concentrate on real-time water monitoring activities and has plans to trial wireless water meters internally before applying these more widely so that the local community can play a role in monitoring its own water budget. These initiatives have been funded as ongoing investments by the City with regular budget allocations made appropriately. The City of Melville is also investigating the ability to access funding through the National Water Initiative.

Further information on the above initiatives is available at www.melville.wa.gov.au or phone (08) 9364 0617.

Table 9: Adaptation Actions for Water and Sewerage Services

IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
Wastewater services				
• Increased rainfall intensity – potentially more frequent incidence of wastewater system overflow.	• Design wastewater systems to prevent overflow events from wetter than normal weather, based on climate change scenarios. If costs are prohibitive, plan for regular system reviews to consider climate change effects.	• Economic, environmental and social benefits of reducing pollution caused by wastewater overflows. Economic benefits of improving efficiency of wastewater system.	• Economic costs associated with upgrading wastewater systems, designing systems to more frequent and heavy rain events and undertaking more regular system reviews in light of changing climatic conditions.	• Wastewater overflow events are an existing problem, and pollute Australian waters. Climate change scenarios show increased incidence of high intensity rain events, which may cause wastewater overflows in many local government areas. Wastewater systems are managed by local governments in some jurisdictions, particularly rural areas.
Water provision and water conservation activities				
• Increased temperatures and reduced rainfall – water a more valuable resource.	• Develop water strategies that incorporate greywater reuse. • Supplement existing supplies with recycled water where possible. • Community education on water efficient garden planting and watering.	• Environmental benefits from more efficient water use. • Economic benefits from decreased levels of potable and non-potable water consumption.	• Economic benefits from decreased levels of community water consumption. • Economic cost of greywater recycling infrastructure. • Greywater reuse may pose health risk if not managed appropriately (social/ economic costs).	• Dry weather and drainage issues from intense rain events are existing problems for Australia and climate change scenarios show that these problems may worsen in many areas of Australia. • Local government could require greywater recycling as part of development approval, and may incorporate greywater recycling in public infrastructure, e.g. Queensland Government has recently introduced legislation to allow people to use greywater on gardens and lawns in sewered areas. The legislation took effect on 1 March 2006. • Coomera in Queensland has taken steps towards supplementing their water supply with water recycling.

IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
• Increased temperatures and reduced rainfall – water a more valuable resource.	• Promotion of use of Sustainable Urban Design Systems (SUDS) and water efficient installations into new developments. • Identification of opportunities to include Sustainable Urban Design Systems in existing developments/ infrastructure. • Prepare or review policies to incorporate demand management strategies such as roof water harvesting in residential areas. • Identify potential water conservation incentives.	• Environmental benefits from more efficient water use. • Increased water availability for other activities including recreation, land management, etc.	• Community education and promotion costs.	• Some councils are already using techniques such as stormwater harvesting as means for meeting irrigation requirements within their local area. • Local government has a role as a community educator, e.g. development and distribution of the Water Sensitive Planning Guide for the Sydney Region. • Relevant for developments initiated and/or approved at a local government level.
Stormwater services				
• Increased rainfall intensity and changes to rainfall patterns will impact on drainage and water management in urban areas.	• Develop urban drainage management plans that optimise active storage capacity to alleviate flood peaks. • Urban based drainage system should be linked to catchment based flood management to avoid impacting on other areas in the catchment.	• Environmental and social benefits of better managing water, and linking to catchment scaled plans. • Economic benefits of optimising existing active storage capacity. • Social benefits from better management of drainage from existing intense rainfall events (health and safety).	• Development of plans. • Engineering/ Consultancy costs.	• Rainfall patterns are expected to change across Australia, affecting drainage management. Local governments typically have responsibility for drainage.



IMPACT	ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS	TRANSFERABILITY IN AUSTRALIA/ EXAMPLES OF EXISTING INITIATIVES
• Increased rainfall intensity and changes to rainfall patterns will impact on drainage and water management in urban areas.	• Development of a stormwater management plan that addresses potential locally-appropriate alternative uses of stormwater and includes measures to reduce peak flows during wet weather, e.g. increased use of stormwater by capturing (such as developing wetlands and aquifer storage and recovery). • Ongoing and periodic review of sewerage system strategies and operations to address hydraulic constraints and overflow risks, and sewer rehabilitation and cleaning regimes. • Limit growth expansion and/or connections to parts of the system where there are potential capacity constraints.	• Reduced pollutant loads due to cleansing of incoming storm water via sedimentation processes. • Reduced amount of stormwater discharged into sensitive ecosystems. • Increased availability of water for reuse for other purposes such as irrigation of ovals, golf courses, etc.	• Development of plans. • Engineering/ consultant costs.	• Rainfall patterns are expected to change across Australia, affecting drainage management. Local governments typically have responsibility for drainage and run-off. • There are examples of aquifer recharge projects in South Australia (see http://www.dwlbc.sa.gov.au/water/projects/frac_rock_aquifer.html).

4.9 GENERAL ADAPTATION MEASURES

There are a number of adaptation measures that can apply across all responsibilities, roles and jurisdictions of local government. These are identified in *Table 10*.

Table 10: Adaptation Actions that Apply Across Sectors

ADAPTATION ACTION	BENEFITS (ECO/ENVIRO/SOCIAL)	COSTS
• Strengthen profile of climate change within local government, and combine with the sustainability agenda.	• Incorporate climate change scenarios into policy and decision-making processes. • Environmental and social benefits of improving awareness of integrated planning principles and the sustainability agenda. • Increased staff capacity.	• Economic costs of education programs and staff time dedicated to these.
• Raise local community awareness of climate change and adaptation actions that can be implemented at home and that have ancillary benefits in addition to those associated with climate change, e.g. water and energy conservation measures, etc.	• Environmental and social benefits of improving awareness of environmental topics.	• Economic costs of awareness campaigns.
• Establish communication channels between scientists and local government officers.	• Economic benefits of having access to communication channels between scientists and local government.	• Economic costs of establishing and maintaining communication channels.
• Improve public sector capabilities through capacity building activities for local government staff.	• Economic, social and environmental benefits of having access to improved environmental services.	• Economic costs of providing capabilities, and potential cost of underutilising capabilities.
• Complete climate change risk assessments.	• Improved understanding of existing climate vulnerabilities of local government functions, potentially leading to improvements in these functions.	• Cost of undertaking risk assessment, and updating the assessment to maintain its validity.

4.10 REGIONAL AND PARTNERSHIP APPROACHES

Adaptation to climate change does not necessarily require a fundamental change to actions that are already being undertaken by local government. Many actions that could be considered to be adaptation actions and programs are already in place within some proactive councils (i.e. green building, water and energy efficiency initiatives) and while perhaps these have been initially established for reasons other than the risk of climate change, they nevertheless represent an adaptation action. An adaptation action may be simply to increase the frequency or magnitude of existing program implementation and monitoring.

The following are approaches that may assist local government in the implementation of actions:

- using a risk management framework to identify risks, set priorities, decide on strategies to manage risks, assign responsibilities for action and monitor progress.
- adopting a regional approach in driving adaptation.
- partnerships with state and federal government and/or private industry.

REGIONAL APPROACHES

A regional approach is an efficient mechanism for local governments to engage in the implementation of adaptation actions because it allows for the sharing of resources and knowledge. Given that many of the climate change adaptation issues that face councils are similar, particularly for neighbouring councils, cooperation can provide substantial benefits.

Collaboration on a regional scale is not a new concept to local government, with regional organisations of councils already operating in most states of Australia. A number of organisations of councils are focused specifically on issues related to climate change and environmental management with examples of these including:

- *Greenhouse Alliances* – these regional alliances in Victoria are funded by the state government but provide local government with the opportunity to network and share resources (see Case Study 2).
- *Regional Councils* – in Western Australia, as within other states, amalgamations of councils into regional groups such as the Eastern Metropolitan Regional Council and the Southern Metropolitan Regional.
- Council has proven to be an efficient mechanism for the implementation of environmental management Programs.
- *Sydney Coastal Councils Group* – promotes coordination between member councils on environmental issues.

Solar hot water panel – Bass Coast Shire Civic Centre Photo Courtesy: Western Port Greenhouse Alliance

PARTNERSHIPS WITH GOVERNMENT/PRIVATE INDUSTRY

Partnerships with different levels of government and/or business are a useful (and sometimes essential) mechanism for increased implementation of adaptation actions. Partnerships enable the sharing of resources, existing knowledge and avoid the "reinvention of the wheel" by local government. In some cases relationships with private organisations will be needed for particular local government functions (such as the building industry). State government agencies may also be able to provide guidance or assistance.

Existing joint initiatives between local and state governments which could potentially be broadened to include climate change as an issue are:

- the Queensland Disaster Management Alliance, a collaborative approach to disaster management planning that is a joint initiative between the Local Government Association of Queensland and the State Department of Emergency Services. This alliance has been driven by the recognition that local governments play a critical role in planning for and managing disasters that impact on their communities.
- Regional Alliance Groups, which are made up of individual local governments, may choose to align themselves with other local governments based on shared risks or other common social, environmental or economic criteria. These groups are established to, among other activities, "raise issues and provide collective solutions to disaster management problems" and "promote and facilitate the integration of comprehensive disaster management planning into local government corporate, operational and financial planning processes".
- a partnership between the Victorian Department of Sustainability and the Environment, the Municipal Association of Victoria and the Country Fire Authority is another example of where a partnership approach is being adopted (see Case Study 11). While this example is not specifically referring to climate change as an issue, it provides a useful example of how different levels of government are working together to achieve an outcome. It also shows how the framework adopted by this project is equally applicable to the development and implementation of adaptation actions at a local government level.

Case Study 11 – Integrated Fire Management Planning Project

The Victorian Department of Sustainability and the Environment is working with the Municipal Association of Victoria and the Country Fire Authority on a project of fire prevention, preparedness, response and recovery (PPRR). This project has been initiated in recognition of the fact that there is a need for more consistency in planning and broader cooperation between fire and other emergency agencies, local government and communities. Its objective is to provide assistance to municipalities to help them to include the fire management planning framework in their current emergency management arrangements.

IFMP
Integrated Fire Management Planning

Further information can be obtained at www.ifmp.vic.gov.au.

Through the Local Adaptation Pathways Program (LAPP), the Australian Government is providing funding to help councils undertake climate change risk assessments and develop action plans to prepare for the likely local impacts of climate change. Under Round 1 of the LAPP, more than 60 local governments from mostly coastal and urban areas received funding for a total of 33 projects. Round 2 of the LAPP seeks to build on the work from Round 1 and to improve participation from local governments in Outer Regional, Remote and Very Remote regions. The funding will help councils integrate climate change risk assessment into their broader decision-making processes. The risk assessment process used in the LAPP projects aligns with that outlined in the *Climate Change Impacts & Risk Management: A Guide for Business and Government* publication.

Five more risk assessment projects at local and regional scales have also been supported by the Australian Government and conducted in partnership with state, territory and local governments, research institutions and local communities. The projects fostered collaboration and recognition of the need for different approaches when integrating adaptation considerations in real life council operations and with the community. These projects built the capacity of local governments to identify climate change challenges and develop targeted and effective responses. Further information can be accessed at http://www.climatechange.gov.au.

The Australian Government also supported ICLEI Oceania– Local Governments for Sustainability to develop guidance materials and pilot them with five Local Councils around Australia. The guide is based on the Department of Climate Change and Energy Efficiency's risk management guide for integrating climate change considerations into council operations. This project's technical and guidance materials are available to all local governments in Australia via the ICLEI Oceania -Local Governments for Sustainability website (http://www.iclei.org/index.php?id=adaptation-toolkit).

An example of a partnership approach between business and government is illustrated by the Insurance Australia Group (IAG). In 2004, IAG developed a partnership with local government planners in New Zealand to determine the most appropriate flood planning levels for the future. IAG provided the scientific modelling results which showed changes in extreme rainfall which the local government then used to determine the likely changes to future flood levels. This was then incorporated into their flood mitigation programs (Stagnitta et al., 2005).

Another example of how partnerships with local government may support uptake of adaptation actions is the voluntary and incentive-based building labelling standard which has been developed by the Urban Development Institute of Australia (see Case Study 12).

Case Study 12 - Development of an environmental labelling scheme "EnviroDevelopment"

As an industry policy organisation, the Urban Development Institute of Australia has recognised the need for both public and private organisations to take greater steps towards both adaptation and mitigation of climate change and its impacts. To assist this, the Institute developed an environmental labelling scheme called *EnviroDevelopment*. The purpose of the initiative is to encourage the rapid adoption of sustainable development principles in the urban sector. The strategies promoted by *EnviroDevelopment* offer benefits in regards to both climate change adaptation and climate change mitigation. Indeed, an awareness of climate change issues was a major driver for the Institute's commitment to the project.

Initially launched in Queensland in October 2006, and subsequently rolled out in other states including South Australia, Western Australia and Victoria, *EnviroDevelopment* assists in raising the awareness of climate change issues within governments (particularly local governments), the development industry, and the community. The standard supports both climate sensitive and water sensitive urban and building design and has elements dedicated to community, ecosystems, energy, materials, waste and water.

As a voluntary, incentive-based framework, *EnviroDevelopment* demonstrates how partnerships with local government can support climate adaptation and achieve development outcomes for mutual benefit.

For further information on the development of this project please contact the Urban Development Institute of Australia on (07) 3229 1589 or visit www.envirodevelopment.com.au.

5 Examples of Climate Change Adaptation Initiatives in Australia

There are many initiatives in Australia that may provide useful examples or sources of information to assist local governments in the development of climate change adaptation actions relevant to their own jurisdictions. This list is not exhaustive and there are many other initiatives being undertaken at all levels of government. Identifying best practice adaptation examples is an ongoing process that requires an integrated approach and interaction between disciplines, consequently many of these examples fall across a number of sectors or areas of responsibility.

INFRASTRUCTURE AND PROPERTY SERVICES

- *BASIX* – the Building Sustainability Index is a NSW web-based planning tool designed to assess the potential performance of residential buildings against a range of sustainability indices. Features required to be incorporated in sustainable building design include recycled water, rainwater tanks, AAA-rated showerheads and taps, native landscaping, heat pump or solar water heaters, roof eaves/awnings and wall/ceiling insulation. Many developments in NSW now require a BASIX Certificate prior to their approval (www.basix.nsw.gov.au).
- *EnviroDevelopment* – a performance-based tool developed by the Urban Development Institute of Australia to encourage developments incorporating efficient energy use, water conservation, biodiversity protection and use of environmentally responsible materials (refer to Case Study 12).
- *Flood plain mapping activities* – a number of local councils are identifying risks within their local area and participating in the distribution of flooding awareness material to the general public with regard to the impacts on their housing and property.
- *Cyclone Testing Station and Hail Gun* – given the relevance of the impacts of climate change to the insurance industry, the Insurance Australia Group (IAG) have been sponsoring adaptation research activities. Examples of these activities include the Cyclone Testing Station which aims to understand the susceptibility and vulnerability of different building types to damage from tropical cyclones and, the 'Hail Gun' project, which is testing the susceptibility of various roofing materials to hail damage.

HEALTH/RECREATION

- Partnership programs such as SunSmart Local Government (www.sunsmart.com.au) in Victoria and *Cancer Council Community Partners* (www.cancercouncil.com.au) in NSW have been developed recognising that local government is uniquely positioned to help reduce the incidence and impact of skin cancer in the community through community education activities.

PLANNING

- *Sustainable Regional and Urban Communities Adapting to Climate Change* project – instigated by the Planning Institute of Australia (Qld Branch) and the then Australian Greenhouse Office (AGO), this four stage project provides guidance on how the planning system in Queensland can assist local and regional communities to adapt to climate change. This project's outputs are relevant to other Australian states.
- *Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering* – prepared by the Australian Institute of Engineers to provide assistance to coastal and ocean engineers in assessing climate change significance for particular situations or projects. This includes possible adaptation options for climate change threats.

- *Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea Level Rise* – identification of Tasmanian coastal areas potentially vulnerable to increased storm surge flooding and sandy shoreline erosion and recession as a result of global climate change and sea level rise.
- *National Coast Risk and Vulnerability Assessment* – identification of regions with relatively greater risk of inundation and coastal erosion as a result of climate change.

Some specific examples of how adaptation has been included in coastal planning policy at a state level are included in *Table 11*.

Table 11: Examples of Climate Change Adaptation Requirements in State Coastal Planning Policies

LOCATION	ADAPTATION
South Australia	The Coast Protection Board (2002) has adopted the median sea level predictions of the IPCC as part of its coastal planning policy – 0.3m sea level rise by 2050, and 1 metre sea level rise by 2100. For major developments, the full range of possible climate change impacts should be considered.
Tasmania	Tasmania has developed an approach based on a 1% annual exceedance probability; that is the probability of a high sea-level event having a 1% chance of occurring once or more in any one year (2008). To determine exceedance probabilities Tasmania coastline is classified into a number of 'tidal zones' and sea level rise projections are based on the IPCC's upper emissions scenarios (A1FI). For any given height of a location, the risk of a high sea level event flooding that point can be determined and the risk over time (up to 2100) can also be identified.
Queensland	The *State Coastal Management Plan* (2002) identifies a climate change adaptation principles that should be referenced in coastal planning. In assessing coastal erosion prone areas, a 0.3m rise in sea level over a 50 yr planning period should be adopted (2005).
Western Australia	The *State Coastal Planning Policy* (2006) suggests that coastal planning strategies should take into account coastal processes and sea level change. The Policy provides for a benchmark of 0.38m when assessing the potential for erosion on sandy shores.
Victoria	The *Victorian Coastal Strategy* (2008) provides a policy of planning for sea level rise of not less than 0.8m by 2100.
New South Wales	The draft *Sea Level Rise Policy Statement* (2009) indicates a sea level rise benchmark of 0.4m by 2050 and 0.9m by 2100, should be adopted in coastal planning.

NATURAL RESOURCE MANAGEMENT

- *National Biodiversity and Climate Change Action Plan 2004 – 2007* – the plan is a result of recognition in the National Greenhouse Strategy that biodiversity is one of the key sectors sensitive to the effects of climate change and for which adaptation planning is needed. This Plan sets out a series of adaptation strategies and actions to minimise negative impacts of climate change on biodiversity and maximise the capacity of species and ecosystems to adapt in the future (http://www.environment.gov.au/biodiversity/publications/nbccap/index.html)
- *Guidelines for Regional Natural Resource Management (NRM) Planning in Queensland* – include a module and guideline, Adaptation to Climate Change in Regional NRM Plans, that address climate change adaptation in regional natural resource management plans, target setting and investment strategies (www.regionalnrm.qld.gov.au/policies_plans_legislation).

WATER AND SEWERAGE SERVICES

- *State-based water efficiency and demand management initiatives* – e.g. Waterproofing Adelaide (www.waterproofingadelaide.sa.gov.au) which requires councils to develop stormwater management plans on a whole-of-catchment basis and the *SA Water Conservation Handbook for Local Government*.
- *Local government stormwater management* – strategies and plans designed to assist councils and other stakeholders to manage the environmental quality of urban stormwater run-off and provide a framework for integrating stormwater management into existing management and planning activities.
- *ICLEI Water Campaign* – a voluntary capacity-building program to assist local governments to conserve water. The program is based on the achievement of milestones including – preparation of an inventory of water consumption and water quality management data; establishment of goals for water conservation and water quality; and development, implementation, measurement and reporting of a *Local Water Action Plan* (www.iclei.org/water/).
- *Water Sensitive Urban Design (WSUD) in the Sydney Region* – a collaborative project to enhance the ability of council staff to promote and implement sustainable water management practices in council operations and development projects. Tools include the *Water Sensitive Planning Guide for Sydney Region and Technical Guidelines* to provide guidance on best management practice design (www.wsud.org).
- *Water Sensitive Urban Design principles* – these have been adopted at a local government level at varying degrees across Australia via activities such as encouraging the increased use of water tanks for domestic supplies and landscaping that reduces overall water use.

Photo courtesy: Alastair Betts and the Department of the Environment, Water Hertiage and the Arts

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Appendix A: Consulted Stakeholders

Organisations consulted during the preparation of this report are listed below.

ACT Office of Sustainability (part of the Chief Minister's Department)

ACT Planning and Land Authority (ACTPLA)

Association of Bayside Municipalities (Vic.)

Australian Building Codes Board (ABCB)

Australian Local Government Association (ALGA)

Brisbane City Council (Qld)

Central Victorian Greenhouse Alliance

City of Marion (SA)

City of Melville (WA)

City of Port Adelaide-Enfield (SA)

Conservation Council of the South East Region and Canberra (CCSERAC)

Darwin City Council (NT)

Department of Agriculture, Fisheries and Forestry (Cwlth)

Department of Conservation and Land Management (WA)

Department of Energy and Infrastructure (SA)

Department of Environment (WA)

Department of Environment and Conservation (NSW)

Department of Health and Ageing (Cwlth)

Department of Local Government and Planning (Qld)

Department of Local Government and Regional Development (WA)

Department of Natural Resources (NSW)

Department of Natural Resources, Environment and the Arts (NT)

Department of Natural Resources and Mines (Qld)

Department of Planning and Infrastructure (WA)

Department of Premier and Cabinet (Greenhouse Unit) (WA)

Department of Primary Industries, Water and Environment (Tas.)

Department of Sustainability and Environment (Vic.)

Department of Transport (SA)

Eastern Metropolitan Regional Council (WA)

Engineers Australia

Environment Protection Authority (Vic.)

Gold Coast City Council (Qld)

ICLEI (Cities for Climate Protection)

Insurance Australia Group

Indian Ocean Climate Change Initiative (IOCI)

Ku-ring-gai Council (NSW)

Municipal Association of Victoria

Northern Alliance for Greenhouse Action (NAGA)

NSW Greenhouse Office

Northern Territory Local Government Association

Northern Territory Power and Water

Office of Local Government (SA)

Parramatta City Council (NSW)

Planning Institute of Australia (Qld Division)

Property Council (SA Branch)

Queensland Health

South Australia Local Government Association

South Australian Office of Sustainability

State Emergency Service (Tas.)

Sydney Coastal Councils (NSW)

Tasmania Local Government Association

Urban Development Institute of Australia (Qld)

Western Australia Agriculture

Western Australia Local Government Association WaterCorp (WA)

Western Port Greenhouse Alliance (Vic.)

Appendix B: Local Government Functions

Six key local government functions and responsibilities have been identified for the development of climate change adaptation strategies. The size, structure and activities of local councils are diverse. This makes it difficult to make broad generalisations when identifying appropriate adaptation actions. State and territory legislation provides the framework for the role of local government across Australia and therefore the roles and responsibilities of local government, and their level of control over these, varies between each state and territory. A summary of the broad functions considered during the preparation of this report is provided at *Table B1*.

Table B1: Description of Local Government Functions

INFRASTRUCTURE AND PROPERTY SERVICES
• Management and maintenance of essential 'hard' infrastructure networks such as provision, replacement and maintenance of local roads, drainage systems, recreational facilities, parks, gardens and open space, and in some states, water and sewerage infrastructure within council areas. • Planning responsibilities affecting the provision of infrastructure, such as town planning, rezoning of land, subdivision approval, development assessment and building regulation. Note: local government in the Northern Territory does not have the functions of planning, such as development assessment, nor building regulation. (Planning powers reside within the Northern Territory Department of Planning and Infrastructure, with most development proposals being considered by the relevant Development Consent Authority – a committee which includes members of the local council). • Management and maintenance of 'soft' infrastructure services such as cultural, civic and library facilities. • Collection and management of municipal waste.
PROVISION OF RECREATIONAL FACILITIES
• Construction, management and maintenance of council-owned community and recreational facilities including parks, sports fields and stadiums, public golf courses, swimming pools, sport centres, halls and camping grounds. • Hosting of community, sporting and recreational events and issuance of permits for events to third parties. • Provision of a range of services and programs such as festivals, sporting programs and leisure programs.
HEALTH SERVICES
• Environmental health activities – such as environmental protection, sanitation services and waste management. • Public health activities – development, implementation and enforcement of public health policies and regulations. • Health promotion and preventative health programs and services. • Health inspections and enforcement of food quality standards. • Recreation and leisure facilities and services – such as provision and maintenance of parks and sporting centres. • Typically provides first management response to emergencies such as bushfires and floods. • Special services to deal with the social consequences during and after natural disasters.
PLANNING AND DEVELOPMENT APPROVALS

- Translation of state planning and management policies and legislation into local actions.
- Strategic planning – through land use zoning and statutory controls on freehold land and locally managed public open space.
- Administration of building regulations in accordance with the Building Code of Australia (BCA) and other planning and building by-laws, e.g. council building standards to “bushfi re proof” and “cyclone proof” buildings in vulnerable areas.
- With the exception of the Northern Territory, development control of nearly all activities and works on freehold land and crown land (except national parks and state forests) through development consent powers e.g. setbacks, density restrictions, clearing controls, erosion and sediment management, waste disposal (including pollution control).
- Enforcement powers for development consent conditions, waste management and unauthorised land uses, e.g. land clearing, drainage, filling, unauthorised construction and some pollutant (including sediment) discharges.
- Development and administration of other incorporated plans and strategies adopted at a council level, e.g. foreshore management plans, local sustainability plans, and asset management plans.

NATURAL RESOURCE MANAGEMENT

- Vegetation management including roadside vegetation, noxious weeds, and pests.
- Bushfire management and prevention in land vested under local government control.
- Influence over land clearance patterns through incentive programs, such as planning amendments, rate differentials, levies and developer contributions.
- Management of local open space to restore remnant vegetation and recreate habitat.
- Local tourism developments.
- Community engagement/provision of resources to volunteer groups under NRM and conservation works.
- Closure of parks and nature reserves to enable natural systems to recover after extended droughts, storms and fires.

WATER AND SEWERAGE SERVICES

- Provision of domestic water supplies, stormwater management control, treatment of household waste, provision of adequate sewerage and drainage works and flood mitigation and flood plain management (although there are some differences across the jurisdictions).
- Queensland – statewide provision of water and sewerage service to Queensland communities. The state government’s role in water planning management is only a regulatory one.
- NSW – councils are only responsible for providing water and sewerage services in urban communities outside the Sydney, Newcastle and Wollongong metropolitan areas.
- Tasmania – local government joint authorities own and operate water services via water authorities such as Hobart Water, Cradle Coast Water and Esk Water that are established under the Local Government Act 1993.
- Western Australia – a number of councils are licensed providers of sewerage services and non-potable water supply that hold operating licences under the Water Services Licensing Act 1995. Under these licences, councils are required to undertake asset management and maintenance activities, and observe the Sewerage Code of Australia in the design and construction of sewerage systems.
- Northern Territory – water infrastructure (with the exception of stormwater infrastructure) is typically delivered and maintained by the Northern Territory Government in both regional and rural areas.

Appendix C: Climate Change Terminology

Table C1 defines key climate change terminology used. Definitions of climate change terminology are sourced from two scientific reports – *Climate Change 2001 – Impacts, Adaptation and Vulnerability* (IPCC, 2001a) and *Climate Change – An Australian Guide to the Science and Potential Impacts* (Pittock, 2003).

Table C1: Glossary of Climate Change Terms

TERM	DEFINITION
Climate change	Any change in the state of the climate that persists over time, whether due to natural variability or as a result of human activity.
Climate prediction	An attempt to produce an estimate of the actual evolution of the climate in the future.
Climate projection	Projection of the response of the climate system typically based upon climate model simulations. These differ from climate predictions in that projections are based on assumptions that may or may not occur (e.g. technological and socio-economic developments) and are therefore subject to substantial uncertainty.
Climate scenarios	A plausible and often simplified representation of the future climate based on a set of assumptions. These can be derived from projections, but are usually based on additional information sources. A "climate change scenario" is the difference between a climate scenario and the current climate.
Mitigation	Response strategies that reduce the sources of greenhouse gases or enhance their sinks, to reduce the probability of reaching a given level of climate change. Mitigation reduces the likelihood of exceeding the adaptive capacity of natural systems and human societies.
Adaptation	Adjustment in natural or human systems in response to actual or expected climatic changes or their effects, which moderates harm or exploits beneficial opportunities. This is the primary means for maximising the gains and minimising the losses associated with climate change. The adaptation actions that are the subject of this report are those that provide a net economic, social or environmental benefit no matter what level of climate change occurs.
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability is a function of the character, magnitude and rate of climatic variation to which a system is exposed (exposure), its sensitivity to those changes and its adaptive capacity.
Exposure	Relates to the influences or stimuli that impact on a system. Broadly it is the changes to the climate conditions that a system will be exposed to.
Sensitivity	Reflects the responsiveness of a system to climate and the degree to which changes in climate might affect a system in its current form (meaning without adaptation). Sensitive systems are highly responsive to climate and can be significantly affected by climate change.
Adaptive capacity	Reflects the ability of a system to change in a way that makes it better equipped to cope with external influences.

Sources – IPCC (2007), Pittock (2003).

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