

Preparing for climate change in the Moira Shire

ADAPTATION ACTION PLAN

- Final
- 10 September 2010



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Australian Government **Department of Climate Change**

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Executive summary

It is already too late for mitigation of greenhouse emissions to prevent climate change from significantly altering global climate systems.

Ross Garnaut, 2008

Delays in effective global action to reduce greenhouse gas emissions means there is a need to adapt to unavoidable climate change impacts. National and state governments will inevitably lack the agility and precision to foster adaptation at a local level. This should not be the case for local government, which is highly connected with households and communities.

Moira Shire already faces serious long-term challenges in maintaining or renewing aging public infrastructure, including: roads, public buildings and recreational facilities. Its community and economy are highly dependent on irrigated agriculture and are struggling with the financial and emotional challenges of the most severe drought on record. With its resilience already eroded by these challenges, addition impacts from human-induced climate change may threaten the long-term sustainability of the Shire and its communities.

Project overview

Moira Shire received funding from the Australian Government's Local Adaptation Pathways Program (LAPP) to help it understand and prepare for challenges associated with climate change. Together with the Shire of Campaspe, it commissioned a project to:

- assess risks for the two Shires due to projected climate change;
- identify adaptation options to address priority risks for their assets, infrastructure and service delivery;
- propose measures that will support development of capacity to adapt to climate change within the respective Councils and their broader communities.

This *Adaptation Action Plan* represents the final output of that project for Moira Shire

Projected future climate

Climate change projections from CSIRO and the Bureau of Meteorology suggest that the future climate of Moira Shire may be characterised by:

- generally warmer weather, with more very hot days (over 35/40°C) and fewer frosts. Average annual temperatures are projected to increase by 1.5-2.9°C by 2070;
- reduced rainfall in all seasons, with the greatest decrease expected to occur in spring and winter. Annual average rainfall is projected to fall by between 6 and 10% by 2070 and occur on fewer rainy days;
- extreme rainfall and other storm events that are more intense;

- increased potential evaporation across all seasons;
- reduced flows in the Murray River and its major tributaries. Worst case projections are for flows to decline by 40-51% by 2055.

Climate change risks and impacts

Adaptation planning has been structured around an assessment of risks due to projected climate change to Moira Shire's assets, infrastructure and services. High and extreme risks were identified under two climate change scenarios:

- 2030 climate change under moderate greenhouse gas emissions levels;
- 2070 climate change under high greenhouse gas emissions.

Identified high and extreme risks related to the eight themes outlined below.

Asset management. Accelerated deterioration in the condition of buildings, car parks, commercial facilities, recreational facilities and Shire roads, reflecting changed climate impacts and/or inadequate maintenance. Maintenance and capital costs incurred to ensure assets remain fit for use under changed climate. Increased operating and/or maintenance costs resulting from Carbon Pollution Reduction Scheme (CPRS) impacts on energy and fuel prices and/or climate linked prices for water.

Biodiversity. Loss of biodiversity in wetlands and floodplains resulting from lack of flooding and/or environmental flows. Loss of biodiversity from terrestrial habitats due to changes in fire regime, rainfall and/or infestations by new pest plants or animals.

Business and economic development. Reduced profitability of the Shire's commercial operations (e.g. caravan park, saleyards) reflecting changed patterns of use due to climate change. Reduced profitability and business confidence resulting from loss of tourist trade due to reduced river flows, loss of amenity of townships and/or increased fuel prices due to the CPRS. Reduced profitability and business confidence resulting directly or indirectly from reduced water allocations and profitability of irrigated agriculture. Loss of Shire revenue due to reduced economic activity.

Emergency management. Injury from bushfires. Bushfire or storm damage to Shire buildings, bridges, roads and other assets. Changed planning conditions reflecting changed incidence and/or severity of bushfires. Capacity of storm water systems exceeded, with resulting damage to Shire and private assets. Major river flood events exceed protection by flood infrastructure. Increased demand for emergency services.

Parks and gardens. Loss of amenity or lifestyle values due to deterioration in parks and gardens resulting from changed climate suitability, inadequate watering and damage by new pests or diseases.

Public and environmental health. New infectious diseases following changed climatic suitability of vectors. Greater incidence of heat stress and/or fire or dust related asthma among elderly and children. Increased incidence of mental illness due to economic consequences of climate change. Incidence of food contamination events following climate-linked power supply interruptions.

Service provision. Reduced capacity for the Shire to provide its various services due to financial constraints resulting from reduced rate revenue and climate change-related economic decline. Reduced capacity for the Shire to provide its various services due to staff recruitment/retention challenges resulting from climate change-related economic decline. Demand for Shire services increases beyond delivery capacity due to increased frequency/impact of bushfires, economic decline, low irrigation water availability, changes in tourist activity, introduction of new pests and diseases, more frequent and severe emergency events and community sustainability awareness. Adjustment in delivery of sport and recreational support services in response to climate change. Shire service disruptions resulting from climate linked failure in power and/or water supply.

Volunteerism. Reduced community engagement in volunteer activities/services due to climate linked population decline or changed demographics.

Adaptation planning

Adaptation is concerned with managing shorter and longer-term risks and impacts associated with climate change. Given that the objective of local government in Victoria is to “*achieve the best outcomes for the local community having regard to the long term and cumulative effects of decisions*”, it is clear that some responsibilities for adaptation lie with local governments.

Advantages of local government taking early action on climate change adaptation include improving risk management and governance and, potentially, reducing the need for expensive action which forced by climate change impacts as they occur.

Adaptation options were defined for the eight priority risk themes listed above. Higher and lower priority options were identified in conjunction with Council staff.

Adjusting to climate change

Key options for developing the capacity of Moira Shire to adjust to climate change included:

- *Internal and external communications* - to improve understanding of climate change issues, build ownership of Moira Shire’s climate change responses and develop partnerships within the community and region for effective action.
- *Revised management arrangements* - incorporation of climate change responses into the Council Plan and its supporting strategic and operational plans. Coordination and integration of climate change responses across Council by the Environment Working Group.
- *Development of a regional governance structure for climate change* - a cross-agency “steering committee’ should be formed with representation from local governments and State government agencies with responsibilities for climate change adaptation.
- *Monitoring and review of this Plan* - strategic monitoring to demonstrate that this Plan is achieving its objectives. Operational monitoring would address accountability requirements for the resources invested in implementation. Monitoring would feed into annual and four yearly reviews of this Plan in phase with performance reporting and Council Plan review activities.

Beyond this plan

While this Plan considers risks from climate change for the broader community, it does so from the perspective of potential impacts on Council operations. Issues associated with recent climate experience (and projected climate change) are pressing for water dependent industries within the Shire, particularly irrigation and tourism. Current and potential impacts of declining water resources may threaten the viability of some communities and Council as a whole. Given their significance, these risks should be assessed more comprehensively than has been possible here. Moira Shire should undertake a risk assessment and adaptation project to address climate change in this broader context.

Glossary

Adaptation	Adjustment in natural or human systems that are taken in response to actual or expected climatic [and other] stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Adaptation is concerned with managing the unavoidable impacts of climate change (and variability) and considers what needs to be done differently – both more and better – to cope with the change
Capacity building	A process of building capabilities in individuals, groups, institutions, organizations and societies to more effectively prepare for and respond to risks. Also referred to as adjustment in this report.
Climate change	<p>Refers to a change in the state of the climate that can be identified by changes in the mean and/or variability of its properties, and that persists for an extended period, typically decades or longer.</p> <p>Climate change may occur because of internal changes within the climate system or in interaction between its components, or because of changes in external forcings either for natural reasons or because of human activities. It is generally not possible to clearly make attribution between these causes. Projections of future climate change generally consider only the influence of climate on anthropogenic increases in greenhouse gases and other human-related factors (IPCC, 2007).</p>
Climate variability	Refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes etc) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability) (IPCC, 2007).
Consequence	Outcome of an event.
CPRS	Carbon Pollution Reduction Scheme, the Australian Government's proposed emissions trading scheme.
Event	Occurrence of a particular set of circumstances. The event can be certain or uncertain. It can be a single occurrence or a series of occurrences.
Extreme risk	In this report, extreme risk is defined as a risk that: <i>cannot be accepted as part of routine operations without Council & senior management approval. Requires urgent assessment of prospects for successful and cost-effective management intervention. Urgent action required wherever possible.</i>
High risk	In this report, high risk is defined as: <i>highest risk level that can be accepted as part of routine operations, without Council &/or senior management sanction. Specific procedures required to reduce and manage risk, implement specific response procedures and/or monitor the risk.</i>
Impact	An effect or influence.
Likelihood	The likelihood of an occurrence, an outcome or a result, where this can be estimated probabilistically. In risk assessment, it refers to the likelihood that the assessed consequence of an impact would occur.
Mitigation	Measures taken to reduce adverse affects on the environment and/or manage associated risks. In the context of climate change it generally refers to human interventions that reduce the sources or enhance the sinks of greenhouse gases.

Organisational capacity	The ability or potential of an organisation to respond successfully to change.
Resilience	The degree to which a system rebounds, recoups or recovers from a stimulus (Smit <i>et al.</i> , 2009) or the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change (Mendis <i>et al.</i> , 2003).
Response	In the context of this report, response generally refers to actions and decisions that are made in response to climate change (and variability), and associated risks.
Risk	The potential for realisation of unwanted, adverse consequences; usually based on the consequence of an event and the likelihood of the consequence should the event occur.
Scenario	A coherent, plausible but often simplified description of a possible future state. Scenarios capture a range of future possibilities and allow decision makers to consider changes that might otherwise be ignored.
Social capital	People, their capacity levels, institutions, cultural cohesion, education, information, skills, and knowledge. Social capital refers to active connections between people that bind together the members of groups, networks and communities and make cooperation possible, and enable people to coordinate actions to achieve desired goals.

Contents

1.	Introduction	1
1.1.	Climate change	1
1.2.	Preparing for climate change in the Shires of Moira and Campaspe	3
1.3.	About this report	4
2.	The Moira Shire	6
3.	Climate change projections	7
3.1.	Global change	7
3.2.	Climate change projections for the Moira Shire	7
4.	Climate change objectives	9
4.1.	Moira Shire's vision and objectives	9
4.2.	Strategic approach to climate change	10
4.3.	Climate change adaptation objectives	10
5.	Potential climate change impacts	12
5.1.	Assets and services of the Moira Shire	12
5.2.	Potential climate change impacts	13
6.	Risk assessment	14
6.1.	Assessing risk	14
6.2.	Risk assessment results	15
7.	Adaptation Action Plan	18
7.1.	Introduction	18
7.2.	What is adaptation?	18
7.3.	The importance of adaptation for local government	19
7.4.	Adaptation actions for Moira Shire	20
7.4.1.	Asset management	21
7.4.2.	Biodiversity	23
7.4.3.	Business and economic development	24
7.4.4.	Emergency management	25
7.4.5.	Parks and gardens	26
7.4.6.	Public and environmental health	27
7.4.7.	Service provision	28
7.4.8.	Volunteerism	30
7.5.	Adjustment	30
7.5.1.	Communications	31

7.5.2.	Governance and management arrangements	32
7.5.3.	Monitoring and review	35
7.6.	Adoption and implementation	37
8.	Conclusion and recommendations	38
9.	Acknowledgments	42
10.	References	43
Appendix A	Climate change projections for Moira Shire	45
A.1	Overview	45
A.2	Temperature	47
A.3	Rainfall	47
A.4	Stream flows	48
A.5	Potential evaporation	48
A.6	Wind speed	48
A.7	Extreme weather	48

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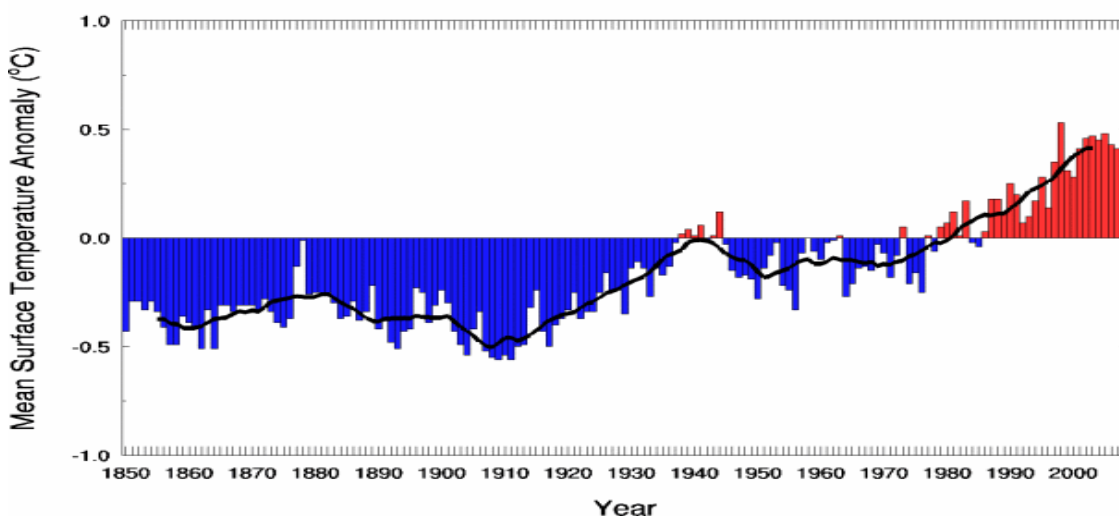
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1. Introduction

1.1. Climate change

The Intergovernmental Panel on Climate Change (IPCC) has concluded that there is unequivocal evidence that the global climate system is warming. This trend has clearly emerged since about the 1950s (Figure 1). Eleven of the 12 years from 1995-2006 were among the 12 warmest years globally in the 150 year instrumental temperature record (IPCC, 2007). The IPCC considers that it is very likely this warming trend is due to observed, human-induced increases in greenhouse gas concentrations, most notably of carbon dioxide (CO₂).



Graph shows difference between global average temperature for any year and the average for 1961-1990. Years with average temperatures higher than the 1961-1990 average are shown in red. Black line is the 11 year running average.

- **Figure 1 Global annual mean surface temperature anomaly (Source: Bureau of Meteorology¹).**

There is increasing evidence that this general warming of the global climate system is contributing to observed changes in sea levels, wind patterns, weather extremes, precipitation patterns and changes in some biological systems (IPCC, 2007; SEACI, 2007; Garnaut, 2008).

While it is already too late for mitigation of greenhouse emissions to prevent climate change from significantly altering global climate systems (Garnaut, 2008), it is not too late to act to at least reduce the impacts of unmitigated climate change. Urgent and coordinated global action to stabilise

¹ www.bom.gov.au/cgi-bin/silo/reg/cli_chg/g_timeseries.cgi?variable=global_t®ion=global&season=0112

atmospheric greenhouse gas concentrations below 550 ppm CO₂e² may not avert major impacts on human settlements and natural ecosystems (Garnaut, 2008, Table 1), but will provide a more manageable climate.

- **Table 1 Potential impacts of unmitigated climate change and stabilised atmospheric greenhouse gas concentrations. (Source: Garnaut 2008).**

Sector	Mitigation		
	No mitigation	550 ppm CO ₂ e	450 ppm CO ₂ e
Irrigated agriculture in Murray-Darling Basin	92% decline in production	20% decline in production	6% decline in production
Natural resource based tourism	Great Barrier Reef (GBR) no longer dominated by corals. Reef ecosystems destroyed.	GBR as currently known disappears. Very high impact on reef-based tourism.	Mass coral bleaching incidence doubles
	Snow based tourism disappears.	Moderate increase in artificial snow making required.	
Water supply infrastructure	Up to 35% increase in cost of supplying urban water due to extensive supplementation with climate independent sources.	Up to 5% increase in cost of urban water. Low level supplementation of water supplies.	Urban water cost increases by 4%. Low level water supply augmentation.
Buildings in coastal settlements	Significant risk from storms and sea level rise. Localised coast flooding and damage from extreme winds.	Modest increase in risk from severe coastal winds	
Human health	Over 4000 heat related deaths in Queensland each year.	Fewer than 80 heat-related deaths in Queensland each year.	Death rate in Queensland declines, due to fewer cold-related deaths.
	5.5 million Australians exposed to Dengue virus.	<1 million Australians exposed to Dengue virus.	
Geopolitical stability	Sea level rise results in major population dislocations in Asian coastal mega-cities and displacement of Pacific Island residents.	Small increase in risk to populations in low-lying areas.	

Note: Impacts assume no coordinated adaptation to climate change.

² CO₂e or carbon dioxide equivalents expresses the total atmospheric concentration of all major greenhouse gases (e.g. carbon dioxide, methane and nitrous oxide), with concentration weighted according to global warming potential of gases relative to CO₂. Methane has a global warming potential 21 times that of CO₂ (over 100 years). Its contribution to atmospheric CO₂e would be 21 times its measured concentration.

The primary focus of responses by government, industry and community to challenges associated with climate change has been on *mitigation* or reducing emissions of greenhouse gases. However, since such actions are too late and not at sufficient a scale, it will be necessary to adapt to climate change impacts (Garnaut, 2008).

Appropriate adaptation responses need to reflect local experiences of climate change and future risk. Adaptation is fundamentally a local, ‘grass roots’ response. Households, communities and businesses are best placed to make the decisions that will preserve their livelihoods and help to maintain the things they value. National and state governments will inevitably lack the agility and precision to respond to climate change impacts at a local level (Garnaut, 2008). In contrast, local government, which is highly connected with households and communities, should be able to respond to local scale risk and impacts of climate change.

1.2. Preparing for climate change in the Shires of Moira and Campaspe

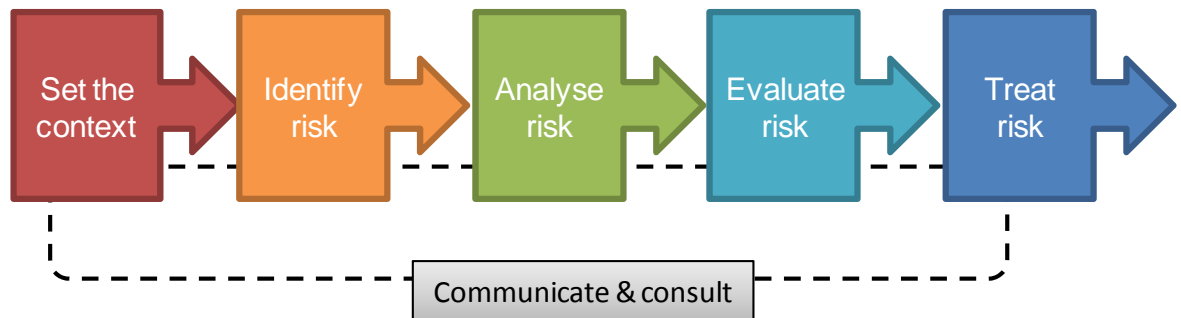
The Moira and Campaspe Shires share similar landscapes, land uses, economic base, community infrastructure and lifestyle. Like many rural municipalities they have a relatively small rate base, cover a large geographical area and face serious long-term challenges in maintaining or renewing aging public infrastructure such as: roads, public buildings and recreational facilities. Many of their communities are highly dependent on irrigated agriculture and are also struggling with the financial and emotional challenges of the most severe drought on record.

The resilience of the two Shires has been eroded by these twin challenges. Climate change threatens to exacerbate this by placing additional pressure on public infrastructure, the Shires’ economic base and the water resources on which their economies depend.

The Shires of Moira and Campaspe, received funding from the Australian Government’s Local Adaptation Pathways Program (LAPP) to help them understand and prepare for climate change. They subsequently commissioned Sinclair Knight Merz to undertake this project to:

- examine risks for the two Shires due to projected climate change;
- redirect internal strategic planning to align with the realities of climate change;
- provide a model to lead local communities to begin to adapt to future climate change.

The project was structured around the assessment and management risks for the two Shire’s assets, infrastructure and services. Its approach was based on the Australian Standard for Risk Assessment and Management (AS/NZS-4360 - Standards Australia, 2004; Figure 2), as adapted help business and local government assess and respond to risks associated with climate change (Australian Greenhouse Office [AGO], 2006). There are five core steps in this process, whose application to local government is described below.



■ **Figure 2 Framework for assessment and management of risks associated with climate change (after AGO, 2006) and its link with delivery of this project.**

1. *Set the context* – determine: the objectives for the risk assessment and the local government area; the risk assessment’s time, issue and geographic scope; the stakeholders who need to participate or be aware of it; and the climate change scenarios being considered.
2. *Identify risks* – describe how climate change may affect the Shire’s assets, infrastructure, service provision, communities, economy and/or natural environments.
Discussion papers on climate change risks were prepared for each Shire at the end of this stage in the project (Sinclair Knight Merz [SKM], 2009a,b).
3. *Analyse risks* – consequences and likelihood of each identified risk or potential impact is assessed. Risk is assessed assuming existing controls remain in place (i.e. the practices currently used to manage risks from climatic extremes and variability).
4. *Evaluate risks* – the severity of risk is ranked according to agreed risk definitions and minor risks screened. Higher priority risks require specific intervention or at least an assessment of the feasibility of intervention. Minor risks are monitored and managed using a Council’s normal business, planning or management processes.
A single risk assessment report, covering this and the previous step, was prepared for the two Shires (SKM, 2009c). It addressed climate change risks in 2030 and 2070.
5. *Treat risks* – existing and new options for managing higher priority risk impacts are identified, evaluated and included in an action plan. This Action Plan provides the framework for adaptation to climate change.

Communication and consultation with stakeholders occurs throughout each of these steps.

1.3. About this report

This *Adaptation Action Plan* is the major output of the *Preparing for climate change in the Shires of Moira and Campaspe* project. It focuses on:

- adaptation actions open to Moira Shire to address priority risks for its assets, infrastructure and service delivery from climate change;

- measures that will support development of capacity to adapt to climate change within Council and the broader Moira Shire community.

The report also provides contextual information on the Moira Shire, regional climate change projections and the risk assessment for Moira and Campaspe Shires.

The Moira and Campaspe Shires collaborated extensively on the project. Most of the workshops have involved staff and Councillors from both Shires and the *Risk assessment report* (SKM, 2009c) was common to both. This report, however, has been prepared specifically for Moira Shire. While much of the content is shared with a companion report for the Shire of Campaspe (SKM, 2009d), the emphasis and priority of adaptation options are unique to the Moira Shire.

The structure of the remainder of this document is outlined below.

- *Chapter 2 The Moira Shire* - brief overview of the location, land use and population of the Shire
- *Chapter 3 Climate change projections* – broad information on projected trends in climate and some associated impacts. Further information on climate change projections is given in Appendix A.
- *Chapter 4 Climate change objectives*– proposed strategic approach for climate change for Moira Shire and objectives for climate change adaptation.
- *Chapter 5 Potential climate change impacts* – an overview of Moira Shire’s assets and services and the potential impacts of climate change.
- *Chapter 6 Risk assessment* – synopsis of the priority risks for Moira Shire for a 2030 mid emissions scenario and a 2070 high emissions scenario.
- *Chapter 7 Adaptation Action Plan* – detailed plan of action for adaptation to climate change, development of adaptive capacity within Council and the community and for reviewing and updating the Plan.
- *Chapter 8 Conclusion and recommendations*– summary of the major conclusions and recommendations of the risk assessment and adaptation planning process.

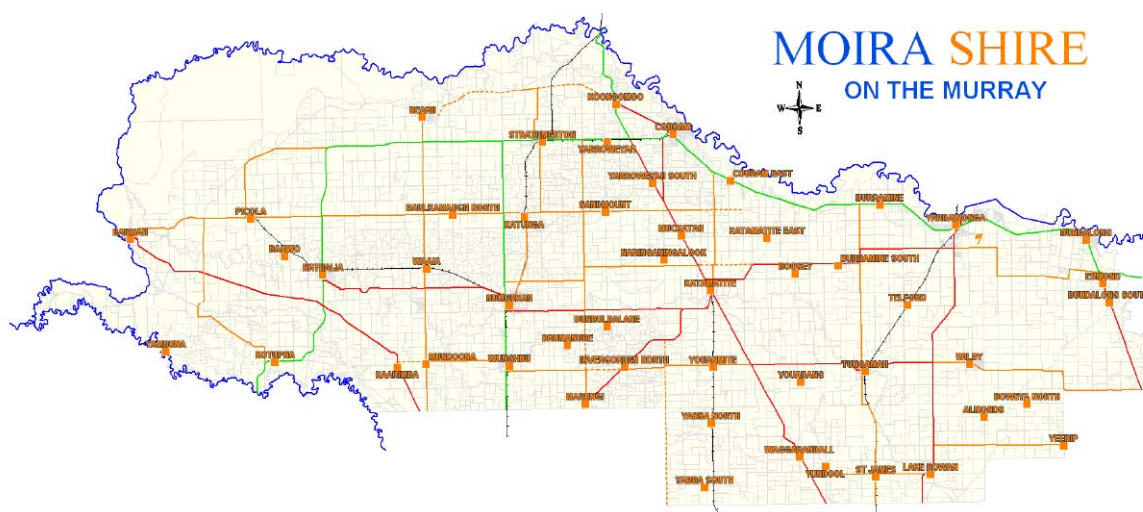
Each chapter begins with a graphic depicting where in the risk assessment and management process (Figure 2) that chapter fits.



2. The Moira Shire

The Moira Shire is located in northern Victoria, some 200-250 km from Melbourne. The Shire is bounded by the Murray, Goulburn and Ovens Rivers and covers an area of over 4,057 km². Its major population centres are Cobram, Nathalia, Numurkah and Yarrawonga (Figure 3).

Land in the Shire is used mainly for agriculture, particularly: dairy farming; horticulture; grain production; and sheep grazing. Agricultural production has traditionally been dominated by irrigation and has been affected by low water allocations in recent years. Dryland areas support broadacre livestock grazing, cropping and timber production. Agriculture is the largest industry sector in the Shire.

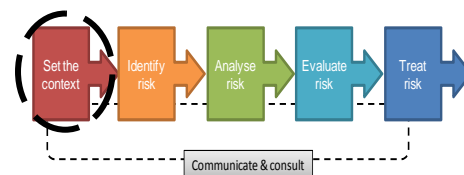


■ **Figure 3 The Moira Shire (Source: www.moira.gov.au)**

The total population was almost 29,000 in 2008 (Moira Shire, 2008). The population is growing rapidly with empty-nesters and retirees, among others, moving into the region. Population is projected to grow to almost 35,000 by 2021.

The Shire's main areas of residual native vegetation are located along the Murray and Goulburn Rivers and includes the Barmah Forest, which is an internationally significant wetland. The Shire borders Lake Mulwala, a major irrigation water storage and recreational lake.

The Shire's unemployment rate is lower than the average for regional Victoria. Average income of residents is 80% of the average for Victoria (ABS data). Moira Shire is ranked as the 13th most disadvantaged community across Victoria (ABS data)



3. Climate change projections

3.1. Global change

Climate change modelling for the IPCC's *Fourth Assessment Report* used emissions scenarios documented in the *Second Report on Emissions Scenarios* (the *SRES scenarios*; IPCC, 2000). These scenarios plot future emissions pathways under four (main) contrasting storylines about growth, technology and global interaction. The scenarios were all considered to be plausible, with no scenario more likely than another (Garnaut, 2008).

Best estimates of projected global warming under the SRES scenarios by the end of the 21st Century ranges between about 2 and 4°C with a likely range of 1-6°C (IPCC, 2007). Global warming even at the lower end of this range would have serious consequences for vulnerable human populations and natural ecosystems.

The *Garnaut Climate Change Review* (Garnaut, 2008) found that global greenhouse gas emissions were rising at a more rapid rate than anticipated by any of the SRES scenarios. This acceleration in emissions was largely due to economic growth and industrial development in China. In the absence of mitigation, this trend is projected to result in about 4.5°C of global warming by 2100, with further increases beyond that time.

While global warming is currently trending at or above the worst case scenarios modelled for the *Fourth Assessment Report*, recent research has identified that critical natural and human systems may be more vulnerable to change than was previously thought. Thresholds for dangerous interference in global climate systems may be as little as 1-1.5°C (Steffen, 2009). Without effective mitigation action, this level of warming may be reached by about 2050 (Garnaut, 2008).

3.2. Climate change projections for the Moira Shire

CSIRO and the Bureau of Meteorology have developed climate change projections for Australia (CSIRO, 2007; see www.climatechangeinaustralia.gov.au). This information is based on international climate change research for the IPCC's *Fourth Assessment Report* (IPCC, 2007) and the SRES emissions scenarios. Outputs of global climate modelling have been used to prepare climate change summaries for each of the Victorian Catchment Management Authority (CMA) regions in Victoria. Those for the Goulburn Broken and North East CMA regions (Department of Sustainability and Environment [DSE] 2008a,b) are most applicable to Moira Shire.

A summary of climate change projections for Moira Shire are given in Box 1. Further details are provided in Appendix A.

Box 1 Climate change projections for the Moira Shire

Future climate of the Moira Shire is projected to be characterised by:

- » generally warmer weather, with more very hot days (over 35/40°C), and fewer frosts. Warming is projected to be greatest in summer and least in winter. Average annual temperatures are projected to increase by about 1°C by 2030 and by 1.5-2.9°C by 2070;
- » reduced rainfall in all seasons, with the greatest decrease expected to occur in spring and winter. Annual average rainfall is projected to fall by about 4% by 2030 and between 6 and 10% by 2070;
- » more intense rainfall events and fewer rainy days. Average rainfall intensity is projected to increase by between 3.2 and 6.1% by 2070. Extreme rainfall events and other storms are projected to become more severe;
- » increased potential evaporation across all seasons, with the most significant change occurring in winter. Average annual evaporation is projected to increase by 3% by 2030 and between 5 and 9% by 2070;
- » slightly lower average wind speed (1-2% reduction in annual average), in all seasons except winter.

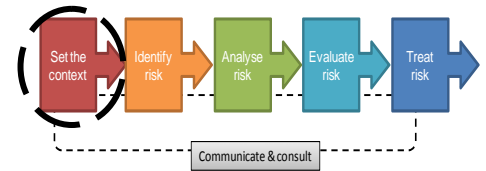
Drawn from information in DSE (2008a,b)

As a result of reduced rainfall and increased temperature and potential evaporation, flows in the river systems that support irrigation and tourism in the Shire are projected to decline. Annual flow in the Goulburn River is projected to decrease by 7- 43% by 2055³. Flows in the Murray River are projected to be less affected, with the change potentially ranging between an increase of 8% and a decrease of 40% by 2055 (Government of Victoria, 2008).

Flows in southern Murray-Darling Basin the decade to 2006/07 have been lower than worst case projections for 2055. There is increasing evidence that these changes are at least partly the result of human influences, such as greenhouse gas emissions and land cover changes (SEACI, 2007).

Reduced rainfall and increased temperature are also projected to increase the incidence of days with high or extreme fire danger, which may result in more severe bushfire conditions.

³ Compared with the long-term average.



4. Climate change objectives

4.1. Moira Shire's vision and objectives

Moira Shire's vision is of *Moira on the Murray with an environmentally, economically and socially sustainable community: the best place to be*. Council's mission is to serve its community through *transparent and open governance, active engagement, strong advocacy and the provision of affordable services* (Moira Shire, 2009).

Moira Shire's *Council Plan* (Moira Shire, 2009) is structured around five pillars, which focus on renewing ageing assets, protecting the environment, providing an appropriate range and level of services, pursuing an ongoing dialogue with the community and maintaining a sound financial position.

Moira Shire's five pillars and key risks posed by climate change are:

- *A liveable shire* – with a built environment that complements the natural environment and meets the needs of the Moira community providing open space, connecting pathways, encouraging innovative building and recognise and value our heritage. Climate change has potential to accelerate deterioration in built infrastructure. Its potential impact on rainfall and water allocations poses risks for values associated with public parks and gardens;
- *Healthy living* – a cohesive community interacting socially across the Shire respecting differences and united in the interests of the community. Loss of water security is already affecting the viability of the irrigation sector and health of some producers. Sustained periods of low irrigation allocations may see the failure of enterprises and dependent towns, with risks to social cohesion and balanced demographic profiles;
- *A growing shire* – a growing, vibrant, sustainable and innovative municipality with a strong economic base to assist and encourage future development in appropriate areas. As above, sustained loss of water security threatens both the irrigation sector and water-based tourism and lifestyle activities. It could substantially weaken the Shire's economic base;
- *Our environment* – a community recognising the value of our natural environment and committing to environmental best practice. Natural environments are threatened by rising temperatures, reduced rainfall and loss of river flows. These changes may also influence the frequency of bushfires and allow new pests or diseases to become established;
- *Working together* – transparent, accountable, fair and honest Council committed to strong positive leadership through community connection and sound forward planning. Given the potential challenges associated with climate change, effective leadership and sound forward planning is required to enable adaptation.

4.2. Strategic approach to climate change

It is proposed that Moira Shire have an integrated response to climate change, structured around the following four strategies⁴ that would address Council's contribution to the drivers of climate change (its greenhouse gas emissions) and any unavoidable impacts. The proposed strategies include:

- *Mitigation* - reduce greenhouse gas emissions from Moira Shire's operations and actions.
- *Adaptation* - manage priority risks from climate change.
- *Adjustment* - build Council's capacity to adjust to impacts from climate change.
- *Influence* – use the example of Council's activities, as well as communications and planning processes to influence the community's overall greenhouse gas emissions and their capacity to adapt to climate change.

The outcomes and strategies articulated in Moira Shire's 2009 *Council Plan* support these four strategies in broad terms, but do not do so explicitly. It is recommended that future iterations of the *Council Plan* refer directly or indirectly to at least its adaptive and mitigation responses to climate change.

This Plan is mainly concerned with the latter three of the four strategies. Moira Shire have in place a Cities for Climate Protection local Greenhouse Action Plan in place to address greenhouse gas emissions from Council's activities and is well advanced with implementation.

4.3. Climate change adaptation objectives

Potential objectives for this *Adaptation Action Plan* were discussed in workshops with representatives of the Moira and Campaspe Shires. A few major themes were identified in these discussions and have been translated into the objectives listed below.

Moira Shire will:

- Achieve general recognition of climate change and the possibility of adaptation.
- Build capacity to adjust to climate change among the community.
- Make adjustments needed to adapt to projected climate change. It will do so in ways that as far as possible maintain the integrity of communities and the things they value about the Shire and target scarce resources.

⁴ This broadly follows the *three pillars* approach to climate change adopted by the Australian Government: (i) reducing Australia's greenhouse gas emissions; (ii) adapting to the impacts of climate change we cannot avoid; and (iii) helping to shape a global solution (www.climatechange.gov.au/about/index.html).

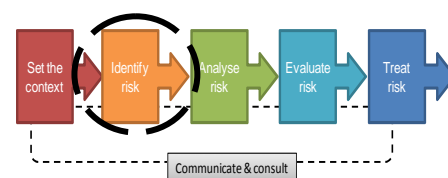
- Ensure planning and other functions are informed by credible and technically sound information on climate change and its projected impacts.
- Take advantage of any opportunities presented by climate change.

Recommendation 2.1

The Moira Shire should incorporate references to the four climate change strategies in future iterations of the *Council Plan*.

If the current structure is maintained it is recommended that this be implemented in the following way:

- » Mitigation – a strategy be introduced under *Pillar 4 Our Environment* to reduce greenhouse gas emissions, with one of the strategic indicators reporting on emissions from all the Shire’s activities.
- » Adaptation, adjustment and influence – a strategy be included under *Governance and leadership* as part of *Pillar 5 Working together*. Reflecting Council’s commitment to take a leadership role in matters of regional significance, the strategy might specify that Council would ensure it engages with the community and key stakeholder organisations to ensure risks from climate change are managed proactively. Supporting strategies could be considered under other Pillars, however including climate change response as part of this Pillar ensures climate change is considered at the core of Council’s responsibilities.



5. Potential climate change impacts

5.1. Assets and services of the Moira Shire

The risk assessment and adaptation planning process for Moira Shire is focussed on its assets, infrastructure and service delivery. These were identified in a workshop conducted during the early stages of the project. Potential impacts of climate change on the Shire’s assets, infrastructure and services are discussed in section 5.2.

While names given to assets, infrastructure and services varied between the two shires, there was such similarity in their types that a single consolidated list was developed (Table 2). Moira Shire is almost unique among local governments in Victoria in that it operates town water and wastewater infrastructure, although only for some small communities.

■ **Table 2 Moira Shire assets, infrastructure and services**

Assets and infrastructure	Services
<p>Buildings – Council offices, heritage buildings, public halls, special use buildings (children’s services, library, seniors), sports stadia, other general community buildings.</p> <p>Commercial facilities – aerodrome, caravan parks, quarries, saleyards.</p> <p>Flood and storm water management – drainage wetlands, drains, flood gates, levees, pollutant traps, pump stations.</p> <p>Land – car parks, land for development, other vacant land.</p> <p>Natural areas – river frontages, roadsides, unused road reserves, wetlands.</p> <p>Parks and gardens – parks, street gardens, street trees.</p> <p>Recreational facilities – bike paths, boat ramps, playgrounds, pools, river foreshore reserves, skate parks, sports grounds.</p> <p>Tourist facilities – Lake Mulwala area (Moira), Port of Echuca (Campaspe), Barmah forest, camping areas, river beaches, national parks, fauna park (Campaspe).</p> <p>Transport infrastructure – bridges and culverts, footpaths, gravel & sealed roads, road drainage, street furniture, street lighting.</p> <p>Vehicles and plant – plant & equipment, vehicle fleet.</p> <p>Waste management – landfill, transfer stations.</p> <p>Water – dams, raw water, reticulation infrastructure, waste water infrastructure.</p>	<p>Aged and disability – falls prevention, home and community care, meals on wheels, personal care.</p> <p>Building – advice, permitting, regulatory compliance.</p> <p>Children’s services – child care, family day care, kindergarten, maternal & infant health.</p> <p>Community services and well being – arts & culture, community development, disability access, healthcare alliance, library services, social recovery, sport & recreation, youth.</p> <p>Customer service and information.</p> <p>Economic development and tourism – business education and development, industrial land development, marketing & industry attraction, tourism.</p> <p>Emergency management – disaster response, disease epidemic/pandemic, fire protection, recovery, volunteer coordination.</p> <p>Internal services – asset management, design, finance, ICT, information management, project management, revenue.</p> <p>Local laws – parking, animal control.</p> <p>Natural resource management and environmental services – climate change & sustainability, community education & awareness, landcare coordination.</p> <p>Planning – land use, statutory, strategic.</p> <p>Public and environmental health – food safety, immunisation, infectious disease, septic tanks.</p> <p>Waste management services – collection, recycling.</p>

5.2. Potential climate change impacts

Increased temperature, changes in the amount, intensity and seasonal distribution of rainfall, increased intensity of storm events and increased fire danger are some of the pressures associated with projected climate change which have the potential to affect Moira Shire’s assets, infrastructure and services.

A comprehensive list of potential impacts of climate change on the Shire’s assets and services is given in Table 3. This list was used to form the risk register and was the basis of the risk assessment (Chapter 6). It is common to both Shires. This list provides no indication of the materiality of potential impacts.

■ **Table 3 Types of potential impact of climate change on Moira Shire assets, infrastructure and services**

Potential impacts on assets & infrastructure	Potential impacts on services
Changed road maintenance requirements & costs	Declining rate base/revenue
Changes in design standards for shire assets required to accommodate climate change impacts	Disruption to Council service provision due to fire, electricity disruption, storm events
Changes in tourist activity & related revenue to businesses	Ecological decline in natural areas, loss of biodiversity
Deterioration in shire assets (generally) associated with more extreme climate	Hospitalisation or death of elderly/young due to extreme weather events
Deterioration in flood protection assets and lack of flood preparedness, associated with irregular use and maintenance	Increase in Council resources committed to planning for emergencies
Ecological decline in natural areas, loss of biodiversity	Increased cost of Council service provision/reduced level of service provision
Increased council operating & capital costs	Increased demand for council services & information – aged care, emergency management & response, heat wave response, social recovery, climate change responses
Increased incidence of algal blooms	Increased incidence of fire/dust related illness
Increased incidence of health issues & complaints associated with dust	Localised/general reduction in population, change in demographics
Changes in road maintenance requirements	Loss of economic activity
In-migration and population increase associated with greater climate impacts elsewhere	Operational changes to shire outdoor & recreational services
Localised flood damage to roads & drainage infrastructure	Reduced residential amenity
Localised/general reduction in population, change in demographics	
Operational changes to Council outdoor & recreational assets	
Reduced council revenue & capacity to deliver services & maintain infrastructure	
Reduced water supply reliability for towns served by Council.	
Reduced retail trade	
Reduced tourist activity	

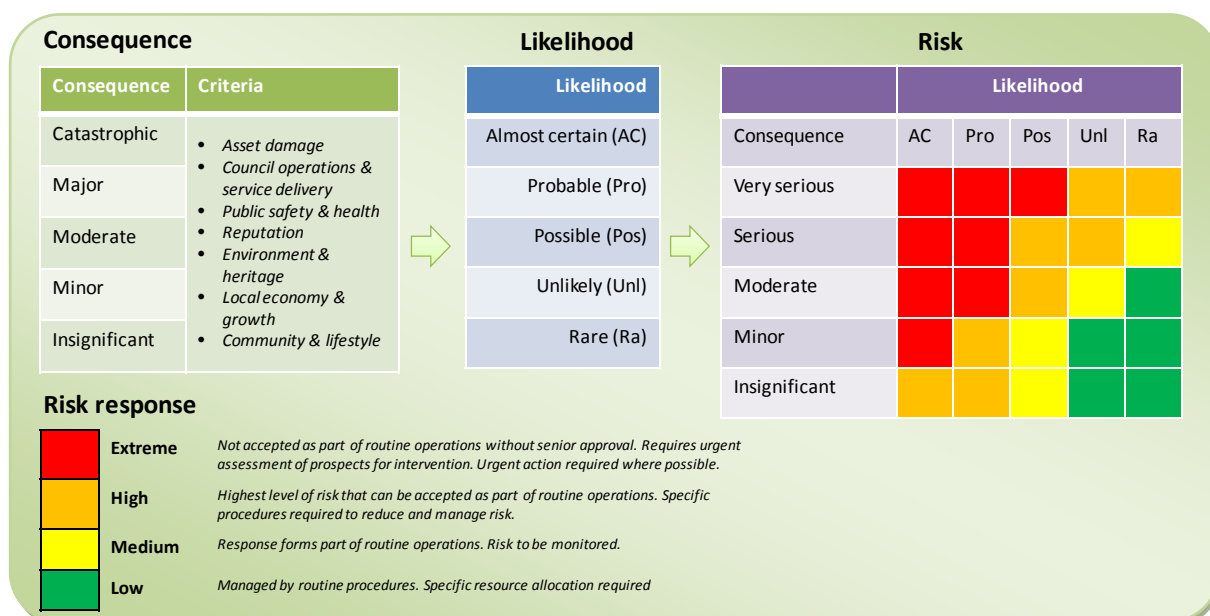


6. Risk assessment

6.1. Assessing risk

The set of potential climate change impacts (Table 3) were used to assess the level of risk posed to Moira Shire’s assets, infrastructure and services. The assessment was conducted jointly with representatives of the Shire of Campaspe.

A risk register was developed for the two Shires that matched assets and services from Table 2 with relevant risks (potential impacts) from Table 3. Risk was assessed following the process depicted in Figure 4. The severity of consequence if the risk event occurred was assessed against one of the listed criteria. The likelihood of that level of consequence occurring was then assessed. Risk is the combination of consequence and likelihood. The required response is determined by the overall level of risk. Extreme and high risks require specific attention by Councillors or senior council staff. Other risks can generally be dealt with under business-as-usual processes. Further information is given in the project’s *Risk assessment report* (SKM, 2009c).

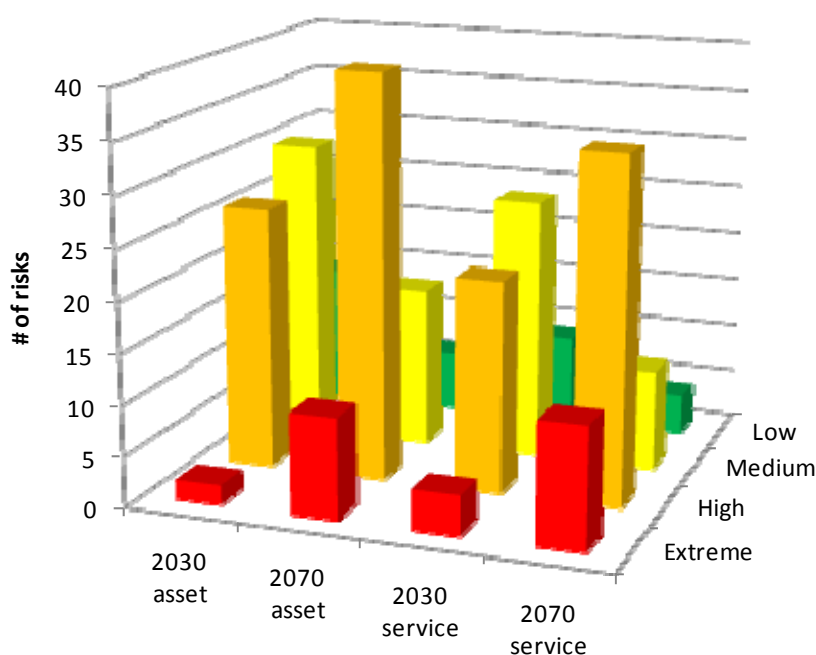


■ **Figure 4 Risk assessment process and proposed responses to each level of risk**

The risk assessment was first conducted for 2030 under a medium emissions scenario and then for 2070 under a high emissions scenario. Assessments for the Moira and Campaspe Shires were conducted concurrently. It was possible for the assessments to differ between Shires, but this rarely occurred.

6.2. Risk assessment results

The risk profile for Moira Shire’s assets, infrastructure and services is depicted in Figure 5. There were more high and extreme risks under the 2070 high emissions scenario than the 2030 medium emissions scenario, mostly reflecting risks from increased temperature, more intense storm events and further reductions in rainfall, streamflows and irrigation water availability. Approximately 40% of the identified risks were rated as high or extreme in 2030 and over 70% under the 2070 high emissions scenario.



■ Figure 5 Climate change risk profile for Moira Shire

Under the definitions used in the risk assessment (Figure 4) extreme and high risks demand specific responses (or adaptations) that would go beyond the Shire’s usual business, management and planning processes. To ensure responses were integrated, risks assessed to be high or extreme (for 2030 and/or 2070 scenarios) were grouped into common themes (Table 4). Adaptation planning (Chapter 7) is largely structured around those priority risk themes.

■ **Table 4 Themes for priority risks for the Moira Shire**

Theme and description
<p>Asset management</p> <p>Accelerated deterioration in the condition of buildings, car parks, commercial facilities, recreational facilities and Shire roads, reflecting changed climate impacts and/or inadequate maintenance.</p> <p>Maintenance and capital costs incurred to ensure assets remain fit for use under changed climate.</p> <p>Increased operating and/or maintenance costs resulting from Carbon Pollution Reduction Scheme (CPRS) impacts on energy and fuel prices and/or climate linked prices for water.</p>
<p>Biodiversity</p> <p>Loss of biodiversity in wetlands and floodplains resulting from lack of flooding and/or environmental flows.</p> <p>Loss of biodiversity from terrestrial habitats due to changes in fire regime and/or infestations by new pest plants or animals.</p>
<p>Business and economic development</p> <p>Reduced profitability of the Shire's commercial operations (especially caravan parks) reflecting reduced tourist activity directly or indirectly associated with climate change.</p> <p>Reduced profitability and business confidence resulting from loss of tourist trade due to reduced River flows, loss of amenity of townships and/or increased fuel prices due to CPRS.</p> <p>Reduced profitability and business confidence resulting directly or indirectly from reduced water allocations and profitability of irrigated agriculture.</p> <p>Loss of Shire revenue due to reduced economic activity.</p>
<p>Emergency management</p> <p>Injury from bushfires</p> <p>Bushfire or storm damage to Shire buildings, bridges, roads and other assets .</p> <p>Changed planning conditions reflecting changed incidence and/or severity of bushfires.</p> <p>Capacity of storm water systems exceeded, with resulting damage to Shire and private property.</p> <p>Major river flood events exceed protection by flood infrastructure.</p> <p>Increased demand for emergency services</p>
<p>Parks and gardens</p> <p>Loss of amenity or lifestyle values due to deterioration in parks and gardens resulting from changed climate suitability, inadequate watering and damage by new pests or diseases.</p>
<p>Public and environmental health</p> <p>New infectious diseases following changed climatic suitability of vectors.</p> <p>Greater incidence of heat stress and/or fire or dust related illness among elderly and children.</p> <p>Increased incidence of mental illness due to economic consequences of climate change.</p> <p>Incidence of food contamination events following climate-linked power supply interruptions.</p>
<p>Service provision</p> <p>Reduced capacity for the Shire to provide its various services due to financial constraints resulting from reduced rate revenue and climate change-related economic decline.</p> <p>Reduced capacity for the Shire to provide its various services due to staff recruitment/retention challenges resulting from climate change-related economic decline.</p> <p>Demand for Shire services increases beyond delivery capacity due to increased frequency/impact of bushfires, economic decline, low irrigation water availability, changes in tourist activity, introduction of new pests and diseases, more frequent and severe emergency events and community sustainability awareness.</p>

Theme and description

Shire service disruptions resulting from climate linked failure in power and/or water supply.
Adjustment of service delivery, particularly for sport and recreational activities in response to climate change.

Volunteerism

Reduced community engagement in volunteer activities/services due to climate linked population decline or changed demographics.



7. Adaptation Action Plan

7.1. Introduction

This *Adaptation Action Plan* will guide Moira Shire in its response to risks from projected climate change. Consistent with the focus of the *Preparing for climate change in the Shires of Campaspe and Moira* project, the Plan's focus on actions which Moira Shire can take: alone or in conjunction with stakeholders such as State government agencies, Catchment Management Authorities or the Municipal Association of Victoria.

This Plan specifically addresses two of the Shire's four climate change response strategies, namely:

- *Adaptation* – section 7.4 outlines proposed responses to priority risks due to projected climate change. The responses are structured the risk themes described in Table 4.
- *Adjustment* – section 7.5 outlines options to build Council's and the community's capacity to adjust to climate change through communications, new governance or management structures and monitoring, evaluation and reporting.

A third pillar, *Influence*, is indirectly addressed through adaptation and adjustment activities.

7.2. What is adaptation?

Adaptations are the '*adjustments made in natural or human systems in response to experience or projected climate conditions or their beneficial or adverse effects or impacts*' (Smit *et al.*, 2001). Adaptation may occur autonomously or as the result of planned action. In the context of a risk assessment process, planned adaptations are the new controls (regulations, planning or management practices introduced to manage priority risks that remain after existing risk controls have been considered.

Some actions that mitigate greenhouse gas emissions also assist in reducing risks associated with climate change.

There are various schemes for classifying types of adaptation. One representation is given in Box 7.1.

Box 7.1 Forms of adaptation to climate change (from Burton, 1996)

Accept the risks –some impacts from climate change cannot be practicably avoided or are likely to be too small to warrant intervention. Decisions may be made to either bear any associated losses or share them among the broader community (e.g. through insurance). This form of response is applied to low or medium risks, for which no action other than business-as-usual processes is required.

Modify exposure to/likelihood of climate change impacts - in which actions are undertaken to reduce the frequency of events which may cause adverse impacts. Fuel reduction burning to protect towns from bushfire and decommissioning buildings which may be damaged by extreme storm events are examples of this form of adaptation.

Modify sensitivity to/consequence of climate change impacts - in which actions are undertaken to lessen the impact of climate events. For example, the composition of road seals may be adjusted to provide greater tolerance of heat wave conditions and stormwater systems may be modified to cope with higher peak flows under more intense rainfall events.

Avoid the risk – options that avoid risks from climate change, either by changing use to something that is less sensitive (e.g. from irrigated to dryland agriculture) or changing location to reduce exposure to climate change (e.g. pulling back residential development from highly fire prone areas).

Build adaptive capacity - undertake research to better understand risks faced and/or improve or extend the range of adaptations. Actions may also include education to improve organisations' and communities' understanding of climate risks and management responses and/or improve planning or governance arrangements to support effective climate change responses.

7.3. The importance of adaptation for local government

The *Local Government Act 1989* notes that the primary objective of local government in Victoria is to, “endeavour to achieve the best outcomes for the local community having regard to the long term and cumulative effects of decisions.” In achieving this objective, Councils must:

- promote the social, economic and environmental viability and sustainability of the municipal district;
- ensure that resources are used efficiently and effectively and services are provided in accordance with the Best Value Principles to best meet the needs of the local community;
- improve the overall quality of life of people in the local community;
- promote appropriate business and employment opportunities;
- ensure that services and facilities provided by the Council are accessible and equitable;
- ensure the equitable imposition of rates and charges;
- ensure transparency and accountability in Council decision-making.

Local Government Act 1989

While adaptation is not explicitly mentioned, it is clear that given these objectives and the potential impacts of projected climate change, adaptation falls within the scope of local government’s responsibilities. While adaptation is clearly not solely the responsibility of local government, there

are significant advantages in local government taking early action on climate change adaptation, for example (Snover *et. al.*, 2007; Garnaut, 2008):

- *Better management of existing risks* - projected climate change may merely pose more extreme versions of risks historically faced by communities. In such circumstances, adaptation to climate change may simply enable existing risks to be managed more effectively than was previously the case.
- *Adaptation is “good government”* - governments at all levels share the goal of ensuring the safety, health and welfare of their communities. Meeting this goal and maintaining the integrity of essential public services requires that governments anticipate trends and changes that could affect their environment, economy, and community wellbeing. The breadth of potential impacts from climate change (see Table 3 and Table 4) is such that adaptation is a matter of “good government” and risk management.
- *Adaptation is fundamentally a local endeavour* – appropriate adaptation responses depend on local circumstances. Households, communities and businesses are best placed to make the decisions that will preserve their livelihoods and help to maintain the things they value. Public programs and policy strategies designed at local or regional levels are in a stronger position to tailor climate change preparedness strategies to their specific circumstances and the unique set of climate change impacts they expect to face.
- *Proactive planning may be more effective and less costly than reacting to climate change impacts as they happen* – pre-emptive action to manage or avoid climate risks may prevent or reduce the dislocation and financial, environmental or social costs of climate change impacts and reactive responses. It may also enable any opportunities that arise from climate change to be developed and investments in adaptive responses to be implemented in a strategic and cost-effective manner.

7.4. Adaptation actions for Moira Shire

Adaptation actions in this Plan focus on the priority (high and extreme) risks identified in the risk assessment (section 6), which is consistent with risk definitions (Figure 4) and previous discussion. These risks were consolidated into eight themes (Table 4) and used as the framework for identifying and documenting adaptations actions. These actions were identified in a joint workshop with representatives from the Moira and Campaspe Shires.

Presentation of adaptation actions (sections 7.4.1-7.4.8) is structured around six questions:

- What is the risk or issue to be addressed?
- What are the risk controls already in place?
- Why is there still a risk, given there may be controls already in place?
- How might the issue be managed differently?

- Which Council department or group has lead responsibility?
- Are there external partners/stakeholders who should be involved in adaptation?

Adaptation actions are discussed in response to the, ‘how might the issue be managed differently’ question. High priority options (nominated by Moira Shire staff) are listed first and are followed by other potential actions. Existing measures that help to manage risks from climate or climate change should be maintained.

7.4.1. Asset management

What are the issues?		
<p>Council assets, including: public buildings, car parks, commercial facilities, recreational facilities and road may experience accelerated deterioration due to increased temperatures, fluctuating river levels and drying climate. Asset deterioration may be compounded by inadequate maintenance, reflecting climate change-linked loss of Council revenues.</p> <p>Maintenance and capital costs may be incurred to ensure assets remain fit for use under changed climate. This reflects changed operating conditions and new, climate adapted design standards.</p> <p>Operating and/or maintenance costs for some Council assets may increase due to the introduction of the proposed CPRS and its effect on energy and fuel prices. Climate linked increases in the price for water may also affect asset operating costs (e.g. sports grounds).</p>		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Council asset management system, incorporating system of asset condition audits, routine maintenance and, for roads, review of the road hierarchy. ■ Asset infrastructure design accounts for historical extremes of climate variability. ■ Council budget structured to meet asset operations/maintenance/refurbishment costs. ■ Monitor conditions of football & other relevant sport grounds to ensure fitness for use. Concentrate water use on fewer grounds when necessary. Purchase water & maintain in fit for use state. Renew sports grounds with drought-tolerant &/or low water use turf varieties. ■ Installation of artificial shade structures in car parks and at sports and recreational facilities. ■ Advocacy to government and electricity utilities to replace existing street lights with low energy alternatives. ■ Council use of biodiesel in trucks and plant. 		
Why is there still a high or extreme risk?		
<p>Changes in climate may accelerate deterioration in condition currently experienced by assets, increasing operating costs. Design standards for some assets may change, requiring retrofits or other adjustments to ensure they remain fit for purpose.</p> <p>Loss of water security for irrigation and river flows may affect economic activity associated with agriculture and tourism. Changes may flow through to population, land value and Council rate base and hence diminish Council's capacity to meeting historical or accelerated depreciation demands. Council already experiencing ‘infrastructure renewal gap’ and is challenged to maintain its built infrastructure.</p>		
How might things be done differently to lower risk?		
	Asset Action	Council lead & partners/stakeholders
Higher priority		
Buildings	Adapt use of buildings to match climate change. Buildings to incorporate sustainable design elements. Consolidate uses into climate resilient buildings.	Infrastructure planning
Storm water	Review storm water management planning in light of projected climate change & revised Australian Rainfall & Runoff engineering handbook. Revise planning as required. Prioritise investment to match services levels and expectations with resources. Communicate to community.	Infrastructure planning <i>EPA, Engineers Australia, CMAs</i>

Transport	Investigate road construction alternatives, e.g. alternative sealing suitable for increased temperatures.	Infrastructure planning
Recreation	Provide natural and artificial shade in sports grounds/recreational facilities to reduce the risk of skin cancer (public health risks) and provide improved amenity values	Recreation <i>Department of Sport & Recreation</i>
Recreation	Renew sports grounds with drought-tolerant and/or low water use turf varieties	Recreation <i>Department of Sport & Recreation</i>
Lower priority		
Buildings	Rationalise building maintenance. Consolidate use into higher priority buildings. Allow planned decline in low priority buildings. Reflect in Council policy. Communication to community on condition of assets, risks and costs of maintenance.	Asset management
Aerodrome	Monitor condition & expenditure. Bear expense to maintain service levels.	Infrastructure planning <i>Civil Aviation Safety Authority</i>
Saleyards	Investigate Council's role and future use of saleyards accounting for climate change.	Infrastructure planning
Storm water & flood	Active asset management/maintenance program, with regular asset condition audit. Develop internal processes to maintain/renew corporate knowledge of infrastructure and ensure maintenance. Introduce measures (including water sensitive urban design (WSUD) to reduce storm water flows.	Infrastructure planning Planning <i>Developers</i>
Car parks	Use forms of bitumen that are adapted to relevant temperature regime	Infrastructure planning
Parks, gardens, recreation	Promote summer indoor recreation (as relevant to sport - e.g. bowls, bocce), especially among more climate vulnerable demographic groups. Develop indoor recreation facilities for appropriate sports	Recreation <i>Department of Sport & Recreation</i>
Tourism	Source State/Australian government funding to support maintenance and restoration of high value heritage buildings.	Economic development <i>Victorian/Australian government</i>
Transport	Regularly review road hierarchy based on usage, resources for maintenance and in light of changing climate conditions. Communication and consultation re road hierarchy and focus of resources on higher priority roads & declining service on low priority roads.	Infrastructure planning
Vehicles, plant	Monitor for new energy efficient technology (fuel, plant, fleet) and purchase when feasible. Reflect in Council procurement policy. Monitor operation of plant & vehicles to ensure fuel efficiency	Corporate services/fleet management
Water	Bear increased water costs, pass on to customers. Rationalise use according to water use plan for non-potable sources	Infrastructure planning

7.4.2. Biodiversity

What are the issues?		
Loss of biodiversity in wetlands and floodplains resulting from lack of flooding and/or environmental flows. Loss of biodiversity from terrestrial habitats due to changes in fire regime and/or infestations by new pest plants or animals.		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Council actively engaging with regional conservation networks. ■ Engagement in regional natural resource management planning processes. 		
Why is there still a high or extreme risk?		
Climate change may result in further reductions in water security. Under current water sharing rules, environmental flows more disadvantaged by low river flows and dam storage levels than consumptive uses. Change in temperature, rainfall and/or fire regime may disadvantage terrestrial flora and fauna. Conditions for new pests to enter or existing pest populations to break out may emerge with climate change.		
How might things be done differently to lower risk?		
Type of action	Action	Council lead & partners/stakeholders
Higher priority		
Regional engagement	Council actively engage in catchment management activities with Catchment Management Authorities (CMAs) – including Regional Catchment Strategy & other regional & sub-regional planning activities & program implementation. Relevant council environmental plans harmonise with companion CMA plans.	Environment Working Group (EWG) CMAs
Planning	Amend planning scheme controls to maintain/enhance connectivity of fragmented vegetation patches.	Planning CMAs, DSE
Private land conservation	Council actively support private land conservation, through: advocacy with government for resources & regulatory review; planning scheme amendments; enforcing compliance with offset requirements, encouraging covenants, partnership program development and implementation.	EWG, Planning MAV, DSE, CMAs, Trust for Nature
Planning	Regional and municipal bushfire planning – biodiversity assets & requirements reflected in planning, preparations & responses.	EWG, Planning Fire management, Municipal Emergency Response Officer (MERO) CFA, DSE
Lower priority		
Environmental water	Incorporate climate change risks into wetland management plans and other general environmental strategies as they are reviewed. Communication to communities on need for environmental water provision. Environmental flow allocation for priority wetlands	EWG CMAs, DSE, G-MW
Planning	Review environmental monitoring outcomes from CMA programs and incorporate information into relevant Council plans and activities Communication to rural landholders on value of habitat connectivity	EWG CMAs EWG, planning CMAs

7.4.3. Business and economic development

What are the issues?		
<p>Reduced profitability of the Shire's commercial operations (especially caravan parks) reflecting changed use patterns due to climate change, in particular reduced River flows.</p> <p>Reduced profitability and business confidence resulting from loss of tourist trade due to reduced River flows, loss of amenity of townships and/or increased fuel prices due to CPRS. This may be exacerbated by impacts of low irrigation water allocations on the profitability of the region's agricultural sector.</p> <p>Loss of Shire revenue due to reduced economic activity, resulting in reduced rate base.</p>		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Economic development and tourism promotion services provided/supported by Council. ■ Pursue export opportunities for regional agricultural and tourism products. ■ Investigate new technologies and promote sustainability-focussed industries (e.g. solar power). ■ Encourage public transportation (trains, buses) to provide low cost transport options and attract tourists. ■ Issue media releases regarding algal blooms to promote alternatives to water based recreation/tourism. 		
Why is there still a high or extreme risk?		
<p>Climate change may result in further reductions in water security. Under worst case scenarios this may substantially reduce River Murray flows and irrigation water allocations. The former would undermine river-based tourism activities (plus golfing and bowls-related tourism) and dependent economic activity. The later would result in restructure of the agricultural economy away from irrigation. This would reduce economic output and employment, with flow on impacts on Council's revenue base, by lowering land values and rates.</p>		
How might things be done differently to lower risk?		
Service	Action	Council lead & partners/stakeholders
Higher priority		
Economic development	Investigate new technologies and promote sustainability-focussed industries (e.g. Yarrawonga - solar city).	Economic development, tourism
Economic development	Maintain open communication and good contact with townships about climate change risks and opportunities.	Councillors <i>Town communities</i>
Economic development	Incorporate climate change responses into small community plans.	Community development <i>Small town communities</i>
Tourism	Diversify tourism base, including promote national parks as a tourism asset and alternatives to climate sensitive tourism uses such as river/water-based activities.	Tourism/Economic Development <i>Parks Victoria, Cobram-Barooga tourism, Murray River tourism</i>
Economic development	Promote opportunities created by climate change (e.g. longer warm seasons, warmer winters).	Economic development
Lower priority		
Tourism	Review tourism strategy in light of climate change risks. Increase staff and resources dedicated to tourism services. Advocate for Victorian Environmental Assessment Council (VEAC) recommendations to be enacted.	Tourism/Economic Development <i>Cobram-Barooga tourism, Murray River tourism</i> Councillor
Economic development	Review economic development strategy in light of climate change risks & opportunities. Support businesses with workshops, seminars, website. Resource efficiency planning for small businesses, e.g. revive Pilot Program Encourage businesses to adopt sustainable practices (e.g. through Business Excellence Awards) Training for economic and community development practitioners in climate change and sustainability for business and communities.	Economic development Economic development, EWG Economic development, EWG <i>EPA, Sustainability Victoria</i> Economic & Community development, EWG <i>PA, Sustainability Victoria</i>

7.4.4. Emergency management

What are the issues?		
Increased incidence and/or severity of bushfires, resulting in injury to population and damage to Council assets. Changes in planning may be required to account for enhanced bushfire risk.		
Flood damage to Council (and private) assets, due to storm water drainage system's capacity being exceeded or due to river flooding that exceeds flood protection infrastructure.		
Increased demand for emergency services.		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Municipal fire protection planning ■ Levees and other river flood protection infrastructure. ■ Storm water drainage system, designed to appropriate standards. 		
Why is there still a high or extreme risk?		
Severe weather events may become more severe, with greater potential impact from fire or flood.		
How might things be done differently to lower risk?		
<i>Issue</i>	<i>Action</i>	<i>Council lead & partners/stakeholders</i>
Higher priority		
Bushfire	Link municipal fire prevention planning with Integrated Fire Management Planning – including identification of higher risk areas, communication and consultation with communities regarding risk and responses. Review use of Wildfire Management Overlay.	Fire protection, Municipal Emergency Response Office (MERO) CFA, DSE, Emergency Services Commission, Police, SES
Bushfire	Encourage township fire protection plans in high risk areas.	Fire protection, MERO CFS, local communities
Storms	Develop plans to manage storms as well as river floods.	Planning, Infrastructure planning CMAs
Emergency management	Advocate to State government for more complete resourcing of local government fire and emergency management roles.	Councillors CFA, DSE, Emergency Services Commission, Police, SES
Flood	Update information base on distribution of floods and flood risk in higher risk township areas.	Planning CMAs, DSE
Lower priority		
Bushfire	Insurance for Council buildings Targeted evacuation of elderly and other vulnerable people under extreme risk conditions. Review fire planning arrangements to reflect recommendations of current Bushfire Royal Commission.	Corporate services Community development Fire protection, MERO CFA, DSE, Emergency Services Commission, Police, SES
Flood	Review new Australian Rainfall and Run-off (AR&R) guidance that accounts for climate change. Review storm water management planning in light of projected climate change & revised AR&R. Revise planning as required. Prioritise investment to match services levels and expectations with resources. Communicate to community. Revise town planning if changes in design storm events Incorporate WSUD to capture and use storm water runoff to reduce drain inflows.	Planning Planning, Infrastructure planning EPA, CMAs Planning, Infrastructure Planning EPA, CMAs

7.4.5. Parks and gardens

What are the issues?		
Loss of important amenity or lifestyle values due to deterioration in parks and gardens resulting from changed climate suitability, inadequate watering and damage by new pests or diseases.		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Keep database of street trees. Regularly monitor & evaluate condition of trees. ■ Sustainable water use plan. Audits of potable & non-potable water use in parks/gardens. ■ Identify/employ drought-resistant species ■ Implement water saving irrigation devices (e.g. drippers) in parks and gardens. 		
Why is there still a high or extreme risk?		
Climate change may exacerbate pressures on parks and gardens, through temperatures extremes extending beyond historical range (& plants' adaptive ranges), further reductions in irrigation water availability and potential for entry of new pest plants and animals or plant diseases.		
How might things be done differently to lower risk?		
Asset/service	Action	Council lead & partners/stakeholders
Higher priority		
Parks & gardens	Landscape master planning (urban design) linking urban design at scale from individual property to neighbourhood and beyond. Plant selection for gardens and streets to be consistent with master plan and focus on species adapted to expected climate, pests and community requirements.	Planning <i>Nurseries, developers</i>
Parks & gardens	'Oasis' planning to concentrate management effort and water on priority parks and gardens and have planned reductions in amenity/service from other park/garden areas. Communicate with communities regarding selection of street trees and 'Oasis' policy.	Parks & gardens
Parks & gardens	Keep database of street trees. Regularly monitor and evaluate condition of trees.	Parks & gardens
Water	Implement water saving irrigation devices (e.g. drippers) in parks and gardens.	Parks & gardens
Parks & gardens	Any renewal of street trees to be with adapted species (and consistent with streetscape and landscape master planning.	Parks & gardens
Lower priority		
Storm water	WSUD to capture & use overland flows and some storm water	Planning, Infrastructure planning <i>Developers</i>
Parks & gardens	Create alternative high quality shade through man-made shelters Monitor information sources for emerging pest plant/animal threats. Respond as advised when/if threat emerges. Use variety of species to avoid monoculture disease risk	Parks & gardens

7.4.6. Public and environmental health

What are the issues?		
Climate change may assist in development and spread of new infectious diseases, including due to changes in climatic suitability for disease vectors.		
Greater incidence of heat stress and/or fire or dust related illness among elderly and children.		
Increased incidence of mental illness due to economic consequences of climate change, including among farmers and other small business operators.		
Incidence of food contamination events following climate-linked power supply interruptions.		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Municipal public health plan. ■ Provision of heat stress education materials to at risk groups & personal care-givers. ■ Direct contact with at risk elderly under extreme heat wave conditions. ■ Food safety reviews of relevant commercial premises. Training of food handlers. ■ Reduce respiratory illness risk by banning incinerators and burning in urban areas. 		
Why is there still a high or extreme risk?		
Climate change may pose risks not considered in current municipal public health plans or exacerbate existing risks.		
How might things be done differently to lower risk?		
<i>Type of action</i>	<i>Action</i>	<i>Council lead & partners/stakeholders</i>
Higher priority		
Heat stress management	Investigate ways to identify and contact at risk elderly residents on days of extreme heat stress risk	Community development <i>DHS</i>
Heat stress management	Council to advocate for changes to building codes to change housing design principles to adequately take into account public health protection for heat, fire protection & other climate change risks.	Building, Councillors <i>MAV Master Builders Association</i>
Mental health	Support mental health agencies working with farming communities during difficult periods.	Community development <i>DHS, rural financial councillors</i>
Mental health	Support enterprise & economic diversification among agricultural community. Support planning & choice of options during periods of low water availability.	Economic development <i>DPI, DIIRD</i>
Mental health	Identify and develop alternative economic activities beyond traditional irrigated agriculture based industries – to provide economically resilient land uses.	Economic development, Planning <i>DPI, DIIRD</i>
Lower priority		
Food safety	Education of food handlers on actions to take in the case of electricity failure – using information developed by State Government	EWG <i>DHS</i>
	Incorporate climate change risks into next & future reviews of municipal public health plans.	EWG
Heat stress management	Conduct SunSmart awareness programs.	Community development
Asthma	Apply conditions on stubble burning to minimise impact on urban residents. Educate farmers about alternatives to stubble burning, including raising awareness of health impacts on broader community	EWG <i>EPA, DPI</i>
	Advocacy to regulatory authorities for tighter control over stubble burning.	EWG, Councillors <i>EPA</i>

7.4.7. Service provision

What are the issues?		
<p>Reduced capacity for the Shire to provide its various services due to financial constraints resulting from reduced rate revenue and climate change-related economic decline (as discussed above). This may be exacerbated by challenges in staff recruitment/retention challenges resulting from climate change-related economic decline.</p> <p>Demand for Shire services increases beyond delivery capacity due to increased frequency/impact of bushfires, economic decline, low irrigation water availability, changes in tourist activity, introduction of new pests and diseases, more frequent and severe emergency events and community sustainability awareness.</p> <p>Adjustment of service delivery, particularly for sport and recreational activities, in response to climate change.</p> <p>Disruptions to Council services resulting from climate linked failure in power and/or water supply.</p>		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Council budget and financial planning processes. ■ Pursuit of State or Australian government grants for special projects. ■ Economic development and tourism promotion services provided/supported by Council. ■ Moira Shire sustainable water plan and water planning by water corporations. ■ Modification of cover to adapted grass species ■ Emergency management planning by Councils. ■ National electricity grid. 		
Why is there still a high or extreme risk?		
<p>Impact of climate change on economic activity would add to current challenges in providing services and recruiting or retaining skilled staff. Economic decline may result in population loss, particularly among those in the working age. Climate change may affect Council's financial capacity and hence capacity to employ staff to meet existing or potentially increased service demand.</p> <p>Climate change may result in climatic conditions (especially heat waves) that make current facilities and/or operating times unsafe. Low water allocations may continue to reduce water availability for irrigation and may require changes to grass/turf-based recreational or sporting pursuits (e.g. bowls, cricket, tennis).</p> <p>Electricity supply systems may be unable to meet demand for electricity under extreme heat wave conditions. Supply infrastructure may not be adapted or may be affected by fire.</p> <p>Failure in water supply may reflect failure of electricity system or extreme collapse in water resource availability.</p>		
How might things be done differently to lower risk?		
Service area	Action	Council lead & partners/stakeholders
Higher priority		
Financial	Long term financial planning to manage debt and maximise resources available to Councils (e.g. allow for trust funds for emergency use; business continuity plans etc).	Corporate services
Financial	Incorporate climate change risks into budget reviews.	Corporate services
Human resources	Share services/resources among neighbouring councils (Vic/NSW) especially for services related to isolated events such as flu pandemic.	Community services <i>Adjoining & nearby Councils</i>
Human resources	Promote Shires as liveable places as part of strategy to attract and retain staff.	Economic development, Tourism
Service delivery	Incorporate climate change risks into decisions when reviewing non-essential and non-profitable council services.	Corporate services
Sport & recreation	Prioritise multiuse facilities for water allocation.	Parks & gardens
Water	Plan for integrated water cycle management, including harvest and use of storm water, reuse of treated waste	Planning, EWG, Infrastructure planning Urban water corporations

	water and use of other fit-for-purpose water sources for non-potable uses. Manage any adverse impact of storm water harvest on environmental flows.	
Lower priority		
Service delivery	Match level and types of services provided by Council to budget. Privatised/outsourced non-core council services. Effectively coordinate services between delivery agencies to minimise overlap and inefficiency in service provision. Communication with community to manage understanding of Council's role / responsibilities & service levels expectations. Increase recycling collection programs. Provide support services for farmers and farm workers to help to deal with drought. Seek external resources to support activities.	Corporate services Councillors Waste management Community services <i>DPI, DHS</i>
Human resources	Offer incentives to retain key personnel at locations where staff are hard to retain (e.g. scholarships). Employ appropriately skilled/experienced local people by preference. Encourage volunteering in local community to provide key services without need for professional staff (e.g. Meals on Wheels program). Partner with metropolitan councils or 'sister cities' in voluntary staff swaps to build skills and share resources.	Corporate services Community development Councillors
Electricity	Advocate to retrofit Council building stock with more energy-efficient and climate adapted buildings.	Infrastructure planning
Electricity	Establish decentralised electricity supply network (e.g. solar panels on council buildings) to augment or replace grid supplies.	Economic development, Asset management <i>Electricity retailers/wholesalers</i>
Electricity	Ensure emergency generators are available for high-priority buildings such as the Municipal Emergency Coordination Centres (MECCs)	Infrastructure planning
Water	Advocate for additional private (or other) investment in new water treatment technologies.	Councillors
Water	Advocate to relevant water authorities to ensure service provision to meet basic human needs and emergency requirements. Construct more reliable water points for road maintenance.	Councillors, Planning Urban water corporations Infrastructure planning
Financial	Advocate for greater sharing of State and Commonwealth funding &/or access alternative funding to rates. Compensate local government for loss of rate revenue due to government policy. Long term financial planning to manage debt and maximise resources available to Councils (e.g. allow for trust funds for emergency use; business continuity plans etc.).	Councillors <i>Victorian & Australian government</i> Corporate services
Sport & recreation	Promote summer indoor recreation (as relevant to sport - e.g. bowls, bocce), especially among more climate vulnerable demographic.	Recreation
Sport & recreation	Change training/operating times so that people are outdoors in cooler parts of day.	Recreation

7.4.8. Volunteerism

What are the issues?		
Reduced community engagement in volunteer activities/services due to climate linked population decline or changed demographics.		
What are the existing risk controls?		
<ul style="list-style-type: none"> ■ Volunteer recruitment activities. ■ Provision of training for volunteers. 		
Why is there still a high or extreme risk?		
Climate change may lead to a deterioration in the local economy, potentially resulting in population loss, changed demographics and disengagement of those most keenly experiencing economic hardship.		
How might things be done differently to lower risk?		
Type of action	Action	Council lead & partners/stakeholders
Higher priority		
Volunteering	Advocate to governments to pay/provide incentives for volunteers to increase personal responsibility and compensate for lost time.	Councillors MAV
Volunteering	Marketing volunteerism in innovative, engaging ways.	Community development
Volunteering	Working with agencies to simplify and create different roles and levels of service so that people can volunteer different amounts of time and receive different levels of training (e.g. Reserve force with basic skills).	Community development CFA, SES, Landcare
Lower priority		
Volunteers	Encourage volunteer organisations to be more inclusive when recruiting	Community development Volunteer organisations
	Share volunteer pool with other Shires	Community development Neighbouring Councils

7.5. Adjustment

A strong capacity to adjust behaviour, resources use and allocation and technologies in line with the challenges presented by climate change, is a necessary condition for successful adaptation. Although local government are positioned to contribute to or even lead local adaptive responses to climate change, they are not necessarily well-resourced or structured to do so. The resources available to most rural Councils are very limited and highly focussed on operational issues. Many local governments are structured around operational ‘silos’ which potentially leads to any climate change expertise being compartmentalised into ‘environmental’ or ‘planning’ departments. These features pose important barriers to long-term strategic responses to climate change across the entire organisation.

Moira Shire is unique in their structural framework in that there is no stand alone environmental department. Rather an Environment Working Group brings together all departments to discuss and advise on environmental issues.

Widespread scepticism about human-induced climate change among rural and regional communities makes it difficult to establish the case for proactive and integrated climate change responses by local government.

This section describes options to build capacity within Moira Shire to address some of these challenges. Most ideas were generated in an adaptation planning workshop run with staff from Moira and Campaspe Shires. Adjustment options are grouped into three categories: communications; governance and management arrangements; and monitoring and review.

7.5.1. Communications

Communication is critical in helping Council and the community adjust to climate change. It should support the adaptation and mitigation strategies that frame Moira Shire's climate change response.

There are three major communication objectives:

- *Improving understanding of climate change issues* – people in rural and regional communities are generally well-connected to their environment. They observe and understand climate variability, witness its impacts on their environment, economy and community and adapt. This does not necessarily translate into understanding or acceptance of human-induced climate change.

Communication with or among Councillors, Council staff and the broader community needs to develop understanding of climate change issues to build support for Moira Shire's adaptation and mitigation initiatives. The information base for such communication needs to be credible, accessible to non-technical people and acknowledge both uncertainty in the science and audiences' understanding and experience of climate variability.

Critical shorter-term risks for Council are those relating to rainfall and water security for irrigation and river flows. It is important that both Council and the broader community understand these risks and their potential implications. Debate should not focus on causality (i.e. human-induced climate change and/or natural variability), but should present the latest science on the issue⁵.

Communication about climate change should not overstate risks on issues for which there are or are likely to be effective adaptations (e.g. temperature impacts on roads). Information must

⁵ The South East Australia Climate Initiative (www.mdbc.gov.au/subs/seaci/) coordinates research on causality of the current dry conditions and low streamflows within the southern Murray-Darling Basin and potential impacts of human-induced climate change.

also be presented in a manner that empowers audiences for action, rather than leaving them without any sense of hope.

- *Building ownership of Moira Shire's climate change responses* – the Shire's climate change responses, including this *Adaptation Action Plan* should be actively articulated within and outside of Council to build ownership and support, empower action and provide a basis for review, innovation and refinement.
- *Building partnerships for climate change responses* – many of the issues underlying Moira Shire's major risks from climate change (e.g. low river flows; loss of irrigation water security) are not within the direct responsibility of Council. Likewise, many of the adaptive responses to climate change risks cannot be undertaken by Council alone. Communication is required to enable the collaboration required for successful adaptation (by Moira Shire and/or other partners) or to obtain the financial or other resources needed.

Stakeholder groups that Council should communicate with are listed in Box 7.2. Given the rapidly expanding knowledge about climate change processes and responses and the need to empower grass roots action, these communications should involve dialogue and not simply the provision or receipt of information.

Recommendation 7.1

Moira Shire should develop a detailed plan for internal and external communications on climate change, based on this action plan. The *Communication Plan* should integrate with communications on Council's *Greenhouse Action Plan*.

7.5.2. Governance and management arrangements

Effective and integrated climate change adaptation must be supported by effective management arrangements within Council and improvements to local and regional governance structures.

Climate change management arrangements for Moira Shire

The level of effectiveness and coordination in climate change responses by organisations is influenced by the degree to which climate change adaptation (and mitigation) is 'mainstreamed' or made to be a fundamental part of the way in which the organisation looks at its own operations and its external operating environment. 'Mainstreaming' climate change does not mean that it becomes the sole or even major influence on any particular policy choice or action. It means that where climate change is relevant, it is always part of analysis and decision-making processes.

Mainstreaming climate change within Moira Shire's operations depends on effective internal communications (as described above: to establish the need to do so), as well as effective internal

management arrangements. Actions proposed to reconfigure management arrangements to mainstream climate change adaptation include the following:

- Clear communication of priority climate change risks to senior management and Councillors.** The priority risks to which this *Adaptation Action Plan* respond, by definition, demand attention from Councillors and senior management. Without engagement in climate change issues at this level, mainstreaming of climate change responses is unlikely.

Box 7.2 Key participants in dialogue on climate change for Shire of Moira	
<p>Moira Shire</p> <p>Councillors CEO and Directors Council staff</p> <p>Community</p> <p>Township communities Business and tourism groups, Chambers of commerce Schools Landcare groups Environmental groups Sporting groups Recreational facilities operators (e.g. YMCA) Goulburn Broken Greenhouse Alliance</p> <p>Local government</p> <p>Adjoining Victorian municipalities - Shires of Benalla, Campaspe and Indigo, the Rural Cities of Benalla and Wangaratta and the City of Greater Shepparton. NSW – Berrigan and Corowa Murray Group of Councils Murray-Darling Association Municipal Association of Victoria</p> <p>Regional and state tourism groups</p> <p>Cobram-Barooga tourism Murray River tourism</p> <p>Health & well being</p> <p>Primary care partnership Rural financial councillors Victorian Health Promotion Foundation</p>	<p>Rural and urban water corporations</p> <p>Goulburn-Murray Water Goulburn Valley Water North East Water Northern Victorian Irrigation Renewal Program</p> <p>Catchment Management Authorities</p> <p>Goulburn Broken CMA North East CMA</p> <p>State government agencies</p> <p>Departments of Primary Industries; Sustainability and Environment; Planning and Community Development; Industry, Innovation & Regional Development; Human Services Environment Protection Authority Parks Victoria</p> <p>Australian government agencies</p> <p>Departments of Climate Change; Environment, Water, Heritage & the Arts; Infrastructure, Transport, Regional Development and Local Government Murray-Darling Basin Authority</p> <p>Science providers</p> <p>CSIRO Bureau of Meteorology SEACI – South East Australia Climate Initiative</p> <p>Waste management</p> <p>Resource GV</p>

- Reflect climate change responses, including adaptation, in the *Council Plan*.** Moira Shire’s *Council Plan* informs the community of the strategic direction Councillors want to take during

their electoral term. Other key high level planning documents, the *Municipal Public Health Plan* and *Municipal Strategic Statement* align closely with the *Council Plan*.

The *Strategic Resource Plan* (a supplementary document to the *Council Plan*) aligns resource allocation with objectives of these key documents, as do departmental planning documents.

- **Establish clear responsibilities for coordination of climate change responses within Council.** For local governments, climate change is not just, and may not even be primarily an environmental issue. Unless carriage of Moira Shire’s climate change response extends across relevant Council departments, efforts to address the important economic and social implications of climate change may falter. However, while mainstreaming will require that responsibility for delivering on climate change responses is dispersed across the organisation, a central point for coordination and gathering and disbursing information is required. Active coordination is also needed to manage tendencies to compartmentalise aspects of Council’s response within particular departments. At present, Moira Shire’s Environment Working Group is best placed to lead this coordination and integration role.

Inter-agency adaptation steering committee

Climate change is a cross-cutting issue with environmental, social and economic implications. In a sense it is both no organisation’s and every organisation’s responsibility. Formal regional governance arrangements for climate change do not exist. While natural resource management organisations (i.e. CMAs) provide models for climate change, the issue is broader in scope and should not just be dealt with by organisations represented.

It is proposed that a cross-agency climate change “steering committee” be developed, with representation from local government and State government agencies across catchment management, environmental, economic and social well-being domains. Such a group should be convened by the Regional Management Forum and focus either on adaptation alone or address both adaptation and mitigation (with the latter preferred). Activities might include:

- information scanning to keep abreast of the latest relevant information on climate change;
- sharing of information on climate change responses and developing integrated regional responses;
- joint projects to understand climate change risks, their implications and potential responses;
- supporting other aspects to develop regional capacity to adjust to climate change;
- pursuing funding opportunities to support projects.

Recommendation 7.2

Moira Shire should devolve responsibilities for its climate change responses to relevant Departments, as indicated by this action plan. These responses should be coordinated and integrated by its Environment Department.

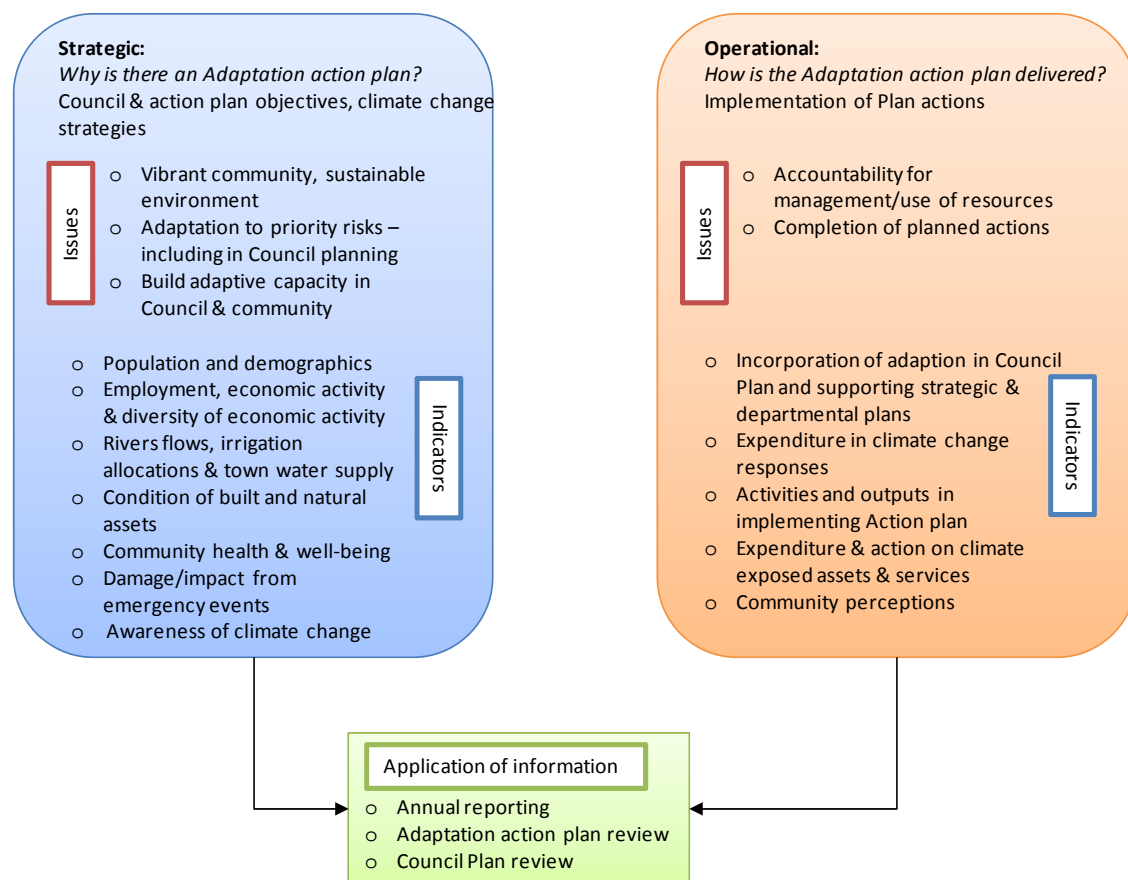
Recommendation 7.3

Moira *Shire* should partner with other regional local governments and relevant State government agencies, via the Regional Management Forum to build an effective regional governance structure for climate change.

7.5.3. Monitoring and review

Monitoring and review are critical steps in any adaptive planning processing. The dynamic science, technology and policy operating environment for climate change reinforce this principle. An *Adaptation Action Plan* such as this must have review steps to address both accountability requirements for resources invested as well as ensuring it is based on a current and robust understanding of risks.

The framework for monitoring and review of this Plan (Figure 6) operates at two levels, strategic and operational. At the strategic level, monitoring activities are concerned with gathering information to demonstrate that the Plan is achieving its purposes. At the operational level, monitoring is concerned with questions of whether the Plan is being delivered effectively. Both levels feed into annual reporting and (proposed) four yearly reviews of this plan. The later follows the local government electoral cycle and Council Plan review processes.



■ **Figure 6 Adaptation Action Plan: framework for monitoring and review**

Strategic monitoring and review

Strategic monitoring and review are concerned with whether the Plan is accomplishing its objectives, addressing relevant climate change strategies and Council’s overall objectives. Figure 6 lists the types of indicators for which data would be collected. Collection of data on these indicators would enable assessments to be made as to the sustainability of Moira Shire in economic, social and environmental terms and the contribution of climate change and Council’s climate change responses.

Given the types of information to be collected, it is recommended that reporting occur no more frequently than the four yearly review cycle. Much of the relevant information would be collected by third parties (e.g. Australian Bureau of Statistics, CMAs) and only needs to be sourced by Council.

Each four yearly review would provide an opportunity to revise the risk assessment upon which the *Adaptation Action Plan* is based. Review of the risk assessment and *Adaptation Action Plan* would

precede updating of the climate change elements of the *Council Plan* and supporting strategic and departmental plans.

Detailed strategic-level reporting would primarily be to Councillors and senior management, with summaries of reporting to the broader community.

Operational monitoring and review

Operational monitoring would be primarily concerned with accountability for delivery of this Plan. An annual reporting process would be developed to demonstrate expenditure in support of the Plan and activity and achievement as a result. It would also track expenditure and activity in relation to high risk assets and services to detect any change in response to climate change or adaptation. Monitoring and review would enable refinement of the Plan in case particular activities are not working or change in priority.

Operational monitoring and review would integrate with routine quarterly and annual Council monitoring and review processes. Relevant questions may be introduced into existing state-wide or local community/customer surveys.

Operational reporting would be coordinated by the Environment Working Group and reported to the Sustainability Awareness Officer and senior management. In turn key findings would also be reported to Councillors.

Recommendation 7.4

Moira Shire should develop a detailed monitoring and evaluation plan, based on this Action Plan and the monitoring and review framework in Figure 6. That Plan would be designed to support four yearly reviews of the climate change risk assessment and of the *Adaptation Action Plan*.

7.6. Adoption and implementation

Several steps are envisaged in adopting and beginning to implement this *Adaptation Action Plan* as follows:

- review, finalisation and endorsement by senior management and councillors;
- formation of internal management arrangements for coordination of climate change responses across Council;
- incorporation of climate change into *Council Plan* and key strategic and resourcing plans and reflection of this Plan in departmental plans (including defined deliverables and responsibility/accountability);
- budget allocation for *Adaptation Action Plan* implementation;
- implement, monitor and review annually.

8. Conclusion and recommendations

Strategic framework

It is proposed that Moira Shire have an integrated response to climate change, which addresses both the drivers of climate change (greenhouse gas emissions) and any unavoidable impacts. This response would be framed around strategies emphasising:

- *Mitigation* of greenhouse gas emissions.
- *Adaptation* to the priority risks from climate change.
- Building Council's capacity to *adjust* to impacts from climate change;
- *Influence* the community's overall greenhouse gas emissions and their capacity to adapt to climate change.

Climate risk and adaptation

This *Adaptation Action Plan* is structured around an assessment of risks posed by climate change to Moira Shire's assets, infrastructure and services. Two scenarios were considered: 2030 climate change under moderate greenhouse gas emissions levels; and 2070 climate change under high greenhouse gas emissions.

Identified high and extreme risks were consolidated into eight themes to enable integrated responses. Those themes and the focus for adaptation in each are:

- *Asset management.* Adapt use of buildings to match climate change, ensure new buildings incorporate sustainable design elements. Review storm water management planning and priorities to account for climate change projections. Ensure materials used in roads are suited to projected extreme summer temperatures. Improve provision of shade in Council operated recreation areas. Renew sports grounds with drought tolerant and low water use turf varieties.
- *Biodiversity.* Active engagement of Council in catchment and natural resource management activities. Ensure planning controls help to maintain or improve the connectivity of fragmented vegetation patches. Actively support private land conservation. Reflect biodiversity asset requirements and vulnerabilities in municipal bushfire planning.
- *Business and economic development.* Promote sustainability focussed industries that are adapted to future climate. Maintain communication with towns about climate risks and opportunities and incorporate climate change responses into small community plans. Extend tourism focus from river-based activities and locations. Promote tourism opportunities based on milder winter weather with climate change.
- *Emergency management.* Link municipal fire prevention planning with Integrated Fire Management Planning. Encourage township fire protection plans in high risk areas. Include storm as well as river floods in management plans. Advocate to State Government for comprehensive resourcing of local government fire and emergency roles. Update information base on flood risk in vulnerable towns.

- *Parks and gardens.* Landscape master planning with focus on climate adapted species. Focus management effort and water into defined ‘oases’. Regularly monitor street tree condition. Use water savings devices in parks and gardens.
- *Public and environmental health.* Instigate system to maintain contact with at risk elderly on extreme heat stress risk days. Advocated for changes to housing design to account for climate-linked public health risks. Support mental health agencies working with farmers during drought. Support economically and climate resilient farming systems.
- *Service provision.* Long-term financial planning to account for risks from climate change to costs and revenues. Share services/resources among neighbouring Councils. Promote Shire as a liveable place to attract and retain staff. Include climate risk in decision-making on levels of service provides to residents. Plan for integrated water cycle management.
- *Volunteerism.* Advocate to governments to incentivise volunteering. Ensure volunteering is well supported and marketed and that opportunities are structured around a variety of roles and levels of service.

Adjustment

A well-developed capacity to adjust behaviour, resources and technologies to challenges presented by climate change is essential for effective adaptation. Four main options to develop this capacity within Moira Shire were identified, including:

- strengthening internal and external communications on climate change;
- dispersing responsibility for action on climate change across Council departments, with coordination and integration provided by the Environment Working Group;
- develop regional governance arrangements for climate change;
- monitoring and review of this Plan and its activities and achievements, in line with Council performance reporting and Council Plan review processes.

Plan implementation

The key steps implementing this plan include:

- endorsement by senior management and Councillors;
- establishing the necessary internal management arrangements for coordination of climate change responses across Council;
- incorporation of climate change into the Council Plan and other key strategic and resourcing documents;
- allocate budget to support implementation;
- implement, monitor and review as implementation progresses.

Beyond this Plan

This Plan and the underpinning project specifically address risks from climate change for Moira Shire's assets, infrastructure and services. While it considers risks from climate change for the broader community, it does so from the perspective of potential impacts on Council operations. Issues associated with recent climate experience (and projected climate change) are pressing for water dependent industries within the Shire, particularly irrigation and tourism. Current and potential impacts of declining water resources may threaten the viability of some communities and Council as a whole.

Moira Shire should develop a risk assessment and adaptation project to address climate change in this broader context⁶.

Recommendations

Recommendations are contained in the body of the report and include:

- 4.1 Moira Shire should incorporate references to the four climate change strategies in future iterations of the Council Plan.
If the current structure is maintained it is recommended that this be implemented in the following way:
 - » Mitigation – a strategy be introduced under Pillar 4 Our Environment to reduce greenhouse gas emissions, with one of the strategic indicators reporting on emissions from all the Shire's activities.
 - » Adaptation, adjustment and influence – a strategy be included under Governance and leadership as part of Pillar 5 Working together. Reflecting Council's commitment to take a leadership role in matters of regional significance, the strategy might specify that Council would ensure it engages with the community and key stakeholder organisations to ensure risks from climate change are managed proactively. Supporting strategies could be considered under other Pillars, however including climate change response as part of this Pillar ensures climate change is considered at the core of Council's responsibilities.
- 7.1 Moira Shire should develop a detailed plan for internal and external communications on climate change, based on this action plan. The Communications plan should integrate with communications on Council's *Greenhouse Action Plan*.
- 7.2 Moira Shire should devolve responsibilities for its climate change responses to relevant Departments, as indicated by this action plan. These responses should be coordinated and integrated by its Environment Working Group.
- 7.3 Moira Shire should partner with other regional local governments and relevant State government agencies, via the Regional Management Forum to build an effective regional governance structure for climate change.

⁶ This is recommendation 8.1

- 7.4 Moira Shire should develop a detailed monitoring and evaluation plan, based on this action plan and the monitoring and review framework in Figure 6. That Plan would be designed to support four yearly reviews of the climate change risk assessment and of the Adaptation Action Plan.
- 8.1 Moira Shire should develop a risk assessment and adaptation project to address climate change and its implications for the broader community.

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10. References

Adger WN, Agrawala S, Mirza, MMQ Conde C, O'Brien K, Pulhin J, Pulwarty R, Smit B and Takahashi K 2007: Assessment of adaptation practices, options, constraints and capacity. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ML Parry OF Canziani JP Palutikof PJ van der Linden and CE Hanson Eds., Cambridge University Press, Cambridge, UK, 717-743.

Australian Greenhouse Office 2006 *Climate change impacts & risk management. A guide for business and government*. Australian Greenhouse Office.

Brooks N and Adger WN 2005 Assessing and enhancing adaptive capacity. *Adaptation Policy Frameworks for Climate Change*. Lim B, Spanger- Siegfried E, Burton I, Malone EL and Huq S Eds., Cambridge University Press, New York, 165-182.

Burton I 1996 The growth of adaptation capacity: practice and policy. In: Smith J, Bhatt N, Menzhulin G, Benioff R, Budyko MI, Campos M, Jallow B and Rijsberman F (eds) *Adapting to climate change: an international perspective*. Springer-Verlag, New York, NY, USA, pp. 55-67.

CSIRO 2007 *Climate change in Australia. Technical report 2007*. CSIRO.

Department of Sustainability and Environment 2008a *Climate change in the Goulburn Broken region*. Department of Sustainability and Environment

Department of Sustainability and Environment 2008b *Climate change in the North East region*. Department of Sustainability and Environment.

Garnaut R 2008 *Garnaut climate change review. Final Report*. Commonwealth of Australia.

Government of Victoria 2008. *Draft Northern Region Sustainable Water Strategy*. Department of Sustainability and Environment.

IPCC 2000 *Emissions Scenarios A Special Report of IPCC Working Group III*. Intergovernmental Panel on Climate Change.

IPCC 2007 *Summary for Policymakers*. In Parry *et al.* [eds] *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK pp7-22.

SEACI 2007 South East Australia Climate Initiative. Climate variability and climate change in South East Australia. Murray-Darling Basin Commission.

<http://www.mdbc.gov.au/subs/seaci/docs/factsheets/SEACIfactsheet-climate.pdf>

Mendis S, Mills S and Yantz J 2003. Building community capacity to adapt to climate change in resource-based communities. Prepared for the Prince Albert Model Forest, Canada. August 2003.

Moira Shire 2009 *Council plan 2009/10-2012/13*. Moira Shire.

Sinclair Knight Merz 2009a Preparing for climate change in the Shires of Campaspe and Moira. Moira Shire discussion paper. Consulting report for Shires of Campaspe and Moira. Project VW04560.

Sinclair Knight Merz 2009b Preparing for climate change in the Shires of Campaspe and Moira. Moira Shire discussion paper. Consulting report for Shires of Campaspe and Moira. Project VW04560.

Sinclair Knight Merz 2009c Preparing for climate change in the Shire of Campaspe. Adaptation Action Plan. Consulting report for Shires of Campaspe and Moira. Project VW04560.

Smit B, Pilifosova O, Burton I, Challenger B, Huq S, Klein RJT and Yohe G (2001) Chapter 18 Adapting to climate change in the context of sustainable development and equity. *IPCC Third Assessment Report*. Intergovernmental Panel on Climate Change.

Snover AK, Whitely-Binder LC, Kay J, Sims R, Lopez J, Willmott E, Wyman M, Hentschel M and Strickler A 2008 Preparing for climate change. A guidebook for local, regional and state governments. ICLEI.

Steffen W 2009 *Climate Change 2009. Faster change & more serious risks*. Department of Climate Change.

Appendix A Climate change projections for Moira Shire

A.1 Overview

The IPCC *Fourth Assessment Reports* released in 2007 provides limited detail on Australian climate change, particularly when it comes to regional climate change projections. CSIRO and the Bureau of Meteorology have published climate change projections for Australia (*Climate change in Australia*; CSIRO 2007), based on modelling in support of the IPCC's *Fourth assessment report*. It also builds on a large body of climate research that has been undertaken for the Australian region in recent years. Climate change projections are provided in 250×250 km grid squares, limiting the ability to infer regional impacts, particularly in regions where altitude, distance from the coast, land cover etc vary considerably across the grid squares.

The Department of Sustainability and Environment (DSE) has developed a series of climate change summary documents for each Catchment Management Authority (CMA) region in Victoria. These documents are based on the information provided in CSIRO (2007). Data for Moira Shire may be drawn from reports for the Goulburn Broken and North East CMA regions (DSE, 2008a; 200b).

Quantitative estimates of change (% or amount relative to 1990) from these reports are reproduced here for temperature, rainfall, potential evaporation, wind speed, relative humidity and solar radiation, as an average for the Goulburn Broken and North East CMA regions (Table 5) and for the nearby city of Benalla (Table 6). Climate change projections for towns are provided for frosts, frequency of rainy and hot days and for rainfall intensity.

Change factors in the DSE reports have been used to adjust local temperature and rainfall records for Tocumwal (across the Murray River from Cobram).

■ **Table 5 Climate change scenarios for Moira Shire 2030 and 2070 (from DSE 2008a; 2008b) – impacts on averages**

Variable	2070		
	2030 Medium emissions	2070 Lower emissions	2070 Higher emissions
Annual average temperature	+0.9°C (0.6 to 1.2°C)	+1.5°C (1.0 to 2.0°C)	+2.9°C (1.9 to 4.0°C)
Seasonal average temperature	summer	+1°C (0.7 to 1.5°C)	+3.2°C (2.1 to 4.7°C)
	autumn	+0.9°C (0.5 to 1.3°C)	+2.8°C (1.8 to 4.1°C)
	winter	+0.7°C (0.4 to 1.0°C)	+2.2°C (1.5 to 3.3°C)
	spring	+0.9°C (0.6 to 1.4°C)	+3.0°C (1.9 to 4.4°C)
Annual average rainfall	-3% (-9 to +2%)	-6% (-14 to +2%)	-10% (-25 to +5%)
Seasonal average rainfall	summer	-1% (-10 to +9%)	-3% (-26 to +28%)
	autumn	-2% (-9 to +6%)	-5% (-26 to +20%)
	winter	-4% (-13 to +2%)	-13% (-32 to + 7%)
	spring	-7% (-17 to +2%)	-20% (-44 to +6%)
Annual average potential evaporation	+3% (+1 to 5%)	+5% (+1 to +8%)	+9% (+2 to +16%)
seasonal average potential evaporation	summer	+3% (0 to +5%)	+8% (0 to +16%)
	autumn	+4% (+1 to +5%)	+13% (+2 to +16%)
	winter	+9% (-1 to +23%)	+28% (-3 to +76%)
	spring	+2% (-1 to +5%)	+7% (-2 to +16%)
Wind speed (annual average)	-1% (-6 to +4%)	-1% (-10 to +7%)	-2% (-20 to 13%)
Relative humidity (annual average)	-0.7% (-1.5 to 0%)	-1.2% (-2.4 to 0%)	-2.3% (-4.7 to 0%)

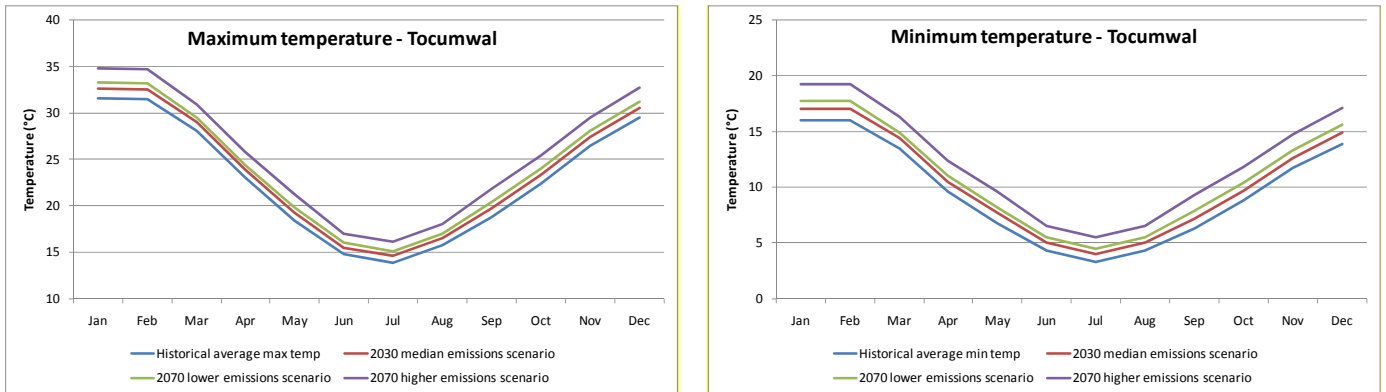
■ **Table 6 Climate change scenarios for Benalla 2030 and 2070 (from DSE 2008a) – impacts on extremes***

variable	2070		
	2030 Medium emissions	2070 Lower emissions	2070 Higher emissions
Frosts	-11 days/yr	-18 days/yr	-29 days/yr
Days over 30 degrees	+9 days/yr	+18 days/yr	+37 days/yr
Days over 35 decrease	+ 5 days/yr	+10 days/yr	+23 days/yr
Days over 40 degrees	+1 day/yr	+2 days/yr	+5 days/yr
Annual average rainfall intensity	+ 0.9%	+ 3.2%	+6.1%
Annual average number of rain days	-5%	-8%	-16%

* note the median change of the 23 models is reported here for ranges refer to DSE 2008a

A.2 Temperature

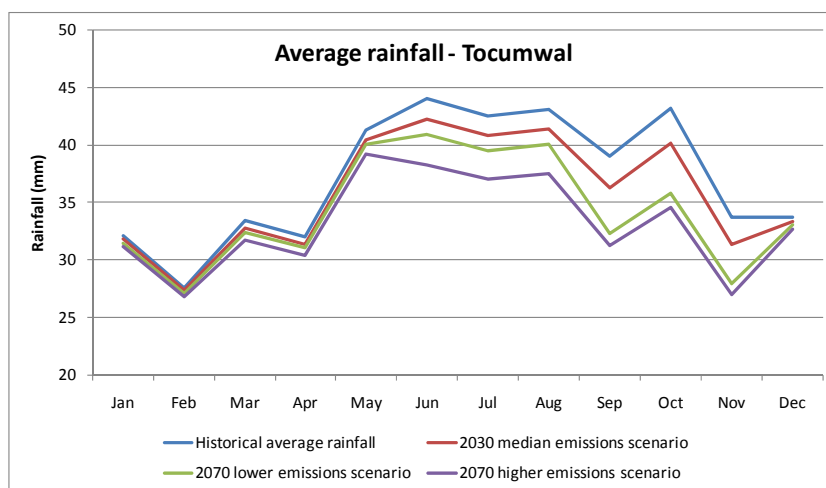
The shire is likely to become warmer, with more hot days (over 30°C) and fewer frosts. Days are projected to be hotter over all seasons, with the greatest warming in summer and the least in winter. Current and projected future temperature regimes of the two shires are similar. Figure 7 and show current and projected maximum and minimum temperatures by 2030 and 2070 for Tocumwal.



- **Figure 7 Current and projected (2030 and 2070) maximum and minimum temperatures for Tocumwal**

A.3 Rainfall

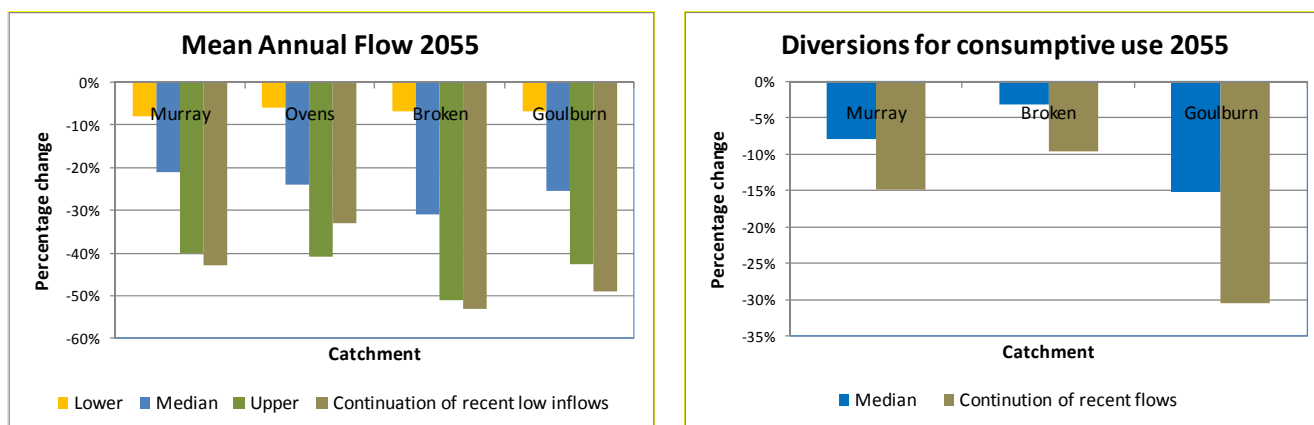
It is projected that rainfall will decrease in all seasons. This decrease is expected to be the greatest in spring and winter, while smaller decreases are expected in summer and autumn (Figure 8). This contrasts with recent climate experience in which dry conditions have been characterised by reduced autumn rainfall. Rainfall intensity is projected to increase, while the number of rain days is expected to decrease.



- **Figure 8 Current and projected (2030 and 2070) rainfall for Tocumwal follows an almost identical pattern.**

A.4 Stream flows

Reductions in annual and seasonal rainfall are projected to lead to reduced streamflows across the riverine plains of northern Victoria. This will lead to reduced irrigation allocations and diversions (Figure 9; data taken from the *Draft Northern Victorian Sustainable Water Strategy*; Government of Victoria, 2008). Reductions in streamflow since the start of 1997 are more severe for than is projected for the 2055 high emissions scenario for some of the major river systems.



- Figure 9 Changes in mean annual flow and water diversions for consumptive use relative to the historical average with projected climate change and in response to the dry period from 1997. Climate change projections for 2055 under low, median and high emissions scenarios. Data adapted from the *Northern Region Sustainable Water Strategy*.**

A.5 Potential evaporation

Potential evaporation is projected to increase across all seasons, with the most significant change occurring in winter. Lower rainfalls and higher evaporation rates will result in less soil moisture and lower river flow.

A.6 Wind speed

Wind speed is projected to decrease in all seasons except winter where a minor increase is projected.

A.7 Extreme weather

The occurrence of extreme weather events are likely to increase as a result of climate change. Moira Shire is likely to experience an increase in the occurrence of extreme daily rainfall under climate change. The average number of days per year with very high or extreme fire danger is also predicted to increase.