

Pilot Water Sector Climate Change Adaptation Action Plan



Over recent decades Victoria's climate has become drier and warmer. The recent Millennium Drought was the worst drought on record in south-east Australia.

Add to that a population forecast to grow from 6 million in 2018 to 10 million by 2050 and it is clear we must do more with less.

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Aboriginal acknowledgment

The Victorian Government proudly acknowledges Victoria's Aboriginal community and their rich culture, and pays respect to their Elders past and present. We acknowledge Aboriginal people as Australia's first peoples and as the Traditional Owners and custodians of the land and water on which we rely. We recognise and value the ongoing contribution of Aboriginal people and communities to Victorian life and how this enriches us. We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

The Minister for Water

Water is a vital resource. Government, communities, business and industry, must manage it effectively for current and future generations, particularly in the face of climate change and population growth.

Victoria's climate is already becoming drier and warmer. The south-east Australian Millennium Drought was the State's worst on record. Stream flows dropped to record lows with water restrictions implemented in 457 Victorian towns – half of these restrictions were severe.

More severe droughts are expected in future, with stream flows in some Victorian catchments projected to drop by approximately 50% by 2065. We are likely to see further impacts as global temperatures rise including:

- more intense rainfall, which may cause more floods and sewer overflows
- warmer water temperatures, increasing the potential for water-borne pathogen growth
- more frequent and intense fires, which will affect our water catchments.

Climate change could threaten water sector infrastructure, the people who work in the sector and the services Victorian communities require.

Add to that a population forecast to grow from 6 million in 2018 to 10 million by 2050 and it is clear we must do more with less.

The Victorian Government is driving our transition to a climate resilient community and economy with net zero emissions by 2050. The water sector is leading this transition with a commitment to reduce greenhouse gas emissions by 42% by 2025.

Leading climate change adaptation across the State's water systems, which include sewerage, drainage and flood management, is an important action in *Water for Victoria*, our long-term plan for effective water sector management.

To succeed, we need to begin adapting now. The infrastructure we build today could still be in use in 70 years,

when climatic conditions will likely be very different.

Acting now will reduce long-term costs. Planning appropriately for climate change and managing the water sector accordingly will reduce the need for expensive retro-fits and help us avoid building infrastructure that can't fully function as the climate changes. It also means Victoria will be better placed to deal with more extreme weather events.

The Pilot Water Sector Adaptation Action Plan aims to drive adaptation across the water sector. Under the *Climate Change Act 2017*, a legislated plan is required by 2021. We have prepared this pilot plan ahead of schedule to ensure the community and the water sector responsible for drainage, sewerage and flood management, are involved in planning for a system that adapts effectively in the face of climate change. It will also help us determine the scale of work required. What we learn from this pilot plan will be built into the legislated Adaptation Action Plan in 2021.

This pilot plan outlines possible climate change scenarios, the actions already taken to address the potential climate change impacts and implications, what we still need to do, and the priority actions needed to put the sector on the right track to a resilient water future for Victoria.

Planning now means Victorians can participate in determining how our water sector will evolve in the face of climate change. It also means we are more likely to successfully adapt so current and future generations of Victorians receive safe, affordable and reliable water, sewerage, drainage and flood management services with minimal negative impacts on our environment as the climate changes, just as previous generations provided for us.



The Hon. Lisa Neville MP
Minister for Water



Water is a vital resource. Government, communities, business and industry, must manage it effectively for current and future generations.

Executive summary

Equipped with the most up-to-date understanding of climate change and associated impacts, Victoria's water sector is committed to providing leadership in the State's climate change mitigation and adaptation.

This pilot Water Sector Climate Change Adaptation Action Plan (WSAAP) has been prepared in response to the current and potential future impacts of climate change on the water sector, its customers, and the Victorian community.

Climate Change Act 2017

Victoria's *Climate Change Act 2017* (the Act) places a statutory obligation on nominated Ministers to prepare sector-based Adaptation Action Plans (AAPs) for seven different 'systems' by 2021.

The 'water cycle system', referred to herein as the 'water sector', is identified in the Act as requiring an AAP. The scope covers all sources of water, sewerage services, drainage services, and flood management services. Waterway health, biodiversity, ecology and agriculture are out of scope and form parts of other system AAPs.

Water Sector Climate Change Adaptation Action Plan

This WSAAP is a pilot, prepared three years ahead of the first legislated AAPs. The purpose is to test the process of developing an AAP, and to develop actions that provide water sector customers with reliable services under an increasingly challenging climate. It reviews the adaptation activities already underway and plans new actions to address gaps in our adaptation program.

Actions undertaken between now and 2021 will build a firm foundation for future actions to ensure that we have a climate change-resilient water sector.

This WSAAP has been developed in close collaboration with representatives from water corporations, catchment management authorities (CMAs) and local government, who each manage parts of the water sector.

Public consultation has recently been undertaken to inform the climate change elements of *Water for Victoria* (2016). Therefore consultation on the WSAAP has focused on the water sector organisations, industry bodies and interest groups. A more extensive public consultation phase will be undertaken to inform the development of the first legislated WSAAP due by 2021.

Climate change and the water sector

Variability has always been a feature of Victoria's climate, from drought through to flood events. Large storage dams, water markets and catchment management processes are just some of the features of Victoria's water system that have been set up to manage this variability.

However, more recently the water sector has observed changes in climate, and built climate change preparedness into its management. This is in part a result of the seriousness of the impacts experienced during the Millennium Drought (1997 to 2009). The 13 consecutive years of drought had a significant impact on water supplies for households, businesses, agriculture and the environment.

There were also three associated large fires – in 2003, 2006 and 2009 – all of which also affected Victoria's catchments and water supplies. The drought broke in 2010 with one of the largest flood events ever recorded. There have also been significant water quality impacts from pest animals, weeds, runoff from fires, erosion and land use change.

Such conditions and events are anticipated to become more frequent and severe with climate change, bringing increased threats to water quality and recreational and environmental values. Figure A depicts potential impacts of climate change on the water sector.

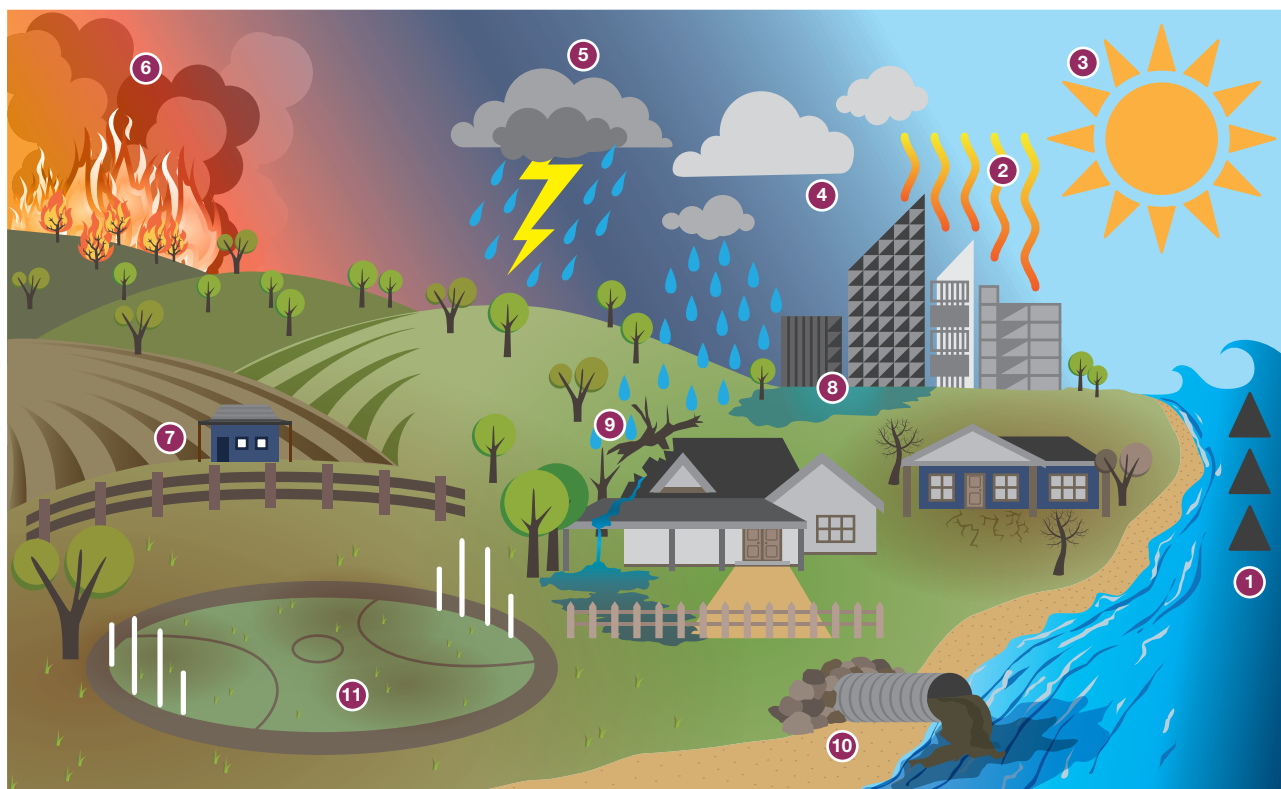
Adaptation underway

Water for Victoria set a long-term plan to prepare for and respond to climate change. In addition, Victoria's water corporations will spend about \$1.2 billion per year over the next three years on water and sewerage infrastructure to deliver reliable services to Victoria's growing population.

The infrastructure programs have been informed by projections of population growth and climate change. Local governments in Victoria are estimated¹ to own and manage over 35,000 km of stormwater pipes and 1.4 million stormwater pits, with an estimated replacement value of \$11 billion. They are actively investing in integrated water management solutions.

Victoria's water sector is now leading the State's response to climate change in both adaptation and greenhouse gas emissions reduction, and has committed to a 42% reduction in greenhouse gas emissions by 2025. The intersection between adaptation and emissions reduction is actively considered in the water sector, where activities such as revegetation can benefit both adaptation and mitigation.

Figure A. Impacts of climate change on the water sector



Legend:

- | | | |
|---------------------------|---|--|
| 1. Sea level rises | 6. More frequent bushfires | 10. Heavier rainfall may lead to sewer overflows, impacting receiving waters |
| 2. More heat waves | 7. More frequent and severe droughts | 11. Limited access to water for agriculture, parks, gardens and recreation areas during drought. |
| 3. Temperature increases | 8. More frequent and extreme flash flooding | |
| 4. Lower average rainfall | 9. More frequent and severe storms | |
| 5. More intense storms | | |

¹ Data provided by Municipal Association of Victoria (pers. comm. 2018) is indicative only, as some councils were unable to provide data and some estimates were made. The data is based on 2014, and was then escalated to account for growth and CPI increases up to end of 2017. The results also do not include Melbourne City Council.

Proposed adaptation actions

This WSAAP commits to 20 further actions to deliver more resilient services to water sector customers. The actions will be cost effective in leveraging existing investments, research and expertise, while having a minimal impact on greenhouse gas emissions.

They address the three short-term objectives of this WSAAP:

- 1 Build knowledge of how climate change will impact Victoria's water sector;
- 2 Develop the frameworks, policy and tools to enable successful adaptation; and
- 3 Enhance the capability and capacity of water sector staff to apply climate change adaptation to business decisions.

The actions will be delivered by DELWP in partnership with water sector organisations. An adaptive planning cycle is in train and will inform adaptation in the sector across successive WSAAPs.

Figure B. The policy objectives of the Act informed the WSAAP's objectives and adaptation actions.

WSAAP Objective 1: Build knowledge

Action 1: Undertake a water grid stress test

Action 2: Understand implications of more intense rainfall in combination with overall drier conditions, for flooding

Action 3: Consider the changing sewerage, drainage and flood management risks under climate change in Integrated Water Management Forums

Action 4: Encourage the use of best practice methods to incorporate climate change into the estimation of future flood impacts

Action 5: Identify the impact of climate change on Traditional Owner values associated with water and how to adapt to them

Action 6: Collate and share knowledge about the impact of climate change on water supply between water sector stakeholders

Action 7: Collate and share knowledge about the impact of climate change on sewerage

Action 8: Improve information sources on adaptation for the water industry



WSAAP Objective 2: Develop frameworks, policy and tools

Action 9: Review the Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria

Action 10: Develop a framework to inform consistent and systematic embedment of climate change considerations into water business decisions

Action 11: Develop a monitoring, evaluation, reporting and improvement plan

Action 12: Review the use of climate change scenarios in water sector planning

WSAAP Objective 3: Enhance the capability and capacity of water sector staff

Action 13: Review emergency management plans used in the water sector in the context of climate change

Action 14: Review and update workforce emergency management capability, capacity and training requirements

Action 15: Identify and manage key risks between water and other critical service sectors

Action 16: Identify key elements of successful adaptation business cases

Action 17: Develop and deliver guidance material for water industry boards and executives on climate change risks and duties of care

Action 18: Estimate the costs of climate change to water corporations

Action 19: Improve management of the potential impacts of climate change on water quality relating to algae

Action 20: Prepare guidelines for assessing the impact of climate change on sewerage systems

1. Introduction

1.1. Context

The way our society manages water will need to change in response to the impacts of climate change and population growth. Victoria's water sector is already adapting to more extreme and variable conditions. This has been prompted in part by the Millennium Drought (1997–2009), which was associated with water shortages and several extreme events in Victoria. These events included three large bushfires (in 2003, 2006 and 2009) that affected our catchments in addition to causing devastating loss in our communities. It challenged the water sector to think about how well it was prepared for changing environmental conditions and more extreme natural events, including temperature increases, sea level rise and the potential for more heatwaves, storms, high winds, bushfires, droughts and floods.

However, preparing for and responding to climate change is challenging. Climate change is complex, and it affects different parts of the water sector in different ways. It also affects different regions of Victoria differently. Climate change needs to be considered alongside other pressures on water security such as population growth and changing economic conditions. In reality there are always uncertainties about the future, including future climate, population growth, consumer behaviour, industry and agriculture changes, and technological advancement. There are also multiple objectives for society, industry and the environment – adapting to climate change is only one of them.

Climate change adaptation needs to be undertaken in an iterative process in which we regularly review our assumptions about the future and assess whether the current strategy still holds or needs to be modified. Adaptation decisions need to keep some options open to be deployed if the future is worse than anticipated, but also avoid over-investing in case the future is not exactly as expected. This is known as an adaptive pathways approach, and will be undertaken through the successive WSAAPs developed under the Act.

An understanding of the potential impacts of climate change and how to best manage the threats will be essential for the continued delivery of high quality services to customers. Not all threats can be avoided, but understanding them will be essential to developing effective risk mitigation strategies. Enabling policy, tools and technologies will allow us to better understand issues before they arise, and to take definite steps to reduce impacts on customers.

This WSAAP will help the water sector to further embed climate change considerations into planning, design and operations. It is an opportunity for Government and water sector organisations to partner and build on the initiatives in *Water for Victoria*, and keep the sector at the leading edge of climate change adaptation planning. As noted above, such adaptation is an iterative process that will require ongoing review and action.

1.2. Objectives

The objectives for this WSAAP are consistent with the direction set out in *Water for Victoria* and in Victoria's *Climate Change Adaptation Plan 2017–2020*. The actions in the WSAAP will help to achieve the short-term objectives as well as achieve progress towards the medium- and long-term objectives.

Short-term objectives (by 2021)

The short-term objectives of this WSAAP are to:

1. build knowledge of how climate change will impact Victoria's water sector;
2. develop the frameworks, policy and tools to enable successful adaptation; and
3. enhance the capability and capacity of water sector staff to apply climate change adaptation to business decisions.

Medium-term objective (by 2025)

The medium-term objective is to integrate climate change adaptation considerations into all relevant business decisions in the water sector.

This objective will require a coordinated and systematic approach to climate change adaptation, supporting and linking with key business systems and processes.

Long-term objective (by 2030)

The long-term objective is to enable the sector to provide reliable services that meet customer expectations under a changing climate, while balancing the associated impacts on customer bills, on water business finances, and on the environment.

This may include consultation with customers about ongoing levels of service, for cases in which customers feel that continuation of the current levels of service has an undue cost or environmental impact.

Table 1.1: Objectives of the WSAAP and the timeframe for each

Objectives		Timeframe
Short-term	1 Build knowledge of how climate change will impact the Victorian water sector	2018–2020
	2 Develop the frameworks, policy and tools to enable successful adaptation in the water sector	2018–2020
	3 Enhance the capability and capacity of water sector staff to apply climate change adaptation to business decisions	2018–2020
Medium-term	Integrate climate change adaptation into all relevant business decisions in the water sector	By 2025
Long-term	The water sector continues to provide reliable services to customers under a changing climate, while appropriately balancing the associated impacts on customer bills and on water business finances and on the environment	By 2030

1.3. Legislation and policy

Climate Change Act 2017

Adaptation Action Plans: background and requirements

The Act introduced system-based planning for climate change adaptation. Under the Act, Adaptation Action Plans (AAPs) are required to be developed every five years from 2021 for systems that are essential or vulnerable to the inevitable impacts of climate change and are therefore a priority for the State Government. The seven systems are:

1. Built environment
2. Education and training
3. Health and human services
4. Natural environment
5. Primary production
6. Transport
7. Water cycle system (referred to herein as the 'water sector')

The Act requires AAPs to be developed in the year following the release of the Act's five-yearly *Climate Change Strategy* (due by 31 October 2020), which will set out a statement of priorities to which the AAPs must be aligned. The first legislated AAPs are required to be prepared by 2021.

However, in *Victoria's Climate Change Adaptation Plan 2017–2020*, the Victorian Government committed to develop pilot AAPs for the water sector, primary production system and health and human services system during the period 2017–2020. The development of pilot AAPs will test the AAP model, provide a learning opportunity for the Government and smooth the path for the delivery of the legislated AAPs from 2021. The Victorian Government selected the water sector as the subject of one of the pilot AAPs to help coordinate and monitor existing adaptation activities in the sector, build on the initiatives in *Water for Victoria*, and help Victoria's water sector to remain at the leading edge of climate change adaptation planning.

The Act requires that all AAPs include:

1. A statement of the roles and responsibilities of the Government and other bodies in relation to the water sector.
2. An assessment of the extent to which existing Victorian Government water policies address priorities of the relevant climate change strategy.
3. A list of further actions required over the next five years that address any gaps between existing water policies of the climate change strategy.

This WSAAP addresses these three requirements through Sections 3, 4 and 5 respectively. As the timeframe for this pilot WSAAP is shorter than the future legislated WSAAPs, the actions are set for implementation over the next three years (2018–2020), rather than the five years required by the Act.

Statement of priorities

The Act requires AAPs to be developed in the year following the release of the Act's five-yearly *Climate Change Strategy*, the first of which is due by 31 October 2020. The *Climate Change Strategy* will set out a Statement of Priorities, against which all AAPs must align. As this pilot WSAAP has been prepared ahead of the *Climate Change Strategy*, there is currently no Statement of Priorities with which to align this WSAAP. Instead, this WSAAP responds to both the Act and *Victoria's Climate Change Adaptation Plan 2017–2020*. The 2021 WSAAP will align with the Statement of Priorities in the *Climate Change Strategy 2020*.

Policy objectives

The Act includes five key objectives, of which objectives 2, 3 and 5 are addressed in this WSAAP.

Table 1.2: Three objectives of the Act are addressed by the WSAAP

Objective from the Act	Included in this WSAAP
1 Reduce the State's greenhouse gas emissions consistent with the long-term emissions reduction target and interim emissions reduction targets.	✗
2 Build the resilience of the State's infrastructure, built environment and communities through effective adaptation and disaster preparedness action.	✓
3 Manage the State's natural resources, ecosystems and biodiversity to promote their resilience.	✓
4 Promote and support the State's regions, industries and communities to adjust to the changes involved in the transition to a net zero greenhouse gas emissions economy, including capturing new opportunities and addressing any impacts arising from the need to reduce greenhouse gas emissions across the economy.	✗
5 Support vulnerable communities and promote social justice and intergenerational equity.	✓

Although the third objective is addressed in this WSAAP, ecosystems and biodiversity are out of its scope. Note also that the first and fourth objectives are being addressed through the water corporations' commitment to reduce greenhouse gas emissions by 42% by 2025. In addition, the Victorian Government is working with local governments, business and other partners to deliver a comprehensive set of actions to reduce emissions, build the resilience of business and the community, and transition to a net-zero emissions economy. While neither is a focus of this WSAAP, the first objective is relevant in that the development of adaptation actions should not increase emissions, wherever possible. The greenhouse gas emissions footprints of all actions proposed in the WSAAP are in Appendix 4.

Guiding principles

The Act also contains six high level principles that must be used in any decision made by the Government, and in any policy, program or process developed or implemented. These are shown below and in Table 1.3:

1. Informed decision-making –

Actions should be based on a comprehensive analysis of the best practicably available information about the potential impacts of climate change. Actions should consider the potential contribution to the State's greenhouse gas emissions.

2. Principle of integrated decision-making –

Actions should integrate the competing long-term, medium-term and short-term environmental, economic, health and other social considerations relating to climate change to ensure that all relevant issues are taken into consideration, there is a proper examination of all the issues, and any actions are cost effective.

3. Risk management –

Actions should be based on an assessment of the likelihood, consequence and risks of climate change. It is a guiding principle of the Act that a lack of full scientific certainty should not be used as a reason to postpone the taking of action.

4. Equity –

Actions should create opportunities for the present and future generations to increase their capacities to adapt to climate change, particularly the capacities of those people most vulnerable to the potential impacts of climate change.

5. Community engagement –

Actions should include providing appropriate information and opportunities to the community. Actions should be developed with adequate consultation with the community.

6. Compatibility –

Actions should seek to promote a coherent policy framework within the State and seek to achieve cohesion with the climate change actions of other States, the Commonwealth, other countries and international bodies.

These principles have also been considered in the development of this pilot WSAAP. Community engagement specifically for this pilot WSAAP has been focused on industry and interest groups and researchers. Broader public consultation has not been undertaken. Community engagement on climate change has also been addressed through the consultation undertaken for policy documents such as *Water for Victoria*. The water sector organisations regularly consult their customers about their climate change activities. A draft of the legislated WSAAP in 2021 will be released for public comment.

The Act also contains six high level principles that must be used in any decision made by the Government, and in any policy, program or process developed or implemented.

Table 1.3. How the objectives of this WSAAP relate to the guiding principles of the Act.

Guiding principle	Objectives of this WSAAP		
	1 – Build knowledge	2 – Develop frameworks, policy and tools	3 – Enhance staff capability and capacity
1 Informed decision-making	✓	✓	✓
2 Principle of integrated decision-making	✓		✓
3 Risk management	✓	✓	✓
4 Equity	✓	✓	✓
5 Community engagement	✓		
6 Compatibility		✓	

Victoria's Climate Change Adaptation Plan 2017–2020

Victoria's Climate Change Adaptation Plan 2017–2020 sets the following priorities to:

- More effectively manage risks to the Government's assets and services from climate change.
- Help the community to understand and manage the risks and potential impacts of climate change.
- Encourage adaptation action across all policy areas and sectors of the economy.

This WSAAP addresses the first and the third of these priorities for the water sector, and notes that each of the water sector agencies already has their own community engagement program which covers a variety of topics such as adapting to water shortage and floods. There will be opportunity to address the second priority in the legislated WSAAP, due in 2021.

Water for Victoria

Water for Victoria was prepared by the Victorian government in 2016 as the water sector's strategic forward-looking policy document. *Water for Victoria* has set a long-term plan for the water sector that includes preparing for and responding to climate change. According to *Water for Victoria*, "the water sector will lead climate change adaptation actions" arising from *Victoria's Climate Change Adaptation Plan 2017–2020* and the Act.

Water for Victoria addresses five key values of water that are important to the community:

- **Chapter 3** – Waterway and catchment health
- **Chapter 4** – Water for agriculture
- **Chapter 5** – Resilient and liveable cities and towns
- **Chapter 6** – Recognising and managing for Aboriginal values
- **Chapter 7** – Recognising recreational values






This WSAAP focuses on how the water sector should adapt to protect resilient and liveable cities and towns (*Water for Victoria* Chapter 5), Aboriginal values (*Water for Victoria* Chapter 6) and recreational values (*Water for Victoria* Chapter 7) as well as improving emergency management capability, which is in *Water for Victoria* Chapter 10: Jobs, economy and innovation. While aspects of waterway and catchment health (*Water for Victoria* Chapter 3) and water for agriculture (*Water for Victoria* Chapter 4) are part of the broader context for this WSAAP, they are addressed in detail through other AAPs.

1.4. Scope

Defining the water sector

The Act defines the water sector, which is referred to in the Act as the 'water cycle system', as water supply, sewerage, drainage and flood management. Therefore, this WSAAP focuses on these elements of the water sector, and the relevant uses and values set out in *Water for Victoria* (Table 1.4).


Table 1.4. Elements of the water sector that are addressed in this WSAAP.

Definition in the Act	How this has been interpreted and considered in this WSAAP
Water Supply	
 <p>The collection, storage, treatment, delivery and supply of water, including recycled water.</p>	<ul style="list-style-type: none"> • All sources of water including recycled water and alternative sources • Availability and allocation of water for consumptive (urban, agricultural and industrial), environmental, recreation and cultural uses • Water quality of all water sources used for consumptive purposes
Sewerage	
 <p>Sewerage services, including the collection, treatment and disposal of wastewater through sewerage systems and wastewater treatment plants.</p>	<ul style="list-style-type: none"> • Sewage transport, pumping and treatment • Sewage quality • Recycled water treatment and quality • Sewerage assets, their planning, operations and management
Drainage	
 <p>Drainage services, including the operation of drainage systems.</p>	<ul style="list-style-type: none"> • Nuisance inundation in urban and rural drainage schemes
Flood management	
 <p>Flood management services, including the operation and maintenance of infrastructure to mitigate floods.</p>	<ul style="list-style-type: none"> • Overland flooding and riverine flooding • Sea level rise, storm surge and coastal flooding
Common issues	
 <p><i>Common issues are not defined in the Act, but have been addressed in development of the WSAAP to meet the Act's policy objectives and guiding principles.</i></p>	<ul style="list-style-type: none"> • Adaptation to extreme events as well as long-term changes. • Decision-making under uncertainty. • Built assets, their design, management, operation, renewal and replacement. • Financial, risk, legal, insurance, reputational and regulatory compliance issues. • Water sector contribution to urban liveability. • Community engagement. • Internal culture, business engagement and capability around adaptation.

Relationship to other 'systems'

This WSAAP is closely related to other systems including the natural environment, primary production, the built environment, and health and human services.

Figure 1.5. The definitions of the water sector AAP and other system AAPs in the Act (top line), and how each is expected to incorporate water-related topics.



Water	Primary production	Natural environment	Built environment	Health & human services	Education & training	Transport
Defined as the collection, storage, treatment, delivery and supply of all water sources, sewerage, drainage services, and flood management services.	Defined as (a) the growing and cultivation of horticultural and other crops, including plantation forestry and farm forestry; and (b) the controlled breeding, raising or farming of animals, and the infrastructure, workforce and communities supporting (a) and (b).	Defined as land, water over that land, and the soils and biodiversity associated with that land; coastal water and the land under those waters, and the ecological processes and systems associated with the things set out above.	Defined as the places and structures built or developed for human occupations, use and enjoyment, including cities, buildings, urban spaces, housing and infrastructure, and how people interact with that system.	Defined as the services and assets primarily engaged in protecting human health from disease resulting from or associated with communicable disease, food, water or the environment; and the services and assets which provide human physical and mental health care, social support and assistance.	Defined as the services and assets primarily engaged in the planning, development, provision and support of education and training, including future workplace skills and needs.	Defined as all the components for the movement of persons and goods, including (a) physical components, including transport networks, facilities and vehicles and (b) services components, including passenger, freight and other transport services to move persons and goods.
Includes sea level rise and storm surge impacts on water sector assets; integrated water management.	On-farm use of water, water quality and water efficiency measures; impact of water availability on irrigated farmers and their communities	Waterway health, biodiversity and ecology; naturally occurring wetlands; the benefits of environmental water; land management	Sea level rise and storm surge impacts on places and structures not owned by the water sector	Regulation of drinking water quality; public health benefit that comes from irrigated recreation and sports fields; supply of water to communities in an emergency	Public education on climate change	Flooding and drainage implications of transport infrastructure design
These topics are all relevant to the water sector, but are expected to be addressed through the other system AAPs						
	Allocation and supply of water for irrigation, stock and domestic purposes to the farm gate; rural drainage	Allocation and delivery of environmental water; constructed wetlands in an urban environmental	Sea level and storm surge impacts on water sector assets	Management of drinking water quality; use of water for irrigation of public land such as parks, recreational areas and sports fields	Education and training of the water industry staff and customers relating to climate change impacts on water sector services	Management of flooding and drainage infrastructure; operations of water sector assets when transport access is compromised
These topics are all part of the WSAAP, and have relevance to the other systems						

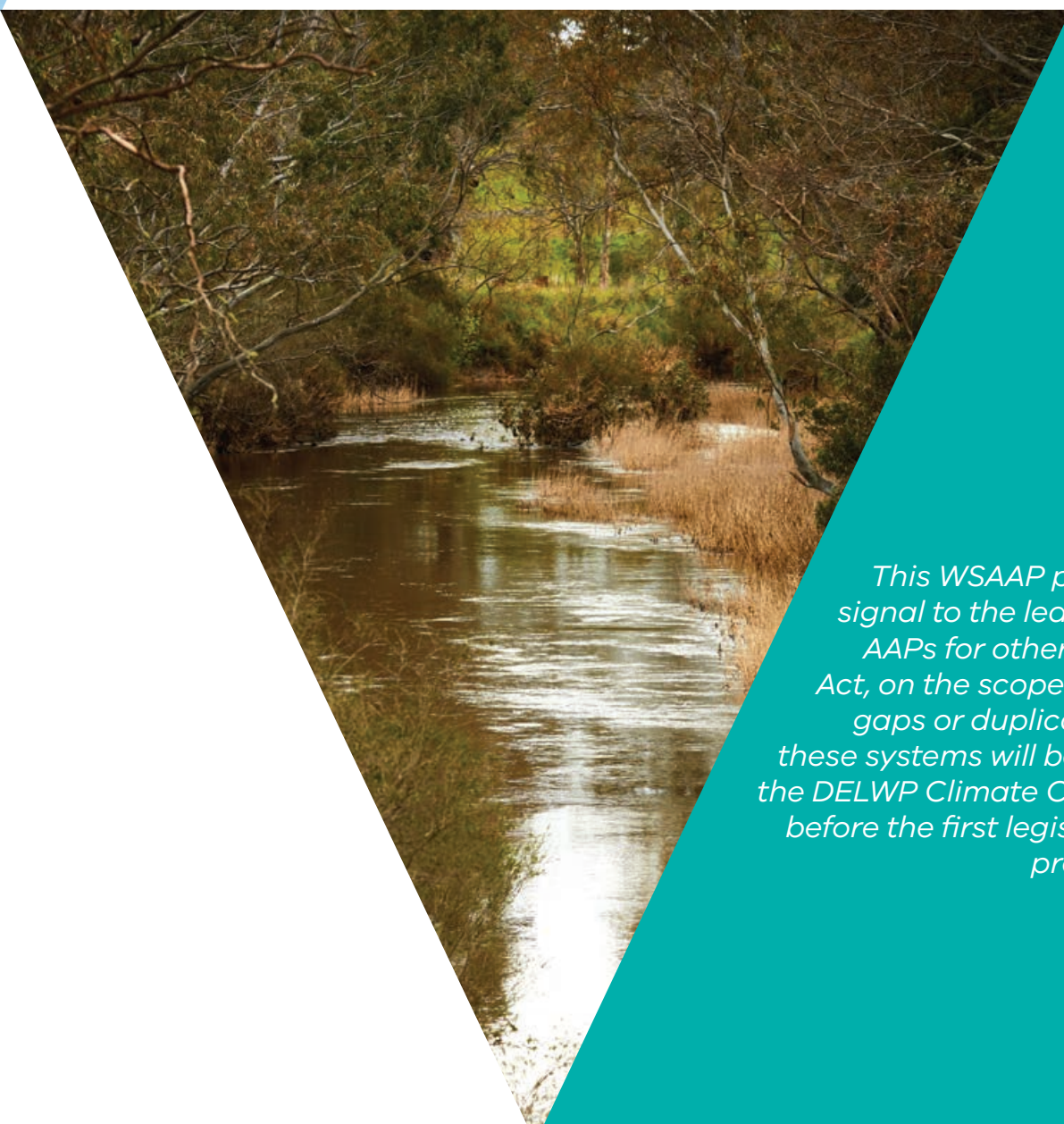
Some potential impacts of climate change impact many systems, such as the coastal impacts of climate change, arising from sea level rise, storm surges and coastal erosion. Another issue common to many or all system AAPs is community consultation, engagement and building a social licence for challenging adaptation decisions. The DELWP Climate Change Policy Division is leading programs to address these overlapping and cross-sector issues. These issues will also be considered in the development of legislated AAPs for 2021.

Some topics are closely related to water but will be covered by other system AAPs. For example:

- The primary production AAP will cover issues relating to on-farm water use. The climate change threats associated with this activity are best considered with other on-farm processes.
- The natural environment AAP is likely to include waterway health, catchment vegetation and rural wetlands on both public and private land. This includes water quantity and quality for environmental, biological and ecological purposes.
- The health and human services AAP and/or the built environment AAP are likely to address the broader issues associated with urban heat and community health through urban design.

The scope and interactions of future AAPs under the Act will be reviewed after the finalisation of the pilot AAPs and before the legislated AAPs are prepared in 2021. Figure 1.5 shows the relationship between the AAPs.

This WSAAP provides a clear signal to the leaders preparing AAPs for other systems in the Act, on the scope of actions. Any gaps or duplications between these systems will be addressed by the DELWP Climate Change Division before the first legislated AAPs are prepared by 2021.



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Photo: Glenelg River.
Photographer Craig Moodie.

2. The climate change challenge

Climate change impacts on the water sector were described in *Water for Victoria*. They include:

- Sea level rise
- Reduced rainfall
- Increased frequency of extreme temperature, rainfall and storms
- Increased average temperatures

2.1 Climate change in Victoria

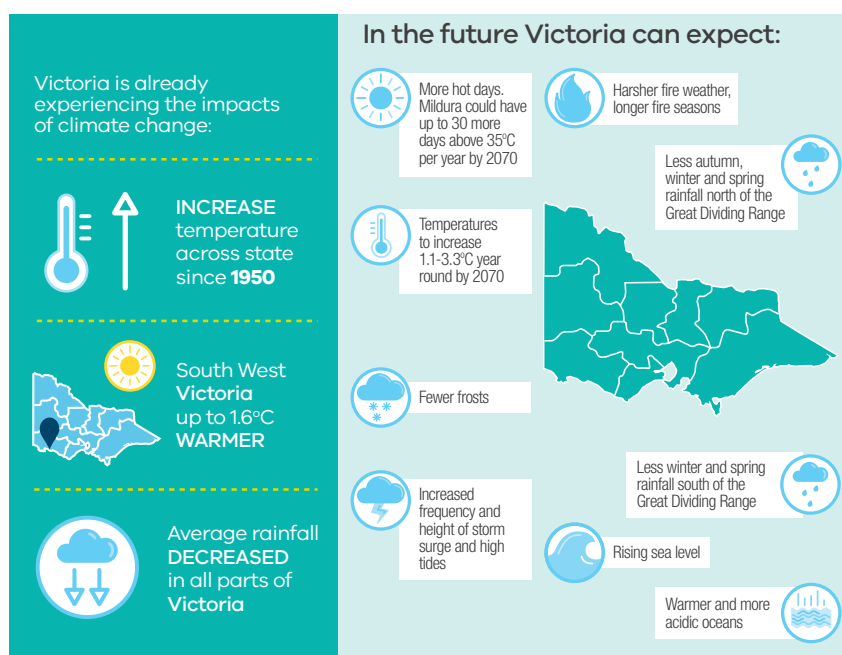
Observed changes

Victoria has already experienced increasing temperatures and decreasing rainfall since the mid-20th century (Figures 2.1 and 2.2.) Average annual rainfall has reduced across all parts of Victoria, since 1950, impacting all our water supply catchments. Temperatures have increased by around 1°C across Victoria and up to 1.6°C in south-west Victoria over the same period (Figure 2.2). Other observed changes include:

- Stream flow in some Victorian rivers has reduced drastically since the mid-1990s in association with the Millennium Drought (Figure 2.3), and some catchments have never returned to their pre-drought yield since the end of the drought.
- Sea level around the coast of Australia has risen by an average of 21 mm per year since the 1960s.²
- Heatwaves in Melbourne occur, on average, 17 days earlier and are 1.5°C hotter than between 1950–1980.³

Figure 2.3 shows that rainfall during the cooler months of the year (April to October) has declined across Victoria. This is particularly significant for water availability as the cooler months are the ones in which the water storages receive most of their inflows. Rainfall during the warmer months of the year is not as effective at filling water storages, as more of the rain that falls is lost in evaporation, uptake by vegetation, and soil wetting. Any increase in rainfall during the warmer months is not expected to compensate for the reductions in rainfall during the cooler months, since rainfall during warmer months does not usually generate sustained inflows to storages.

Figure 2.1. Summary of Victoria's changing climate, showing changes already experienced (left) and likely future changes (right).



² Grose, M. et al., 2015, Southern Slopes Cluster Report, In *Climate Change in Australia: Projections for Australia's Natural Resource Management Regions: Cluster Reports*, eds Ekström, M. et al., CSIRO and Bureau of Meteorology, Australia

³ Steffan W., 2015, *Quantifying the Impact of Climate Change on Extreme Heat in Australia*, Climate Council of Australia

Figure 2.2: Victoria's temperatures have been steadily increasing for decades. This trend is consistent with global temperature trends. Victorian temperature data sourced from Bureau of Meteorology, global temperature data sourced from World Meteorological Organisation.

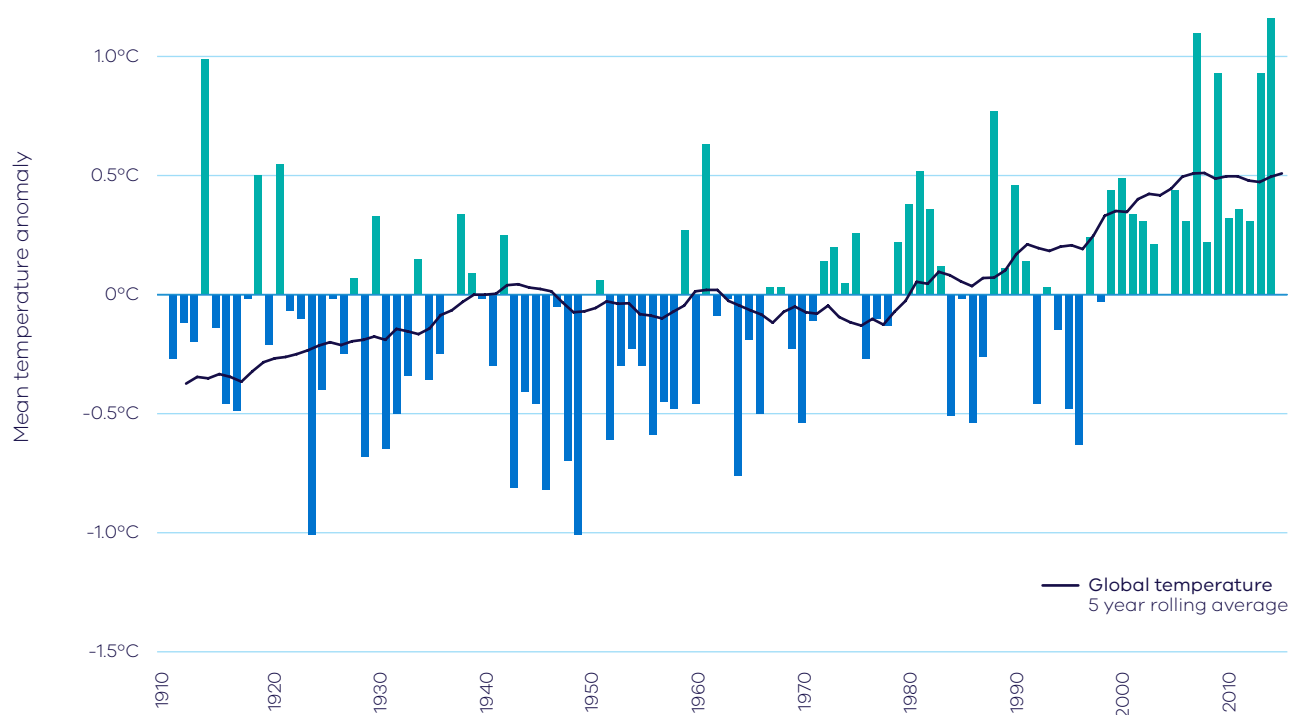
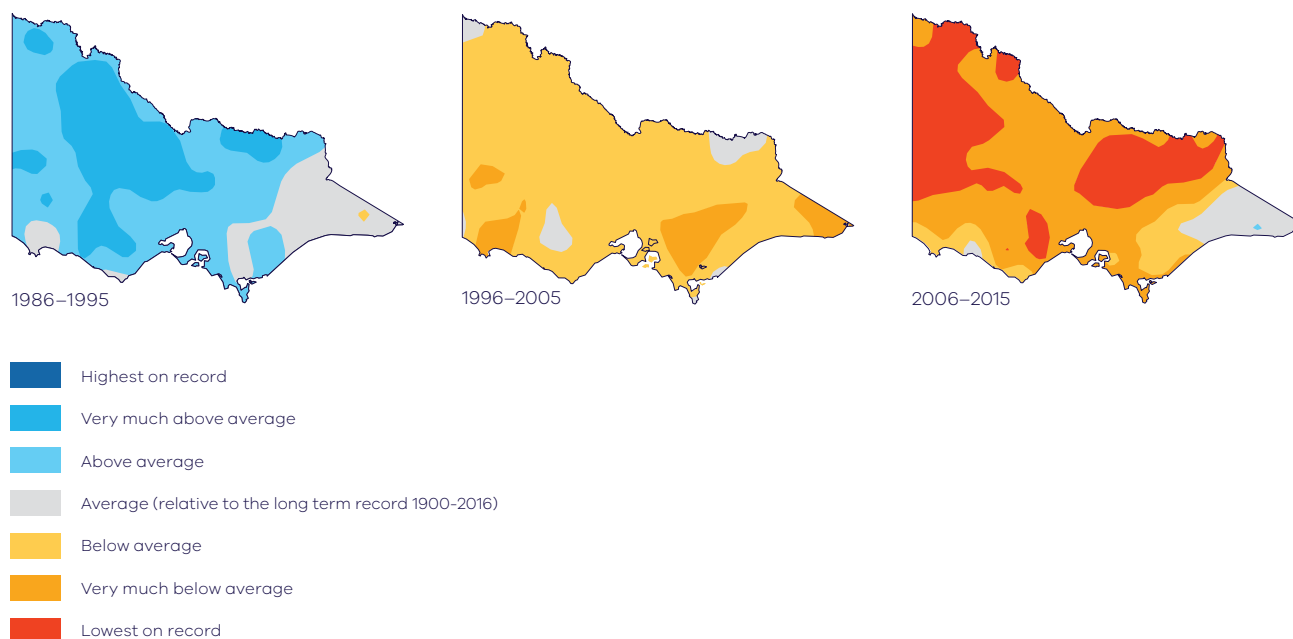


Figure 2.3. Rainfall received during the cooler months of the year (April to October) has declined across Victoria. Data sourced from the Bureau of Meteorology through the Victorian Climate Initiative (VicCI)



Projected changes

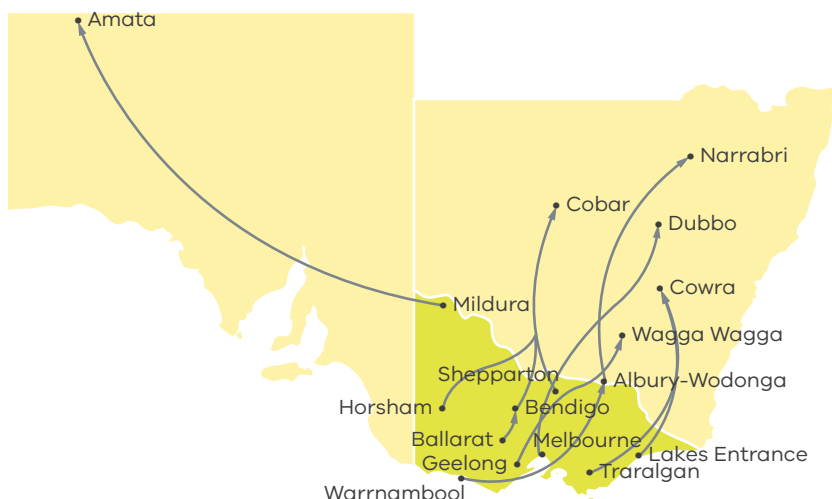
Projections of future global trends in climate are wide-ranging and affected by factors such as carbon emissions and feedback loops. Based on climate modelling, average annual stream flow reductions of around 50% could occur in some catchments by the year 2065 in Victoria⁴. Climate change could also result in more extreme events than in the past.

Climate analogues can illustrate some possible future climates of specific cities and towns by matching their possible future climates to locations that currently have similar rainfall and temperature. Figure 2.4 shows plausible analogue cities for Victoria under a 4°C warming scenario, which may be experienced around 2100 under a high greenhouse gas emissions trajectory. It highlights that changes in temperature and rainfall will be different in different parts of Victoria, and so will the likely threats of climate change.

Most of Victoria's water sources are climate-dependent, so planning for a range of future climate change scenarios is important.

Figure 2.4. Some plausible future climates of Victorian cities and towns, matched with the current climate (comparing annual temperature and rainfall settings) experienced in another location (climate analogues), for a world that is 4°C warmer than pre-industrial.

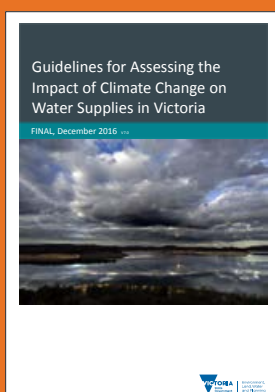
For example, Melbourne's future climate is anticipated to be similar to the current climate of Dubbo in New South Wales. There is uncertainty around future emissions as well as their impact on future climate, which mean that other future scenarios with more extreme climate change, or less extreme change, are also very plausible. This map also shows one point in time, after which the climate will still continue changing. (Independent Expert Panel on Interim Targets, *'Issues paper: Independent Expert Panel: Interim Emissions Reduction Targets for Victoria (2021-2030)'*, DELWP (2017))



DELWP's *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria* can inform many potential future climate change scenarios to enable water sector staff to make better decisions regarding supply of water resources. These guidelines can also help DELWP and the water sector manage for the range of potential climatic changes.

⁴ Potter, N.J., Chiew, F.H.S., Zheng, H., Ekström, M. and Zhang, L. 2016. Hydroclimate projections for Victoria at 2040 and 2065. CSIRO publishing, 58 pp. <https://publications.csiro.au/rpr/pub?pid=csiro:EP161427>

Putting Climate Science into Practice – *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria*



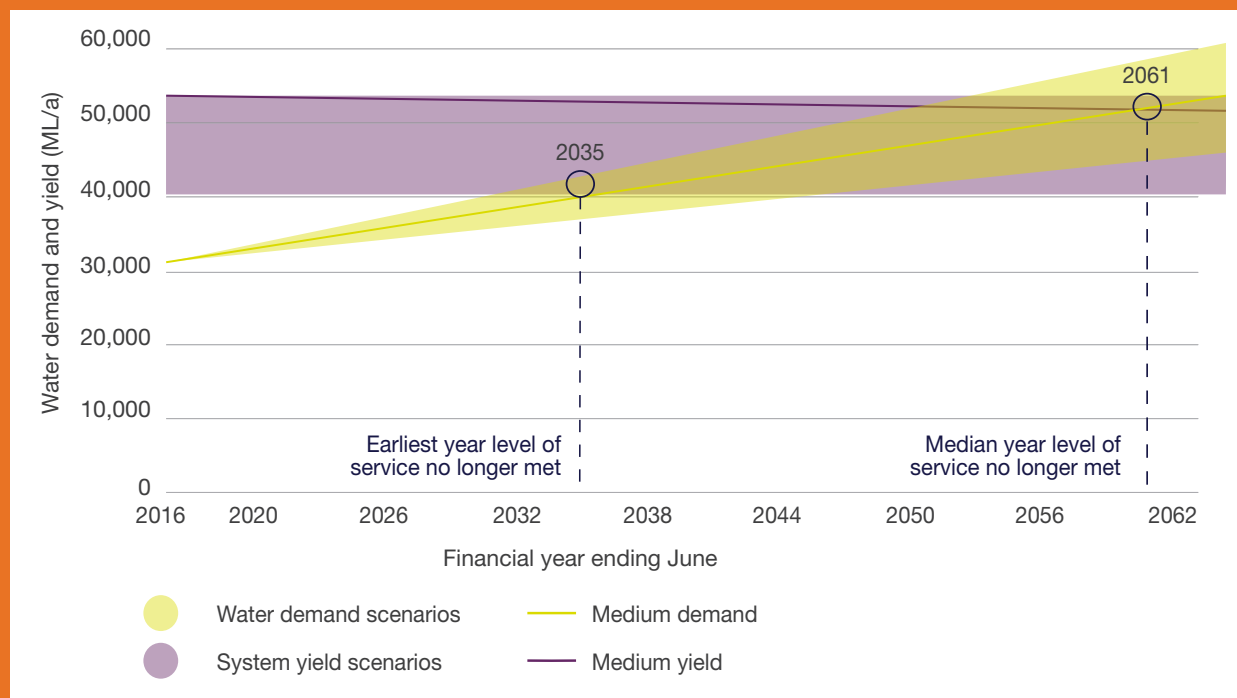
The *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria* are a key resource for equipping the water sector with the most up-to-date understanding of climate change and associated threats to water resources.

They provide projections for long-term changes in temperature, potential evaporation, rainfall, runoff and recharge, which are to be used by water corporations across Victoria to model the impact of climate change on water supplies. Application of the guidelines will help protect Victoria's water security.

DELWP developed these guidelines from the findings of the *Victorian Climate Initiative*, which included modelling from the CSIRO and Bureau of Meteorology (BOM).

Figure 2.5 shows how Barwon Water has used the guidelines to inform a range of supply and demand scenarios. Such graphs can be used to inform the timing of actions required to maintain service levels.

Figure 2.5: Forecast balance between water supply and demand for the Greater Geelong system (Barwon Water's Urban Water Strategy (2017), reproduced with permission).



The guidelines are also useful to others involved in the water sector, including waterway managers, environmental water holders and local governments. The application of the guidelines among the wider water sector provides a consistent approach to assessing the impact of climate change on water availability across Victoria.

Building on the success of these guidelines for water supply, this WSAAP commits to developing guidelines to address the impact of climate change on sewerage services (see Section 5).

2.2. Impacts of climate change on the water sector

Observed impacts

As explained in Section 2.1, Victoria has already experienced some changes in climate. These have impacted the water sector and its customers in various ways. Some of these impacts are illustrated through case studies. This mix of case studies covers some direct impacts of climate changes, some of the impacts of extreme events that are exacerbated by climate change, and some impacts that climate change has on community values associated with water.



Impact on water quality

Deterioration of water quality as a result of climate change, such as through higher temperatures, drought, bushfires, floods and storms, can pose threats to human health. Infection may occur from contamination of a variety of water sources such as drinking water supply, water bodies used for recreation, alternative water sources, waterways or marine waters (the latter two are out of scope of this WSAAP). In some water systems, the location, capacity and design of treatment plants may need to be reconsidered.

For example, blue green algae blooms occur naturally in waterways and storages throughout Victoria. Some strains of the algae are toxic to humans and livestock.

In mid-February 2016 a major algal outbreak was detected in the Murray River extending 1,450 km from Hume Dam to just downstream of Wentworth. This was one of the longest lasting blooms in the Murray, lasting more than 12 weeks and impacting many river communities.

The warmer average temperatures that year and low rainfall are thought to have contributed to this protracted outbreak. Other experiences in the Victorian water sector in recent years have shown that blue-green algae outbreaks may now occur in water bodies that haven't experienced blooms in the past, and in cooler months when they weren't expected in the past. Warmer, drier average conditions anticipated under climate change may lead to algal blooms that are more frequent or extensive, or occur in unexpected locations.



Photograph: Blue-green algae bloom in the Murray River, 2016. Source: anonymous.



Impacts of bushfires

Bushfires are likely to be more frequent and intense with climate change, posing an increased threat to water security. Fires can burn natural assets such as vegetation and infrastructure assets such as pumping stations, pipes, storages or treatment plants. For many months after bushfires, ash and sediment washed into reservoirs can affect the quality and quantity of water supplies, potentially rendering them unusable. Or in some cases, water may continue to be supplied to customers but at reduced quality, which may cause inconvenience. Reservoirs are also threatened by debris flows, which are typically triggered by intense rainfall and more likely to occur in post-fire landscapes.

Even after reservoirs recover from these direct impacts, in some situations forests that are regrowing after a bushfire might intercept and use more runoff than established forests. The reduction in runoff reaching reservoirs can last for many years. This means reduced total water available for water users.

DELWP and the water sector manage bushfire threats by undertaking strategic planned burns, maintaining fire breaks and roads for firefighters, and identifying fires as quickly as possible.

Current research by Melbourne Water and the University of Melbourne is investigating the impacts of bushfires on long-term water yield and short-term water quality under climate change.



Impact of changing snowpack

In some parts of the State, the amount and timing of snowmelt impacts stream flow and water supplies, including some urban supplies. In particular, snow acts as a store of precipitation in winter, which is released to waterways in spring, filling water storages in preparation for peak summer demand. More work is needed to quantify the likely future impact of reduced snow and snowmelt on Victoria's water supplies.

Bushfires are likely to be more frequent and intense with climate change, posing an increased threat to water security. Fires can burn natural assets such as vegetation and infrastructure assets such as pumping stations, pipes, storages or treatment plants.



Impacts of storms

The intensity of extreme rainfall events is projected to increase with climate change, and lead to higher costs and more disruption to essential water services. Storms can cause damage and disruption in many ways, such as through intense rainfall, flooding and high winds. They can also bring storm surges, which may overwhelm sewerage systems and increase contaminant runoff from catchments, polluting water supplies and waterways. Storms can wash debris into water supply catchments and rivers that impact water quality.

Storm damage to the Sydney Desalination Plant is an example of how some of Victoria's water sector assets could be affected in future. In December 2015, the Sydney Desalination Plant was hit by a very severe storm. The strongest maximum wind gust ever recorded in NSW (213 km/h) occurred at the site, which the Bureau of Meteorology confirmed was consistent with a tornado.

The storm caused significant damage to several roofs, the control room, electricity transformers and other parts of the facility. It has been undergoing major repairs.

As a critical piece of infrastructure, the desalination plant should be ready to help secure Sydney's drinking water supply when needed. However, it has been unavailable for three years during its repairs.

Victoria can put in place safeguards and a disaster preparedness plan to mitigate damage that could occur in this State so that water security is optimised.



Impacts of drought on water availability

Between 1997 and 2009, Victoria experienced unprecedented dry conditions – a period now known as the Millennium Drought. These 13 consecutive years of drought, including the lowest annual inflows to storages recorded (2006/07), resulted in conditions well outside the boundaries in which the water supply systems and water sharing rules across Victoria were designed to operate. By the 2006/07 summer, many areas faced severe water shortages. Water customers were impacted through water restrictions, loss of plants in recreational areas, sports grounds and gardens, and impacts on agriculture and other businesses such as nurseries, whose sales dropped as customers' irrigation was restricted. These water shortages were more extreme than envisaged possible when water entitlements were developed, and the effectiveness of Victoria's water management frameworks was tested.

The experience of managing water resources for all competing uses during the Millennium Drought was influenced by the complex interaction of:

- climatic conditions (that is, patterns and reliability of rainfall across Victoria)
- physical water systems (nature of supply infrastructure and natural waterways)
- water sharing arrangements (secure water entitlements and trade)
- water planning arrangements (preparedness in the short and long term)
- demand for water for different purposes (domestic use including gardens, rural consumption including irrigation, stock and environmental water.).

While the Millennium Drought was in part caused by natural variability with limited climate change impact, climate science indicates that we should expect longer and more frequent drought in future.



Impacts of flood

Flooding is a regular occurrence in Victoria. The floods that occurred between September 2010 and March 2011 were some of the most extensive and damaging floods in Victoria's history. These floods affected 70 of the 79 Victorian local government areas, and there was major damage to communities, transport infrastructure, community infrastructure and the natural environment⁵. Some communities were inundated several times, and sustained repeated damage to houses, businesses and agriculture. In January 2013 the total cost for relief and recovery was estimated as \$971 million⁶.

The change in frequency and extent of flooding under climate change is not clear, particularly in regional areas, and the WSAAP commits to investigating this knowledge gap. It is anticipated that flash flooding will increase, particularly in small, urban and steep catchments.



Impacts of climate change on recreational water

Water for Victoria recognises that connection to nature through water storages, lakes, wetlands, rivers and streams in regional Victoria is important for our health and wellbeing and the social fabric of communities. Victorians and other visitors appreciate and seek these benefits through fishing, water skiing, rowing, camping, walking, bird watching, sporting events, social gatherings, gardens and other activities on or near waterways.

The *Wimmera Southern Mallee Socio-Economic Value of Recreational Water*⁶ study in 2017 examined the social and economic contribution of the region's 24 lakes, weir pools and rivers. In 2016/17 these waters were estimated to provide over \$27 million in economic contribution to the region and recreational services to over 85,000 people. The study also found significant community health benefits.

The study found that drought which leads to loss of recreational waters impacts the region socially and economically. For example, following drought conditions, Lake Wallace was empty until late in 2016. Real estate sales slumped while the lake was empty in 2015, and buyers returned during the 2016-17 year when the lake refilled. The Edenhope and District Memorial Hospital, located on the banks of Lake Wallace, found it noticeably easier to attract aged people as residents when there was water in the lake. They also found that staff recruitment and staff retention was better when the hospital was able to promote the environmental features and amenities offered by Lake Wallace.



⁵ Victorian Auditor-General, *Flood Relief and Recovery*, Victorian Auditor-General's Report 2015 13:35, PP No 241, Session 2010–13 (June 2013)

⁶ Street Ryan and Wimmera Development Association, *Wimmera Southern Mallee Socio-Economic Value of Recreational Water*, (2017).



Impacts of climate change on Aboriginal values of water

Aboriginal people have the longest living cultures in the world, and have managed the land and water sustainably over thousands of generations.

The water sector now increasingly understands that Traditional Owners have cultural, spiritual and economic connections to water through their associations and relationship with Country and that connectedness to water on Country is important for Aboriginal health and wellbeing and therefore must be protected. This is especially important in Victorian water sector adaptation, as 80% of Aboriginal cultural heritage sites are found within 200 m of a potable water source.

Improving access to water for Traditional Owners will help support Aboriginal water values and provide opportunities for economic development. However, climate change may jeopardise water availability or damage the Traditional Owner places of significance through reduced or intermittent stream flow, hotter temperatures, flooding, or erosion of culturally significant sites. Climate change is not the start of the impacts. European settlement brought with it many changes for example through dams, pipes and sewers which have all impacted the natural water cycle.

However, under climate change average annual stream flow reductions of around 50% could occur in some catchments by the year 2065. Decreased flows, floods, erosion and drought are likely to have significant impacts on Aboriginal water-related values and culturally significant sites, many of which are already under threat.

Potential impacts

Some of the potential future threats to the water sector will be direct, such as droughts and lower average rainfall. Others will be indirect, through the potential impacts of climate change on other services, such as the power supplies needed to pump and treat water during heatwaves. All values of water identified in *Water for Victoria* are likely to be impacted by climate change. The WSAAP focuses on Water for Victoria themes resilient and liveable cities and towns, Aboriginal values and recreational values. Noting however there are also impacts anticipated for waterways, agriculture and the economy, but they are out of scope of this document.

A summary of potential impacts of climate change and related extreme events on the water sector are described in Table 2.1. It is important to note that not all regions in Victoria will be affected the same way. For example, regions on the coast are impacted by sea level rise and storm surge. The table illustrates that climate change and extreme events can impact the services to customers, and the ability of the water corporations to provide services. It is therefore important to put in place effective adaptations to promote resilience in the water sector to adapt to these occurrences.

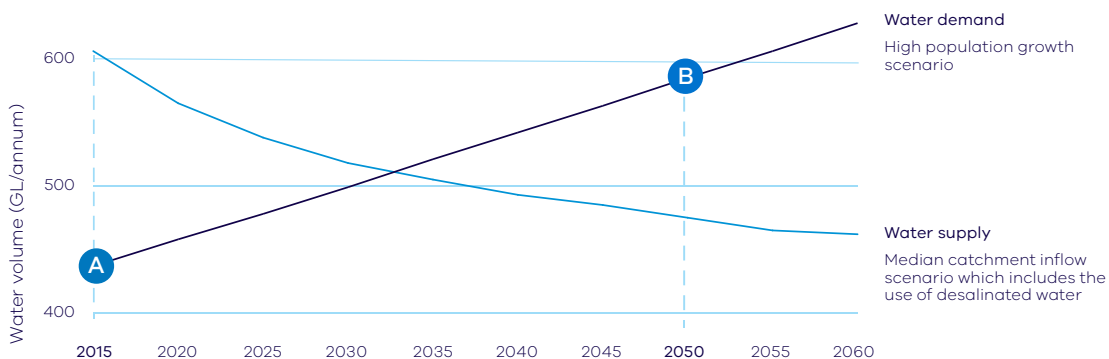
These potential impacts will occur concurrently with other pressures such as population growth, changing community expectations and changing economic conditions. *Water for Victoria* notes that Victoria's population is projected to reach 10.1 million by 2051, and the community has a range of expectations relating to reliability of water supply, water quality, waterway health, recreation and access to information.

Potential future supply and demand scenarios for Melbourne were set out in *Water for Victoria* to illustrate the potential impacts of climate change in a period of increasing population and demand (Figure 2.6). It illustrates the challenge faced in Melbourne to supply sufficient water under a high population growth and median catchment inflow scenario, and also the diversification of water sources that may be needed to meet demand. This need to diversify sources to meet demand under a drying climate applies to several regions in Victoria, and indeed many are already using sources such as recycled wastewater and stormwater.

Potential future supply and demand scenarios for Melbourne were set out in Water for Victoria to illustrate the impact of climate change in a period of increasing population and demand.

Figure 2.6. Potential future supply and demand scenario for Melbourne
(source *Water for Victoria: Water Plan (2016)*)

The future is uncertain so we need to act now to keep our water supply secure



We need a range of sources to secure our water supply

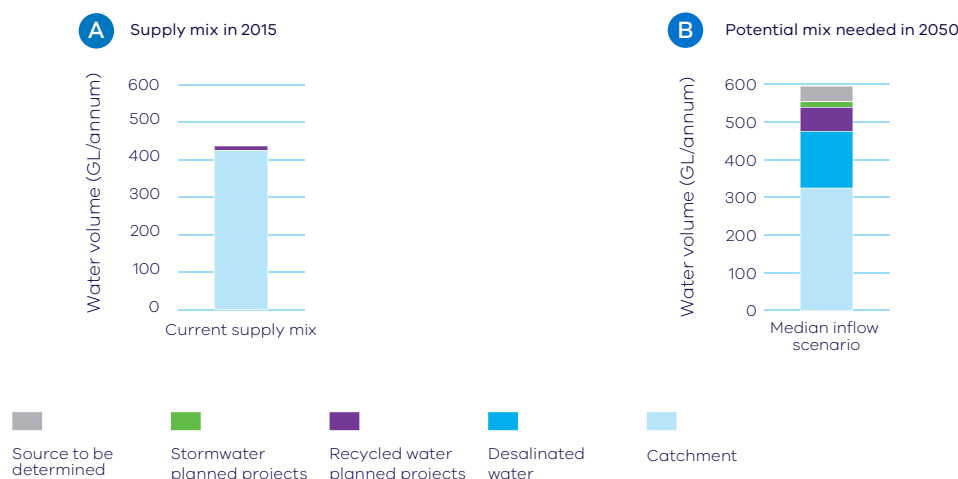










Table 2.1. Summary of potential climate change and related extreme events⁷, and some potential implications for the water sector services – arrows indicate whether an increase (up) or decrease (down) is likely.

Changes in climate and extreme events	Potential implications for water supply, sewerage, drainage and flooding
 Temperature Increases	<ul style="list-style-type: none"> ▲ annual demand for water, putting more pressure on water resources ▲ water quality impacts caused by turbidity from drier soils or vegetation dieback, pests, weeds, and increased pathogen growth ▲ recreational value of water bodies to the community which are particularly valued during warmer weather ▲ need to irrigate recreation areas, sporting and parks/gardens ▼ snow, leading to less inflow to snowmelt-fed water storages in spring ▲ sewage quality changes and impacts on sewerage infrastructure e.g. corrosion and odour ▲ impacts on other asset performance e.g. mechanical and electrical equipment overheating ▲ drying soils which can cause cracks in underground structures such as pipes
 More Heatwaves	<ul style="list-style-type: none"> ▲ threats to the health and safety of field crews or limit working hours, potentially impacting on many services to the community ▲ power outages, which may affect water supply and sewerage services ▲ water demand, potentially exceeding the capacity of the water grid ▲ incidence of harmful algal blooms
 Lower Average Rainfall	<ul style="list-style-type: none"> ▼ stream flow and water quality in natural waterways (waterway health will be covered in the Natural Environment AAP) ▼ quantity and quality of water available, and possible tensions between water supply for consumptive and environmental uses (also relevant to the Primary Production AAP and the Natural Environment AAP)
 More Droughts	<ul style="list-style-type: none"> ▼ quantity and quality of water available for use ▼ recreational opportunities, both on water (e.g. fishing, swimming) and on land (e.g. poor sports ground surfaces, private gardens) ▲ damage to water, sewerage, drainage and flood management infrastructure due to dry soil which shifts and cracks, or tree roots seeking water sources
 More Intense Rainfall	<ul style="list-style-type: none"> ▼ quality of water for recreational, cultural, spiritual and environmental uses when sewerage systems spill ▼ performance of drainage infrastructure, which may require investment to maintain historic service levels ▼ runoff quality, especially from rainfall events after long dry periods ▲ flash flooding (see More Floods) ▲ storm damage to water sector assets

⁷ Wind is not included in this as there is limited understanding of how winds will change under climate change conditions. While wind can have an impact on water sector assets, such as by increasing storm surges and uprooting trees, it is not considered as important as other climate change impacts such as lower average rainfall.

Changes in climate and extreme events	Potential implications for water supply, sewerage, drainage and flooding
 Sea Level Rise and Storm Surge	<ul style="list-style-type: none"> inundation of coastal infrastructure, environmental, cultural, spiritual and recreational sites saline ground water infiltration, impacting on sewerage assets, wastewater recycling, and availability of water near the coast for agricultural and environmental uses effectiveness of low-lying coastal drainage networks, that may be partially filled by sea water
 More Bushfire Weather	<ul style="list-style-type: none"> impact on water catchments and long-term quantity and quality of water in storages storages temporarily off line due to contamination from ash or from debris flows, reducing water availability damage to other water sector assets and recreational, cultural, spiritual and environmental sites
 More Flash Floods	<ul style="list-style-type: none"> flash floods impacting on urban areas and industry. For larger rural catchments, or places where floods are generally caused by snow melt, the likely future changes in flooding are much harder to quantify disruption to communities by causing injury, loss of life, property damage, personal hardship and disruptions to regional economies damage to water sector assets, water-related recreational, cultural, spiritual and environmental assets disruption of essential water and wastewater services, leading to a spread of waterborne diseases

3. Governance, roles and responsibilities

This section summarises the roles and responsibilities of the government and other bodies in relation to the water sector, as context for their role in adapting to climate change.

3.1. Water sector governance framework

Figure 3.1 provides an overview of the key roles and responsibilities in the water sector. The water sector is a heavily regulated system to ensure essential water services are affordable and safe, and impacts on the environment are managed.

Figure 3.1. Water sector key roles and responsibilities

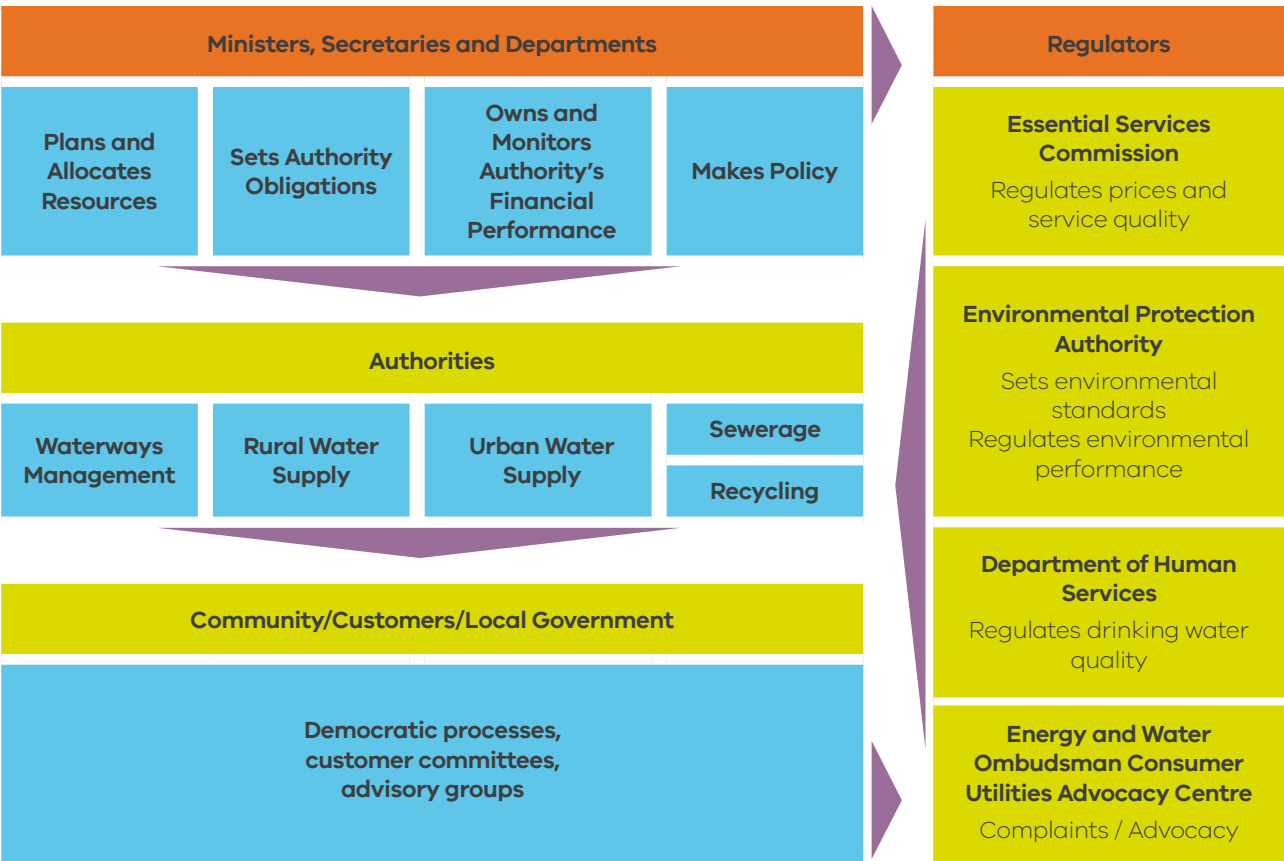


Table 3.1 on page 30 summarises the functions performed by catchment management authorities (CMAs), local governments and water corporations in relation to climate change, the Act, and *Water for Victoria*. Climate change adaptation planning cannot be undertaken in isolation of other factors affecting the water sector. Planning needs to consider factors such as population growth, changes in economic conditions, and emergency management planning needs concurrently.

3.2. Roles and responsibilities in climate change adaptation

Broadly speaking, the roles and responsibilities for climate change adaptation planning are:

- DELWP sets the agenda for adaptation at state-wide level through preparation of climate change strategies and implementation of the Act. It also mainstreams climate change and adaptation planning into key plans, policies, and programs such as *Water for Victoria*, urban water strategies and catchment management strategies.
- Water corporations develop their own adaptation programs and deliver specific activities set by DELWP, such as drought preparedness plans and urban water strategies, for urban and regional urban water corporations.
- Rural water corporations develop low flow contingency plans that include an appropriate range of climate scenarios. The roles and responsibilities of these authorities are set out in a Statement of Obligations, issued under the *Water Industry Act 1994*.
- Catchment Management Authorities will consider climate change in the renewal of their Regional Catchment Strategies in 2019 and associated sub-strategies, and will build on Regional Climate Change Adaptation Plans developed in 2012. The roles and responsibilities of these authorities are set out in a Statement of Obligations, issued under the *Catchment and Land Protection Act 1994* and *Water Act 1989*.
- Local Government provide stormwater management and drainage services, some sewerage and flood mitigation services, monitor blue green algae in some waterways and facilitate emergency management planning at the municipal level in partnership with state and local agencies.
- The Department of Health and Human Services (DHHS) safeguards Victoria's drinking water supplies to both protect and enhance public health and wellbeing. To achieve this, the department ensures drinking water is delivered to Victorians by water businesses in accordance with the requirements of the *Safe Drinking Water Act 2003* and the *Safe Drinking Water Regulations 2015*.

Further information about the roles and responsibilities of these and other organisations is presented in Table 3.1. The relationship between some key documents that consider climate change is shown in Figure 3.2.

Figure 3.2. Relationship between some key documents. (Note that this is not an exhaustive list of work relevant to climate change adaptation in the Victorian water sector.)



Table 3.1. Organisations and their responsibilities relating to climate change adaptation in the water sector.

Organisation	Responsibilities relating to climate change adaptation
Catchment Management Authorities (CMAs)	<ul style="list-style-type: none"> • Coordinate the development, review and support implementation of Regional Catchment Strategies (RCS) and related regional sub-strategies or plans in line with the Act. The RCSs address activities to promote sustainable use, conservation and rehabilitation of land and water resources, including waterway restoration, reforestation and sustainable agriculture programs which benefit climate change adaptation. • Integrate the existing regional Climate Change Adaptation Plans into CMA catchment and waterway management activities and incorporate learnings into the next iteration of RCSs. • Inform adaptive management and efficient use of water for the environment in partnership with the Victorian Environmental Water Holder. • Provide advice on flooding and development controls including those subject to sea level rise. • Conduct strategic assessment of flood management priorities for adapting to climate change. • Initiation and stewardship of flood management projects to facilitate adaptation to climate change.
Department of the Environment, Land, Water and Planning (DELWP)	<ul style="list-style-type: none"> • Administer the <i>Climate Change Act 2017</i> and setting the requirements for this WSAAP. • Manage Victoria's water resources in conjunction with other water sector organisations. • Work with the sector to implement a pathway to net-zero emissions for the water sector. • State water resource planning. • Ensure that water is shared to support a healthy environment, a prosperous economy, and thriving communities for all Victorians. • Ensure that long-term planning frameworks are in place and are considering the potential impact of climate change. • Play a key role in preparing and providing climate change guidance and fact sheets for use by water corporations and the community. • Assess and prioritise government investment in major water sector infrastructure projects delivered by water corporations. • Fund floodplain management resources in CMA and flood initiatives/ projects, often with contributions from the Commonwealth and local authorities. • Consider the financial impacts on water corporations of investing and not investing in climate change adaptation.
Department of Health and Human Services (DHHS)	<ul style="list-style-type: none"> • Regulate the quality of water supplies in accordance with the <i>Safe Drinking Water Act 2003</i>. • Address the health impacts of heatwaves, temperature increases, droughts, floods, fires and water quality threats.
Department of Treasury and Finance (DTF)	<ul style="list-style-type: none"> • Implement and oversee the water sector's financial management standards.

Organisation	Responsibilities relating to climate change adaptation
Emergency Management Victoria (EMV)	<ul style="list-style-type: none"> Lead emergency management in Victoria by working with communities, government, agencies and business to strengthen their capacity to withstand, plan for, respond to and recover from emergencies.
Environment Protection Authority (EPA)	<ul style="list-style-type: none"> Monitor and oversee the environmental performance of the State's water sector. License the discharge of treated wastewater into waterways and the management of biosolids generated at treatment plants. Consider the potential impacts of climate change on waterways when issuing or renewing licences to discharge to waterways.
Essential Services Commission (ESC)	<ul style="list-style-type: none"> Regulate the water sector including price regulation. Measure performance against the customer service indicators affected by climate change. Approve water corporation expenditure, including expenditure on climate change adaptation actions.
Local Government	<ul style="list-style-type: none"> Provide and maintain public open space and streetscapes, which are essential to Victoria's liveability – this includes adaptation to drought and other climate change events that threaten public spaces. Provide stormwater management and drainage services which aid flood prevention and protect waterways. Some local governments also provide and manage flood mitigation infrastructure (e.g. urban levees and weirs). Monitor blue green algae in some waterways. Facilitate emergency management planning at the municipal level in partnership with State and local agencies. Land use planning authority, maintaining their planning scheme including the Land Subject to Inundation Overlay. Some local governments are also maritime authorities.
Rural water corporations	<ul style="list-style-type: none"> Provide irrigation, drainage, storage services and administer waterway diversions and groundwater extraction. Deliver bulk water to regional urban water corporations for treatment and distribution. Manage reservoirs to provide water supply and irrigation services. Any flood mitigation from a Victorian dam is incidental and opportunistic. Consider the financial impacts of investing and not investing in climate change adaptation, particularly in relation to drought and heatwaves.
Traditional Owner groups	<ul style="list-style-type: none"> Contribute to climate change adaptation strategies and plans throughout Victoria. Review local plans to ensure the protection of local Aboriginal cultural and significant sites (tangible and intangible heritage). Consider including climate change in Country Plans.

Organisation	Responsibilities relating to climate change adaptation
Urban water corporations and regional urban water corporations	<ul style="list-style-type: none"> • Manage water resources and deliver water supply, sewerage and wastewater treatment services within our cities and towns. • Provide wholesale drainage and flood protection services to local government (Melbourne Water only). • May have opportunities to invest in diverse water sources that will make the sector more resilient to climate change. • Consider the financial impacts of investing and not investing in climate change adaptation.
Victorian Environmental Water Holder (VEWH)	<ul style="list-style-type: none"> • Hold and manage Victoria's environmental water entitlements. • Manage environmental water to protect our rivers and wetlands, ensuring that the right volume of water is released at the right time. • Respond to water quality events associated with droughts and low flows.

4. Existing climate change adaptation policies, initiatives and gaps

This section assesses the current state of adaptation planning in the water sector and identifies 20 gaps to be addressed by climate change adaptation actions. It includes a high level overview and assessment of existing Victorian Government water policies and water sector activities, as needed to illustrate the gaps. Further information on existing frameworks and work underway that supports climate change adaptation in the water sector can be found in Appendices 3 and 4. Each gap or opportunity identified in section 4 is addressed by a specific action in section 5.

Each gap identified in Section 4 has a corresponding action in Section 5 based on the likelihood and consequences (risks) of climate change in line with the risk management principle of the *Climate Change Act*. It is a guiding principle of the Act that a lack of full scientific certainty should not be used as a reason to postpone the taking of action.

During a drought, the grid will enable water to be moved to where it is most valued and needed, and allows Victorians to share the water security benefits of water resources such as the Victorian Desalination Plant.

4.1. Building knowledge

Building knowledge about climate change underpins policy development and feeds into the development of strategies. In turn, these strategies lead to investment to protect water uses and values from the potential impacts of climate change. Continually improving our understanding of the risks and potential impacts of climate change enables the water sector to plan effectively.

Building knowledge of water grid function under climate change

Water sources are connected to water users by Victoria's water grid, via pipes, pumps and rivers. The \$80 million *South West Loddon Rural Water Supply Project* is expanding the water grid to connect the Western Waranga Channel to the Wimmera Mallee Pipeline. Over the last decade, other investment in the water grid has included:

- Goldfields Superpipe
- Melbourne-Geelong Pipeline
- Tarago-Warragul-Moe Pipeline
- Wimmera Mallee Pipeline
- Sugarloaf Pipeline
- Hamilton Grampians Interconnector

During a drought, the grid will enable water to be moved to where it is most valued and needed, and allows Victorians to share the water security benefits of water resources such as the Victorian Desalination Plant. This investment reduces the vulnerability of the Victorian community, agriculture and industry to water shortage.

Water sector specialists have indicated that they are interested in knowing how the grid might be used during times of low water availability. They are also interested in knowing how the entitlement framework (see Appendix 2) and markets will function to support the most efficient movement of water through the grid, in an equitable and efficient way. This is also relevant to emissions reduction, as pumping water through the grid over greater distances would increase energy use. The water grid in the northern part of the state is already well established, but there remains a knowledge gap around how the new southern grid will function under climate change, for example during more severe drought. The gap in our knowledge of how water might be shared between different consumptive and environmental water users under climate change will be explored through **Action 1**.

The Victorian Desalination Plant (VDP)

The \$3.5 billion VDP is a rainfall and climate independent source of water. It is capable of supplying up to 150 GL/year of high quality drinking water, or around one third of Melbourne's annual water consumption. The VDP can provide different volumes of water each year and it is anticipated to provide more water during drought years, which would mean the grid would be delivering water from a different mix of sources and locations.



Building knowledge of potential flooding

The Victorian population is vulnerable to floods, which can lead to loss of life as well as extensive damage to property, agriculture, industry and environmental, social, recreational and cultural sites. It is possible this vulnerability may increase in future as climate change is expected to cause an increase in the intensity of extreme rainfall events.

Work is underway in assessing the potential impact of future flooding. In the past decade, the Victorian Government has invested \$7.9 million in 76 flood studies across Victoria. These studies have produced high quality flood mapping, covering a range of flood magnitudes from frequently occurring events up to the Probable Maximum Flood.

While an increase in flooding with climate change is likely for flash flooding (see Section 2), it is possible that overall drier conditions in Victoria will allow catchments to absorb more rainfall, offsetting projected increases in rainfall intensity. This means the implications for flood depth and extent are unclear, for catchment flooding, stormwater and drainage. Research is needed to understand the combined effect of rainfall intensity and drier average conditions, and what this means for flood and stormwater management. This is addressed through **Action 2**.

Building knowledge of adapting through integrated water management

Integrated water management (IWM) is "a process which promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" according to the Global Water Partnership. The three principles governing IWM are social equity, economic efficiency and ecological sustainability. IWM is a flexible process rather than a fixed mechanism in policy making and allows decision-makers to make rational and informed choices between alternative actions depending on the situation.

Urban areas are particularly vulnerable to heat under climate change, as the temperatures in urban areas on hot days can far exceed those in landscapes with more vegetation. This heat can cause premature deaths. Urban areas are also vulnerable to flash flooding during intense rainfall, where the rain overwhelms the capacity of the stormwater system. Thirdly, urban waterways are vulnerable to ecological damage and pollution, caused by litter and contaminants entering the waterways and flashy discharges during rainfall events that may erode riverbanks. In more intense rainfall events, as well as drier average conditions that may stress waterways, this means the urban waterways will become increasingly vulnerable under climate change.

IWM can reduce those vulnerabilities by capturing more water and holding it in the landscape, to support more urban vegetation using stormwater, rainwater, or recycled water, and filtering and retarding stormwater before it enters the waterways. These combined effects reduce urban heat, improve waterway health, as well as provide greater urban amenity and social and environmental benefits.

Recognising these benefits, the Government has established 15 IWM Forums across the State, which will encourage greater collaboration across organisations and disciplines that influence the urban water sector.

The IWM Forums will identify, coordinate and prioritise IWM opportunities. They are facilitated by chairs and include participants from organisations that have a role in IWM including local government, catchment management authorities, water corporations and traditional owner groups. DELWP establishes and supports these forums, and contributes when agreed by the partners.

It is important that the IWM Forums take a whole-of-catchment view including sewerage, stormwater and sea level rise, and consider challenges relating to changing flooding risk under climate change.

This whole-of-catchment approach is currently challenging to undertake, and this is addressed by **Action 3**. While IWM projects and the IWM Forums themselves cannot address all challenges relating to climate change, they are important contributors to the solution and provide multiple social and environmental benefits, not just climate change adaptation. The case study on MUSIA highlights the importance of integrated water management to achieve successful outcomes on a catchment scale.



Melbourne Urban Stormwater Institutional Arrangements Review (MUSIA)

We're reviewing the arrangements between Melbourne Water and local government to clarify stormwater responsibilities in the Melbourne metropolitan area.

Urban flooding is a serious issue to the economic, social and environmental cost in metropolitan Melbourne. DELWP is committed to reviewing the arrangements between Melbourne Water and local government in a bid to clarify responsibilities for urban stormwater risk management, related assets and services in the Melbourne metropolitan area.

DELWP, the Municipal Association of Victoria (MAV) and Melbourne Water will be working together to seek input from councils and other stakeholders to the review.

Fast facts




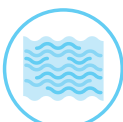


- Flash flooding in metropolitan Melbourne and urban areas across Victoria is a growing problem as we see increased severe storm events and more non-permeable surfaces.
- Flood, drainage and stormwater management needs to deliver several outcomes to better meet the needs of the community and the environment now and into the future.
- In metropolitan Melbourne, many stormwater and drainage assets are currently impacted by the 60-ha catchment boundary threshold.
- The review of urban stormwater management will help clarify responsibilities between Melbourne Water and local government.
- DELWP, MAV and Melbourne Water will be working together to seek input from councils and other stakeholders to the review.

This project is driving a catchment level approach to water management and will help enable better catchment-wide consideration of stormwater drainage and flood management across the metropolitan Melbourne area

<https://www.water.vic.gov.au/managing-floodplains/stormwater-review>

The IWM Forums will produce Strategic Direction Statements and new integrated water management initiatives. They have seven strategic outcomes. Each of these will have a significant role in shaping the liveability, prosperity and resilience of Victoria's cities and towns. These outcome areas provide a guide to identify and assess the various IWM opportunities.

Table 4.1. IWM Strategic Outcomes

Outcomes	
	Safe, secure and affordable supplies in an uncertain future
	Effective and affordable wastewater systems
	Opportunities are optimised to manage existing and future flood risks and impacts
	Healthy and valued waterways and marine environments
	Valued landscapes for health and well-being
	Strengthened community knowledge and local values reflected in place-based planning
	Jobs, economic benefits and innovation



The Victorian water corporations invest in sewer corrosion research, and there have been some sewer asset management studies that address aspects of the impacts of climate change, such as overflowing in storms and groundwater ingress.

Barwon River, Geelong, flooding in 2016.
Image supplied by Ventia.

Building knowledge of best practice methods to incorporate climate change into the estimation of future flood impacts

The Australian Rainfall and Runoff (ARR) national guidelines is the key source of technical information for the estimation of peak flows associated with extreme rainfall, flooding and storm surge. It is used in the design of culverts and bridges, urban drainage systems, flood levees and dam spillways. It is also used to define the peak rainfall events used when designing sewers, in modelling the depth and extent of anticipated future floods, and in designing new buildings and planning urban developments. A new version of ARR was released in 2016 (ARR 2016).

ARR 2016 indicates that the expected change in heavy rainfall is between 2% and 15% per degree of warming. Although the average total rainfall under climate change is expected to reduce, the rainfall events are expected to be more intense, and it is these events that are addressed through ARR 2016. It recommends that, given the uncertainty in rainfall projections and regional variability, an increase in rainfall of 5% per degree of local warming be adopted. ARR 2016 also provides a 6-step process for incorporating climate change risks into decision-making. Organisations may choose to plan for a greater future change in rainfall if they choose.

ARR 2016 acknowledges that there are still many uncertainties around climate change and the estimation of peak flows. For example, antecedent catchment conditions may be drier under climate change,

and this could partially offset the impact of increased rainfall intensities.

DELWP has taken a first step to understand this relationship better, by commissioning a project to model the impact of long-term drying on flood peaks (Action 2). The results of this study will be shared with the water industry.

ARR 2016 replaces an earlier version launched in 1987. ARR 2016 recommends updated tools and methods, which are based on an improved understanding of rainfall runoff processes. There is a need for users of ARR, including local governments and their service providers, to adopt the new tools and methods that supersede those used over the previous 30 years. This gap between current guidelines and current practice is addressed by **Action 4**.

Building knowledge of how climate change will impact Traditional Owner cultural values associated with water

The Victorian Government⁸ and water industry organisations have committed to better recognise and manage Aboriginal values by increasing Aboriginal participation in water management. In particular to:

- Recognise Aboriginal values and objectives of water;
- Include Aboriginal values and traditional ecological knowledge in water planning;
- Support Aboriginal access to water for economic development; and
- Build capacity to increase Aboriginal participation in water management.

Through these commitments, water industry organisations are working to include the priorities and values of Traditional Owners in climate change adaptation planning and activities. This will continue to build meaningful relationships and achieve mutually beneficial outcomes with Traditional Owner groups.

For example, The *Aboriginal Waterways Assessment* tool was developed by the Murray Darling Basin Authority, Murray Lower Darling River Indigenous Nations (MLDRIN) and Northern Basin Aboriginal Nations. The tool allows Traditional Owners to systematically assess the cultural health of their Country and therefore identify specific values that may be vulnerable to climate change. DELWP has provided funding to MLDRIN to support training in and use of the tool. Traditional Owners are also participating in Sustainable Water Strategy reviews, via consultative committees, to help ensure that the reviews consider opportunities for achieving shared benefits for Aboriginal values of water.

Aboriginal water-related values are vulnerable to climate change, for example they are vulnerable to reduced rainfall that may see significant ecological or cultural sites along waterways not receiving the levels of water they have in the past. There is a gap around what the expected impacts are of climate change on Aboriginal cultural values associated with water, what can be done to adapt to the changes, and what we can learn from Aboriginal groups about how they have adapted to past water-related changes. This is addressed by **Action 5**.

⁸ Schedule 16 of the *Regional Settlement Agreement* between the Victorian Government and the Dja Dja Wurrung Clans Aboriginal Corporation specifically provides that the State will provide the opportunity for DDWCAC to "actively participate in the development ... of natural resource management policies, the development of State funded management plans, and publicly funded natural resource management research" in the Agreement Area.

Building knowledge about good practice adaptation

As mentioned, the Victorian community, agriculture, industry and environment are very vulnerable to water shortage. Even with an excellent water entitlement and planning framework (Appendix 2) and robust 50-year planning such as the water corporations' Urban Water Strategies, there remains unavoidable vulnerability due to our reliance on rainfall-dependent water sources. More can be done with water corporations to share information about the impact of climate change on water supply. This is addressed by **Action 6**. The sharing of knowledge and adaptation planning tools for water supply will assist the water sector in planning for anticipated changes to supply and demand. Opportunities to share what has been learnt will help water managers to understand what actions may be taken to protect water supply into the future.

Section 2 highlighted the vulnerability of the sewerage system to intense rainfall, sea level rise and changes in sewage composition. There are also uncertainties around best practice management of odour and corrosion in sewers. Concrete sewer corrosion costs hundreds of millions of dollars in Australia alone.⁹

The Victorian water corporations invest in sewer corrosion research. There have also been some studies of sewer asset management that address some aspects of the potentially complex impacts of climate change, such as overflowing in storms and groundwater ingress, including coastal saline groundwater from sea level rise. However, there is no compilation of best practice engineering and science on the topic that is readily applicable for sewerage planners, managers and operators, to assist in making business decisions. There is a need to collate knowledge from multiple sources and summarise it for use and application by sewerage professionals. This is addressed by **Action 7**.

Sharing case studies and information on climate change and adaptation approaches can help water industry staff more quickly undertake their own adaptation work, as well as share tips for success and problems to avoid. Greater sharing will lift overall industry efficiency and performance on adaptation. Existing data, guidelines and tools are already helping decision-makers understand how to apply research to policy, planning and practice. The *Climate Change in Australia* website and the WSAA *Climate Change Adaptation Guidelines* (2016) for water corporations are examples of these. The Victorian Government also provides regional *Fact Sheets* and regional *Data Sheets* that forecast the potential impacts of climate change and help communities make decisions about managing risk and reducing emissions.

The data sheets provide temperature, rainfall, evaporation, wind speed, relative humidity, solar radiation, soil moisture and sea level rise forecasts for 2030 and 2070.

The initial stakeholder consultation in the preparation of this WSAAP indicated there was further interest among staff from different organisations to learn more from one another, by sharing case studies and other information about climate change adaptation. This is addressed by **Action 8**. Action 2.2 in *Water for Victoria* already commits to sharing information about climate science, guidelines and data. This action will expand that work to also include case studies and broader information to support adaptation.

9 ARC Sewer Corrosion & Odour Research Linkage Project (<https://score.org.au/>), site undated.

4.2. Frameworks, policy and tools for adaptation

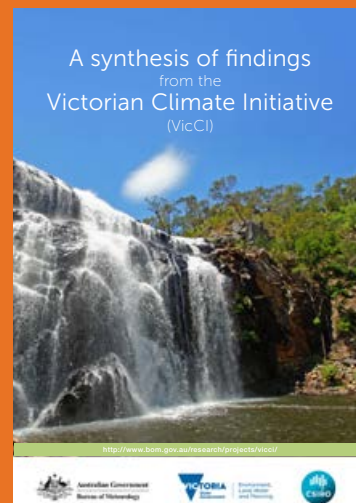
Review guidelines for assessing impacts of climate change on water supplies

The Victorian water sector is heavily reliant on surface water and groundwater supplies, which are extremely vulnerable to changes in total and seasonal rainfall, as well as catchment runoff characteristics and evapotranspiration. This is a critical vulnerability for the sector. Building knowledge of how climate change will impact the Victorian water sector is an ongoing process and needs to be regularly updated. The research undertaken as part of the *Victorian Water and Climate Initiative* (Table 4.2) will provide up-to-date information regarding the impact of climate change on water resources, delivering Action 2.2 of *Water for Victoria*. The results of the program will be used to review the *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria* (Table 4.2), and make sure that the recommendations reflect the most recent knowledge of climate change impacts on water supply. The need to review these guidelines is an ongoing requirement which helps to reduce the vulnerability of the water sector customers to the impacts of water shortage. This requirement is addressed by **Action 9**.

This project is an example of exploring an adaptive pathways approach in which these guidelines have been used for a number of years successfully, and it is now time to review whether they are up-to-date with recent research and whether there are any opportunities for further improvement.

DELWP investment in research

DELWP and its predecessors have a long history of investing in research to improve water sector understanding about climate variability and climate change. For example, the Victorian Government was a partner in the *South East Australian Climate Initiative*, which ran from 2006 to 2012 and improved understanding of the impacts of climate variability and climate change on water availability in south east Australia. The Victorian Government then invested in the *Victorian Climate Initiative* (VicCI) which finished in 2017 (see Table 4.2).



Current research

Investment in research continues through the implementation of Action 2.2 of *Water for Victoria*. DELWP has established research agreements with the University of Melbourne, BOM and CSIRO as part of the Victorian Water and Climate Initiative:

- The research being undertaken by the University of Melbourne is focused on increasing our understanding of where runoff rates across Victoria have reduced since the Millennium Drought (some catchments have still not recovered) and the reasons for the decline. This will help build our knowledge of future water availability across Victoria.
- BOM is undertaking research designed to improve understanding of different weather types in terms of their influence on rainfall for different parts of Victoria. BOM will also look at ways to better characterise Victoria's current climate, and the influence of tropical expansion on rainfall in Victoria.

- CSIRO is undertaking research to improve methods of generating hydroclimate projections for Victoria, including methods for generating transient stochastic time series to the year 2100.

The Government also continues to co-fund and participate in various programs of the *Cooperative Research Centre for Water Sensitive Cities*, which was established in July 2012 to inform the way we design, build and manage our cities in the face of climate change, rapid population growth and challenging economic conditions. DELWP is also an end-use partner of the *Bushfire and Natural Hazards Cooperative Research Centre*, which undertakes research to help build a more disaster-resilient Australia such as improving predictions for severe weather to help predict bushfires and storms.

Table 4.2. Some statewide and national policies and tools that inform climate change adaptation in the water sector.

Policy / tool	Summary
<i>WSAA Climate Change Adaptation Guidelines</i>	The <i>Climate Change Adaptation Guidelines</i> prepared by the Water Services Association of Australia (WSAA) is a key document for water corporations in developing these documents.
<i>Victorian Climate Initiative (VicCI)</i>	This research initiative was started in May 2013 by the Victorian Government and research partners BOM and CSIRO. It was designed to further develop our understanding of climate impacts on water availability and water supplies, and to better inform Victorian water resource planning and management. The outcomes have been published in a series of reports. The initiative ended in 2017 with the publication of a synthesis report, which informed the <i>Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria</i> .
<i>Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria</i>	These guidelines were released by DELWP in December 2017. They provide the water sector with low, medium and high annual average stream flow projections for 2040 and 2065. Water corporations use this information to plan when to augment their supply systems, taking into account the impact of climate change on stream flow. They were last used by urban water corporations to prepare their 2017–2067 <i>Urban Water Strategies</i> . See also Section 2 of this WSAAP.
<i>Victorian Water and Climate Initiative</i>	This initiative supports priority research into the impact of climate on Victoria's water resources. It includes three distinct, but related research projects undertaken in partnership with the University of Melbourne, the Bureau of Meteorology and CSIRO. The initiative will include the development of new methods for generating stream flow projections.
<i>Victorian Climate Projections</i>	<p>The <i>Victorian Climate Projections</i> project will produce new high-resolution projections of Victoria's future climate to a 5 km grid, including variables such as temperature, rainfall, relative humidity, evapotranspiration and wind. It will produce a complete package of data and information, including datasets that can be applied in impact assessments, regional reports and fact sheets.</p> <p>This project will complement but not supersede existing information such as the <i>Victorian Climate Initiative</i> or the <i>Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria</i>. It will be available in early 2019. The project will not produce stream flow change projections, but will inform the next round of water sector stream flow projections that are being developed through the complementary Victorian Water and Climate Initiative.</p>
<i>Water Measurement Information System (WMIS)</i>	DELWP monitors and reports on the health and availability of Victoria's water resources through a number of programs and partnerships, and this information is made available via the WMIS. The data can be used to analyse trends in the short to long term and includes both surface water and groundwater data.
<i>Long-Term Water Resource Assessment (LTWRA)</i>	LTWRAs provide a picture of water availability and waterway health across Victoria. Under the <i>Water Act 1989</i> , DELWP performs LTWRAs every 15 years (the first commenced in August 2018). These assessments determine whether long-term water availability has changed and, if so, whether there has been a disproportionate impact on people and industries consuming water or the environment. If either of these has occurred, an open and consultative review will determine how to restore the balance between water users and the environment. See also Appendix 3.

Policy / tool	Summary
<i>Victorian Floodplain Management Strategy (VFMS)</i>	The Victorian Government has developed the VFMS to clarify the roles and responsibilities of government agencies and authorities involved in flood management, and to improve the evaluation and communication of flood risks. The VFMS and associated <i>Regional Floodplain Management Strategies</i> (see Table 4.3) are designed to ensure appropriate responses and actions are taken before, during and after a flood.
<i>Victorian Rural Drainage Strategy</i>	The Victorian Government is developing a <i>Victorian Rural Drainage Strategy</i> to clarify the roles and responsibilities of government agencies and landholders in dryland rural drainage. It supports landholders to decide how they manage rural drainage while considering the environmental and cultural impacts of dryland rural drainage.

Table 4.3. Some regional-scale policies and tools that inform climate change adaptation in the water sector.

Policy / tool	Summary
<i>Climate Change Adaptation Plan or Strategy</i>	<p>The 10 Victorian CMAs developed their own <i>Climate Change Adaptation Plans or Strategies</i>, completing them in 2016. They help integrate climate change planning into regional natural resource and waterway management. They include spatial tools, adaptation pathways planning, extensive engagement with the community and key stakeholders, and comprehensive natural resource management plans for climate change adaptation.</p> <p>Plans and strategies for climate change adaptation have also been prepared by some water corporations and local governments.</p>
<i>Victorian Natural Resource Management Planning for Climate Change Forum</i>	Through this forum, the Victorian CMAs promote collaboration and partnerships on climate change within the water and catchments sector, share information on climate change activities, and develop high priority adaptation options for natural resource management in Victoria, including on local climate change adaptation planning.
<i>Climate Ready Natural Resource Management Planning in Victoria</i>	This online portal developed by the Victorian CMAs provides access to regional natural resource management planning information, including regional climate change projections.
<i>Regional Catchment Strategies</i>	<p><i>Regional Catchment Strategies</i> are the primary integrated planning framework through which the Victorian CMAs manage land, water and biodiversity resources. Each CMA prepares a strategy that outlines regional priorities and actions. They were last produced in 2014.</p> <p>Each CMA also produces a <i>Regional Waterway Strategy</i>, which is an eight-year strategy document that aligns with the CMA's <i>Regional Catchment Strategy</i>, and considers climate change adaptation.</p>

Policy / tool	Summary
<i>Regional Floodplain Management Strategy</i>	<p>A recent milestone in the implementation of the VFMS (see Table 4.2) is the development of 10 Regional Floodplain Management Strategies (one for each CMA). These regional strategies interpret and apply the policies, actions and accountabilities outlined in the VFMS at the regional and local levels. They were developed in consultation with communities and stakeholders such as local governments and the Victoria State Emergency Service.</p> <p>They apply a rigorous, consistent and transparent method across the state to identify local flood threats and suitable mitigation actions. Rolling three-year work plans have been agreed, which outline priority actions to be completed over the strategies' life cycle. The regional floodplain management strategies are an important component of the "all hazards, all agencies" approach to emergency management in Victoria.</p>
<i>Urban Water Strategy (UWS)</i>	<p>Each urban water corporation produces an UWS, last prepared in 2017. These strategies provide a detailed 50-year forecast of water demands for communities, along with supply options, but do not focus on water quality. They set out actions that water corporations will implement for climate change adaptation to ensure safe, secure and affordable water services. The strategies make recommendations for supply augmentations and/or demand management based on hydrological modelling. This modelling uses climate change projections from the <i>Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria</i>.</p>
<i>Sustainable Water Strategy (SWS)</i>	<p>Each SWS covers one of four regions of Victoria; Central, Northern, Gippsland and Western. They focus on long-term water resource planning, including threats to the supply and quality of water for both environmental and consumptive uses.</p> <p>The <i>Water Act 1989</i> requires the strategies to be comprehensively reviewed at least every 10 years (the last review occurred in the period 2006 to 2011). A range of climate change scenarios will inform those reviews. Each SWS also addresses any State significant challenges identified in Urban Water Strategies or disproportionate impacts identified through Long-Term Water Resource Assessments.</p>
<i>Integrated Water Management Framework for Victoria</i>	<p>The Victorian Government is creating <i>Integrated Water Management Forums</i> across metropolitan Melbourne and regional Victoria. The Forums will prioritise opportunities for collaboration and incorporate community and Traditional Owner values into urban place-based planning.</p> <p><i>Integrated Water Management Plans</i> will be prepared by these Forums. The plans may be at any scale and will identify opportunities to improve resilience by identifying opportunity to provide alternative sources of water. These water sources may, for example, be used for irrigation of urban vegetation to cool the city and combat the urban heat island effect. They will cover place-based project development from conception to delivery.</p>

Frameworks for adaptation and its implementation

Climate change affects nearly all business decisions in the water sector. In order to successfully adapt, climate change impacts should be considered in all relevant business decisions. This includes planning future services and managing threats to current assets and services.

The *WSAA Climate Change Adaptation Guidelines* (2016) provide a useful high-level framework for adaptation in water corporations. However, these were not intended for use in catchment management authorities or local government. In addition, the high-level nature of the Guidelines means that they do not deal with individual business decisions. They are also not at the level through which the Victorian water sector could track its progress over time towards better adaptation, and progress toward reaching the medium-term and long-term goals in the WSAAP.

DELWP has also developed a Monitoring, Evaluation, Reporting and Improvement framework for adaptation across the State of Victoria, which is high level and does also not assist with the tracking of progress against medium- and long-term targets in the WSAAP.

A business systems framework that examines business decisions made in water sector organisations and their climate change consideration is needed. This need is addressed by **Action 10**. It will provide a basis for:

- Reviewing the current status of adaptation decision-making across different water-related business functions;
- Identifying opportunities for improvement, which can form the basis for generating new actions for subsequent WSAAPs; and
- Tracking progress against the medium-term and long-term goals of the WSAAP.

A plan for monitoring, evaluation, reporting and improvement on the actions in the WSAAP is needed, to implement an adaptive pathways approach to improvement. This will be addressed through **Action 11**. However, monitoring and evaluating genuine adaptation is not easy as all adaptation activity is being undertaken against a backdrop of changing population, land use, economic activity, consumer behaviour, policy and regulatory settings at all levels of government including international.

These are essential components to set up an effective adaptation pathways approach for future WSAAPs, so we can monitor how well the water sector is adapting and how successful our adaptation actions in this WSAAP have been.

Scenario planning

Scenario planning is used extensively by the water sector in strategic planning activities. It is a valuable tool that identifies and plans for a range of possible futures, and is an important part of the adaptive pathways style of planning. Apart from climate change and other environmental factors, scenarios may consider changes in population, consumer behaviour, economic conditions and technology. However, given that scenarios are developed by many different people within the broader water sector, including those who are not climate experts, there is a degree of uncertainty about their accuracy and how they align with future greenhouse gas emissions and climate change mapped out by the Intergovernmental Panel on Climate Change (IPCC).

Improper representation of climate futures in scenario planning in the water sector may result in a sector that is not adequately prepared for all futures. This could result in stranded assets that were built but can no longer be used, or poor levels of service to customers.

DELWP already provides detailed guidance and data sets on how scenario planning is to be used for long-term water supply planning in water corporations, and is also in the process of generating high-level climate change scenarios to be used across all of government for future planning. However, there remains an opportunity to review how scenario planning is used across the water sector beyond water supply, to see if it is in line with best practice. This is addressed by **Action 12**.

Water Research Australia is currently undertaking a research project that will provide guidance on climate change adaptation to water sector organisations, one component of which is scenario planning. Their project has a national focus. Following completion, DELWP will work with Water Research Australia and participating Victorian water corporations to understand the outcomes of the project and how it should be applied in a Victorian water sector context.

This project is an example of exploring an adaptive pathways approach in which we recognise scenario planning has been used as an effective tool across much of water sector planning, and it is now time to review how well it is working and whether there are any opportunities for further improvement.

Water Research Australia is currently undertaking a research project that will provide guidance on climate change adaptation to water sector organisations, one component of which is scenario planning.

4.3. Enhancing staff capability and capacity to apply adaptation to business decisions

Minimising customer service disruption during emergency events

The water sector provides critical services upon which the Victorian community rely. The complex, interconnected and often interdependent nature of water sector infrastructure with other critical infrastructure, such as communications, transport, food supply and energy increases the risk of a disastrous systemic failure. It is impossible to prevent all fires, floods, storms and heatwaves, climate change is expected to result in more frequent and prolonged events.

Particular challenges come from compounding or cascading impacts (such as fire leading to power outage, or flooding to storm surge) and the water sector needs to consider and be prepared for worst-case scenario, multiple and prolonged events. Emergency events will put increased pressure on the water sector. The water sector will also be required to assist the emergency services sector and other organisations, such as by providing access to water supplies for firefighting. Improving our ability to respond effectively to emergency events will reduce their impacts on services and the community.

The water sector prepares for such events by writing emergency management plans. Given the increased likelihood of extreme and prolonged events in the future, it will be particularly important that water corporations and local government have up-to-date and robust plans to manage fire, floods and other extreme events, as well as cascading events impacting on water services. Currently the sector's emergency management

plans do not explicitly consider climate change. This gap is addressed by **Action 13**.

It is also important that the water sector reviews its workforce management principles and training framework to plan, manage, recruit and retain an emergency management workforce in the context of climate change. This will allow the water sector to make enhancements to its capability, capacity and training frameworks, to meet its emergency management challenges in the future. The need to review and update emergency management workforce strategies and training requirements, is addressed by **Action 14**.

Finally, emergency events associated with climate change may also impact on water sector operations and impact their services to customers indirectly. For example, if a storm causes a tree to fall across a road, or a bushfire makes it dangerous to drive along a road, this is a disruption to a transport corridor that may impact the services of a water or wastewater treatment facility. Similarly, disruptions in supply chains that provide chemicals used in water and wastewater treatment can also affect the water industry's ability to provide services.

One of the critical inter-sector risks is with the energy sector. The water industry uses energy for pumping and treating water and wastewater. Without power for prolonged periods, sewage can back up in its pipes and may spill into waterways. Most water corporations have backup generators for critical assets in case of power failure, but they may not prevent every sewage spill. Energy failures are most likely

to happen during heatwaves, typically occurring in summer, when sewage spills into waterways are most likely to have a negative impact on the environment.

In recent summers blackouts have also been experienced in operating centres and ICT networks which impacts widespread operations. The energy industry is also heavily reliant on water for cooling its power stations. There is an opportunity for the water industry to work with the energy sector and other sectors to understand the critical inter-sector risks and explore opportunities to mitigate the risk. The current gap in inter-sector collaboration is addressed by **Action 15**.

Financial management and governance under climate change

To reduce the vulnerability of the water sector customers to climate change it is necessary to invest in programs or infrastructure that can perform under a wider variety of climatic conditions than have been experienced in the past. Adaptation business cases may be difficult to prepare, as they will have to contend with risk, uncertainty, possible step changes and various benefits and costs. There can also be psychological, social and institutional complexity around adaptation that challenges decision-makers.¹⁰ Furthermore, due to the long lifetimes of water industry infrastructure, which may be 70 years or longer, the benefits may not be realised for several decades into the future.

One study has found that due to the long-term timeframes, and the difficulties involved in measuring returns on investment, the justification of adaptation business cases in Australia coastal areas has relied on demonstrating strategic benefits, not just financial benefits.¹¹

There is an opportunity to build water sector knowledge of both successful and unsuccessful knowledge of adaptation business cases, and identify the elements that make a business case successful. This is addressed by **Action 16**. By learning from the experiences of others, water sector staff can more quickly and easily prepare their own successful business cases for adaptation.

Climate change impacts the supply chains and operations of service providers on which the water sector relies, such as transport, chemical and energy suppliers. There are also broader global risks relating to the crude oil market, shifts towards renewable energy and global and federal carbon policies that can significantly affect water corporations' financial position. Legal and financial risks also may result from decisions the water industry may need to make in the context of more extreme flooding and sea level rise, or reduced rainfall.

There is an opportunity to further integrate climate change topics into board and executive training packages to ensure that they are mindful of their obligations, and all the potential implications of climate change to their organisations. This is addressed by **Action 17**.

Cost of climate change to water corporations

Climate change will have financial, social and environmental impacts on the customers and water sector services they receive. There has been considerable research on the social and environmental impacts of climate change on waterway health, which will be addressed in the Natural Environment AAP. The financial impacts of climate change have received relatively less attention. This is also true within the water corporations where the focus to date has been on managing operations and assets, and human and environmental water needs under climate change. The recent release of the Financial Stability Board's Recommendations of the Taskforce on Climate-Related Financial Disclosures has prompted action across the global financial market. This impacts the public water sector in Victoria through the cost of finance and insurance, where businesses that cannot demonstrate that they are managing the risks of climate change on their business may be charged higher costs. Therefore, it is important the water corporations understand the impacts of climate change on all parts of their business including cost impacts.

¹⁰ Mark Stafford Smith, Lisa Horrocks, Alex Harvey and Clive Hamilton, 2011, 'Rethinking adaptation for a 4°C world,' *Phil. Trans. R. Soc. A* 369, 196–216.

¹¹ Hales, R., Banhalmi-Zakar, Z., Sarker, T., Lo, A., Choi, A., Whittlesea, E., Fleming, C., Kelly, K., and Bun, M., 2016, 'Building the business case for climate change adaptation'. National Climate Change Adaptation Research Facility, Gold Coast.

Extreme events associated with climate change may impact on the services provided by water sector organisations or require them to invest more to maintain service levels. For example, a water corporation's revenue may decline when water restrictions are introduced in response to drought and heatwaves, and storms can also lead to service disruptions and asset damage. Some of the performance measures used by the Essential Service Commission to monitor and assess services provided by water corporations, which may be affected by climate change, include the number of:

- Water supply reliability complaints
- Sewerage service quality and reliability complaints
- Sewerage odour complaints
- Water supply interruptions
- Sewer blockages
- Sewage spills

Depending on the potential impacts of climate change and ongoing efficiency improvements, water corporations, in consultation with customers, may need to decide to lower levels of service or invest more to maintain or improve service levels. Climate change may affect operations and compliance with industry standards, but it may also affect the costs for staff to manage these events.

Water corporation boards, executives and senior managers have a responsibility to understand the costs of climate change on their businesses, in order to strategically manage the impacts. The benefits of intervention and adapting to climate change can then be estimated and used to inform climate change related business investments. This gap is addressed by **Action 18**.

Managing the impacts of algae on drinking and recreational water under climate change

Deterioration of water quality as a result of climate change poses serious risks to human health. Infection risks may occur from a variety of sources such as drinking water, water bodies used for recreational purposes, alternative water sources, waterways or marine waters. The latter two are out of scope of this AAP. Exposure to contaminated water not only exposes Victorians to the risk of gastrointestinal illness, and in some cases death, but other infections such as ear, nose and throat infections and dermatitis.

Increased temperatures can lead to a risk in the prevalence of harmful algae, weeds or pest animals, expansion of the range of previously climatically restricted pathogens and vectors, and may increase biofilm formation and growth of pathogens. More frequent bushfires can impact on water quality in water supply catchments over periods ranging from months to years. Changes in vegetation, and in particular dieback of vegetation, can impact water quality and the ability of water corporations to achieve microbial health-based targets used in the *Australian Drinking Water Guidelines* and the *Australian Guidelines for Water Recycling*. Storm events can have a significant impact on water quality and overwhelm the capacity of treatment barriers. Storm surges can overwhelm the sewerage system and increase contaminant runoff from catchments, polluting water supplies and waterways, with impacts on humans (both drinking water and recreational water) and environmental and agricultural uses.

Floods can wash sediment, nutrients, human and animal waste and chemicals into water supplies and receiving waters, in some extreme cases rendering drinking water sources unusable for months. Heavy rainfall events are particularly bad following a drought or fire, where vegetation is limited and soil is dry, as more sediment washes into the water body.

Water quality is well managed in Victoria, and there has been much research undertaken to inform management of water quality under climate change. But there remains an opportunity to review current management practices around water quality threats associated with climate change and, where gaps are identified, to strengthen management practices.

This will take a number of years to address. The first step will be to address algal management, as water sector organisations have experienced toxic algal blooms that are occurring longer or in water bodies where they've not occurred before. This is addressed by **Action 19** which will focus on managing algal water quality in both drinking water and recreational water.

Management of the impacts of climate change on sewerage

More intense rainfall and drier average conditions both affect sewer and wastewater infrastructure and operations. One way water corporations are addressing this is keeping abreast of new technology through programs such as Intelligent Water Networks (IWN) and Technology Approval Group and applying some of these technologies to their businesses. The IWN is a partnership between VicWater, 18 Victorian water corporations, and DELWP.

The IWN is investigating new technologies, such as leak detection and energy optimisation equipment, to meet the range of potential future challenges associated with population growth and climate change.

The *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria* are used by water resource planners to ensure that towns and cities have secure water supplies under climate change, but there are currently no analogous guidelines for sewerage planners. This gap is addressed by **Action 20**.

Specialist sewerage planners have indicated that statewide climate change guidelines would help them better prepare for climate change. The guidelines will be based on best practice science and engineering collated through Action 7 (Section 5) and will be regularly updated as the science improves.

South East Water. Photograph Craig Moodie.



5. Actions: three-year plan

This section lists the actions required to address the 20 gaps identified in Section 4. These actions are to be completed between 2018 and 2020. They correspond to the short-term objectives of this WSAAP, and collectively they inform the medium- and long-term objectives. They have been developed through discussions and workshops with DELWP, water corporations, catchment management authorities and local government representatives.

In 2021, a new five-year plan of actions will be identified in the first legislated WSAAP, informed by the latest research, thinking and policy. The actions are intended to improve adaptation in the water industry to improve service delivery in future climate conditions without adverse effects on consumer costs. One action specifically seeks to quantify the cost of climate change to water corporations, which informs the broader question of costs to customers. Note however it does not specifically quantify the costs to customers, as this is a financial question for each water corporation and the pricing regulator, Essential Services Commission.

DELWP is leading most actions, and will carry them out in close partnership with the relevant water sector organisations, government departments and regulators. DELWP is engaged in a robust cycle of adaptation planning for climate change. Monitoring, evaluation, reporting and improvement inform an adaptive planning cycle that is explained in Appendix 1 and detailed in a separate implementation plan. The greenhouse gas emissions of each action have been considered and are explained in Appendix 4.

Table 5.1 lists adaptation actions to address each gap identified in Section 4, the timeframe of delivery, and which organisations will be involved.

DELWP is leading most actions, and will carry them out in close partnership with the relevant water sector organisations, government departments and regulators. DELWP is engaged in a robust cycle of adaptation planning for climate change.

Table 5.1. New climate change adaptation actions, which have been developed to address each of the gaps identified in Section 4.

Action	Lead
Objective 1: Build knowledge of how climate change will impact Victoria's water sector	
Action 1: Undertake a water grid stress test	DELWP
Action 2: Understand implications of more intense rainfall in combination with overall drier conditions, for flooding	DELWP
Action 3: Consider the changing sewerage, drainage and flood management risks under climate change in Integrated Water Management Forums	Water corporations, CMAs, Local government
Action 4: Encourage the use of best practice methods to incorporate climate change into the estimation of future flood impacts	DELWP
Action 5: Identify impact of climate change on Traditional Owner values associated with water and how to adapt to them	DELWP
Action 6: Collate and share knowledge about the impact of climate change on water supply between water sector stakeholders.	DELWP
Action 7: Collate and share knowledge about the impact of climate change on sewerage	DELWP
Action 8: Improve information sources on adaptation for the water industry	DELWP
Objective 2: Develop the framework, policy and tools to enable successful adaptation in the water sector	
Action 9: Review the Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria	DELWP
Action 10: Develop a framework to inform consistent and systematic embedment of climate change considerations into water business decisions	DELWP
Action 11: Develop a monitoring, evaluation, reporting and improvement plan	DELWP
Action 12: Review the use of climate change scenarios in water sector planning	DELWP
Objective 3: Enhance the capacity and capability of water sector staff to apply climate change adaptation to business decisions	
Action 13: Review emergency management plans used in the water sector in the context of climate change	DELWP
Action 14: Review and update workforce emergency management capability, capacity and training requirements	DELWP
Action 15: Identify and manage key risks between water and other critical service sectors	DELWP
Action 16: Identify key elements of successful adaptation business cases	DELWP
Action 17: Develop and deliver guidance material for water industry boards and executives on climate change risks and duties of care	DELWP
Action 18: Estimate the costs of climate change to water corporations	DELWP
Action 19: Improve management of the potential impacts of climate change on water quality relating to algae	DELWP
Action 20: Prepare guidelines for assessing the impact of climate change on sewerage systems	DELWP

Participants	2018	2019	2020
Water corporations, CMAs, VEWH			
Victorian Water Sector; Bureau of Meteorology			
DELWP			
Stormwater Victoria, Engineers Australia, water sector organisations			
Traditional Owners, DELWP			
Water corporations			
Water corporations			
Water corporations, CMAs, Local government			
Victorian water sector			
Water corporations, CMAs, Local government			
Water corporations, CMAs, Local government			
Victorian water sector			
Water corporations, Local government, Emergency management sector			
Water corporations, Local government, CMAs, Emergency management sector			
Water corporations			
Water corporations, DTF, CMAs, Local government			
Water corporations, CMAs, Local government			
Water corporations, DTF			
DELWP, DHHS, Water corporations, Parks Victoria, Local government, other local water managers			
Water corporations			

5.1. Actions to build knowledge

Action 1

Undertake a water grid stress test

Deliverable: Future climate change test scenarios and results

Outcome: To identify the resilience of our water systems to cope with major shocks and identify areas where further investigation and action is required

Timeframe: By December 2020

Organisations: DELWP (lead), water corporations, CMAs, VEWH

DELWP will develop and apply stress-test scenarios to examine the response of the water grid (in terms of water quantity only) and the entitlement framework under climate change. This work will be conducted in conjunction with water corporations and the grid oversight function, and will consider all water users including environmental water.

It will be delivered through DELWP's project to establish a state-wide water grid oversight function, which commenced in early 2018. Consistent with *Water for Victoria*, it will establish a centralised forum for testing strategic decisions, which will inform regional and system-wide water resource investment decisions. In its development, there is an opportunity to consider grid operation during different climate futures, including those not experienced in the past. This will ensure that the grid can operate to deliver maximum customer service during future climate variability and change. Work is continuing on the particulars of the model which is scheduled to commence operation in early 2019.

Action 2

Understand implications of more intense rainfall in combination with overall drier conditions, for flooding

Deliverable: Report

Outcome: Provide up-to-date understanding of the flooding implications of drying conditions and increased intensity of rainfall to inform improved flood estimation

Timeframe: By July 2019

Organisations: DELWP (lead), Bureau of Meteorology, water sector organisations

DELWP is leading and funding this research, which will explore changes to Victoria's flow regimes arising from changes to rainfall intensity in combination with reductions in long-term annual rainfall. The project will explore the implications of these changes for both rural catchment flooding, and urban stormwater flooding, by considering changes to baseflow and antecedent conditions.

Action 3

Consider the changing sewerage, drainage and flood management risks under climate change in Integrated Water Management Forums

Deliverable: Influence

Outcome: IWM Forums and plans consider climate change

Timeframe: By April 2019

Organisations: Water corporations, CMAs, Local Government (leads), DELWP

CMAs, local government, water corporations and Traditional Owner groups will consider the need for a whole-of-catchment approach to managing drainage, sewerage and flood management under climate change, and raise relevant risks and gaps to the IWM Forums to be addressed.

Action 4

Encourage the use of best practice methods to incorporate climate change into the estimation of future flood impacts

Deliverable: Industry workshops and/or training

Outcome: Awareness raising and a resulting change in practice

Timeframe: December 2020

Organisations: DELWP (lead), Stormwater Victoria, Engineers Australia, water sector organisations

DELWP will support Stormwater Victoria to deliver training in the use of the methods and tools recommended by ARR 2016, including the methods to model more intense rainfall under climate change. The training will enable council drainage engineers and their service providers to apply Australian Rainfall and Runoff climate change guidance to the design of urban drainage systems.

Action 5

Identify the impact of climate change on Traditional Owner cultural values associated with water and how to adapt to them

Deliverable: Report on how Traditional Owners cultural values will be impacted by climate change and how the water sector and Traditional Owners can best partner to adapt

Outcome: Awareness raising; Traditional Owner groups' input to water sector plans and strategies includes consideration of climate change adaptation

Timeframe: December 2020

Organisations: DELWP, Traditional Owners (co-lead)

DELWP will build on the work undertaken through the Victorian Aboriginal Waterway Assessments, and will partner with the Dja Dja Wurrung to:

- Examine how the Traditional Owner values associated with water will be impacted by climate change;
- Identify how to adapt to those impacts; and
- Identify and share what we can learn from adaptation of traditional owners to water-related changes to date.

Other Traditional Owner groups will be invited to participate.

Action 6

Collate and share knowledge about the impact of climate change on water supply between water sector stakeholders

Deliverable: Workshop/Forum

Outcome: Greater industry knowledge of good practice management of water supply under climate change and variability

Timeframe: By January 2019

Organisations: DELWP (lead), water corporations

DELWP will work with water corporations and CMAs to collate and share information on the impact of climate change and variability on water supply. The sharing of knowledge and adaptation planning tools will assist the water sector in planning for these anticipated changes to supply and demand. Opportunities to share what has been learnt from dealing with inadequate water supplies in the past will help water managers in understanding what actions may be taken to protect water supply into the future.

Action 7

Collate and share knowledge about the impact of climate change on sewerage

Deliverable: Discussion Paper

Outcome: A common understanding of the impacts of climate change on sewerage system, agreed scope for preparing guidelines

Timeframe: By January 2019

Organisations: DELWP (lead), Water corporations

DELWP will work with water corporations to collate information on the impact of climate change and variability on peak wet-weather flows, sewerage asset management, odour and corrosion in sewers, and sewage quality. EPA will be consulted in delivery of this action, to align regulatory expectations and adaptation efforts.

Action 8

Improve information sources on adaptation for the water industry

Deliverable: Accessible information

Outcome: Improved understanding of best practice adaptation and climate change projections/data

Timeframe: By April 2020

Organisations: DELWP (lead), Water corporations, CMAs, Local Government

DELWP will collate and share international information on adaptation case studies, best practice approaches to adaptation, and Victorian climate change projections and data. It will be stored in a convenient, online location accessible to the water industry.

5.2. Actions to develop frameworks, policy and tools

Action 9

Review the *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria*

Deliverable: Report (updated guidelines)

Outcome: Improved planning for water availability using up-to-date climate science

Timeframe: By December 2020

Organisations: DELWP (lead), water sector organisations

DELWP will work with stakeholders to review and update the *Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria*, based on up-to-date climate science.

Action 10

Develop a framework to inform consistent and systematic embedment of climate change considerations into water business decisions

Deliverable: Water sector business systems framework for climate change

Outcome: A framework that enables climate change to be incorporated into all relevant business decisions. The Framework should also inform future gaps and development of future WSAAPs

Timeframe: By October 2020.

Organisations: DELWP (lead), Water corporations, CMAs, Local Government

DELWP will work with water service providers and develop a draft framework to inform consistent and systematic embedment of climate change considerations into all relevant water business decisions. The framework will be developed, reviewed and tested by the water service providers, and improved over time. It could include elements such as assessing the sensitivity of a decision to climate change, assessing sensitive decisions against a range of future climate scenarios, and identifying preferred approaches and triggers for action in the future.

A number of the actions outlined in this plan leads towards better embedding of climate change in a range of decisions, such as those for scenario planning, emergency management and improving information sources. These can provide good starting points for water businesses to consider what a framework could look like and how it may be applied. The framework would build on existing work such as the *WSAA Climate Change Adaptation Guidelines*, which outline six core functions for water corporations that are impacted by climate change but may not cover the full suite of functions for other water service providers. It will also align with the Water Research Australia research project, which aims to provide guidance and a toolbox for the water corporations to enhance climate change adaptation across the business.

The framework will also create a framework whereby the water sector can examine which areas of the business in which climate change is well integrated, and in which areas further work is needed. It will inform the development of actions for subsequent WSAAPs.

Action 11

Develop a monitoring, evaluation, reporting and improvement plan

Deliverable: Monitoring, evaluation, reporting and improvement detailed in implementation plan

Outcome: Implementation of WSAAP will be monitored, reported on and evaluated at intervals specified in the implementation plan. Improvement opportunities are identified and acted upon

Timeframe: By January 2019

Organisations: DELWP (lead), Water corporations, CMAs, Local Government

DELWP will develop a monitoring, evaluation and reporting plan (not a framework), for this WSAAP and, in doing so, will explore opportunities to link it to broader high-level reporting frameworks for adaptation. It will provide a basis for an adaptive cycle in which lessons will be learnt from the WSAAP and inform the development of the next WSAAP.

Action 12

Review the use of climate change scenarios in water sector planning

Deliverable: Completed review and report

Outcome: Greater understanding of use of scenarios in water sector planning

Timeframe: By July 2020

Organisations: DELWP (lead), water corporations, CMAs, local government

DELWP will work with the water sector to review how climate change has been incorporated into selected long-term planning activities relating to water, sewerage, drainage and flood management. Differences in approaches will be identified and considered. Reviewing the existing activities for the extent to which they include climate change and variability will build awareness and, potentially, identify opportunities to better integrate climate planning into broader water sector activities.

5.3. Actions to enhance staff capability and capacity to apply adaptation to business decisions

Action 13

Review emergency management plans used in the water sector in the context of climate change

Deliverable: Guidance material for water sector to update their own emergency management plans

Outcome: Improved assessment of risk to water sector in emergency incidents in the context of climate change, improved preparation, reduced vulnerability, and safer and more resilient communities

Timeframe: By March 2019

Organisations: DELWP (lead), water corporations, local government, emergency management sector

DELWP will facilitate the review of emergency management plans amongst the water corporations and local government and develop guidance material regarding the incorporation of climate change. The broader emergency management sector will be consulted. Water corporations and local government will review and, where necessary, update their emergency management plans in the context of climate change, to be prepared for the more frequent extreme events expected in future.

Action 14

Review and update workforce emergency management capability, capacity and training requirements

Deliverable: A gap analysis

Outcome: Gap analysis complete and implementation of actions to address gaps brought up in review

Timeframe: By July 2019

Organisations: DELWP (lead), Water sector organisations, emergency management sector organisations

DELWP will facilitate the review of water corporations and local government workforce capabilities, capacity and training frameworks in the context of climate change.



Action 15

Identify and manage key risks between water and other critical service sectors

Deliverable: Framework for identifying critical inter-sector risks

Outcome: Risk professionals in water sector can identify critical inter-sector risks and actively manage them

Timeframe: By January 2019

Organisations: DELWP (lead), Water corporations

DELWP will develop a framework for identification and management of key interdependent risks between the water and other critical infrastructure sectors.

Action 16

Identify key elements of successful adaptation business cases

Deliverable: Guidelines

Outcome: Water sector is better informed on what constitutes a successful adaptation business case

Timeframe: By January 2020

Organisations: DELWP (lead), Water corps, DTF, CMAs, Local Government

DELWP will work with interested water sector organisations to collate and share case studies of adaptation business cases, both successful and unsuccessful. They will analyse and share the common traits of successful business cases and unsuccessful ones, identify the financial analysis tools useful for adaptation.

Action 18

Estimate the costs of climate change to water corporations

Deliverable: Report

Outcome: Water corporation can determine value of investing in adaptation

Timeframe: By January 2019

Organisations: DELWP (lead), Water corporations, DTF

DELWP will work with four water corporations (one rural, one regional, one retailer and one bulk supplier) to estimate the cost of climate change on their businesses, and the financial impacts of continuation of current practices versus further adaptation. Results will be shared with all water corporations and other interested water sector organisations.



Action 17

Develop and deliver guidance material for water industry boards and executives on climate change risks and duties of care

Deliverable: Guidance material and training

Outcome: Board members are aware of their duties regarding climate change and actively fulfil them in their work

Timeframe: By April 2019

Organisations: DELWP (lead), Water corporations, CMAs, Local Government

DELWP will lead the development of a training package for boards and executives on climate change impacts on water sector organisations and will work with relevant agencies to deliver the training.

Planned burn preparation, Lysterfield Park, 2015.
Photograph copyright State of Victoria, DELWP.

Action 19

Improve management of the potential impacts of climate change on water quality, relating to algae

Deliverable: Information provision, stakeholder engagement and training

Outcome: Greater knowledge of the impact of a changing climate on algal management

Timeframe: By January 2020

Organisations: DELWP (lead), DHHS, Water corporations, Parks Victoria, Local Government, other local water managers

DELWP will work with water service providers and other local water managers, with input from DHHS, to review the current approach to managing algae and its impacts on drinking water and recreational water quality.

Action 19 may have a range of implications, including better knowledge sharing and information on managing climate change threats to water quality resulting from increased occurrence of algae, changes in catchment management to reduce risks, and possibly also treating water more extensively. This last step typically uses more energy, which will exacerbate greenhouse gas emissions unless renewable energy is used.

Action 20

Prepare guidelines for assessing the impact of climate change on sewerage systems

Deliverable: Guidelines

Outcome: Guidance is provided on impact of climate change, implemented in sewerage strategies

Timeframe: By January 2020

Organisations: DELWP (lead), Water Corporations

DELWP will work with water corporations to prepare Guidelines for Assessing the Impact of Climate Change on Sewerage Systems. The guidelines will be relevant to the planning, design and operation of sewerage systems. The EPA will be consulted in delivery of this action, to align regulatory expectations and adaptation efforts.



5.4. Funding sources

Resourcing differs for each action. Money will be funded by DELWP with in-kind time and resources from water sector organisations that volunteer. With the exception of the IWM action which is facilitated by DELWP and led by water sector organisations.

Representatives from Gunditj Mirring Traditional Owners Aboriginal Corporation and Glenelg Hopkins Catchment Management Authority at Lake Condah. Photograph Craig Moodie.

Appendix 1 – Process of development and delivery

The process for preparing this WSAAP has included:

- Stocktake, gap analysis, rapid international review of best practice adaptation
- Workshop and working groups to agree the challenges and develop actions
- Consultation draft released to water sector as well as Government Departments, regulators, other relevant parties including academics and industry bodies.
 - Peer review
 - Submissions
 - Finalisation of draft

Engagement with the water sector

This WSAAP has been developed in consultation with CMAs, local governments, water corporations and the Victorian Environmental Water Holder. These organisations participated in a detailed stock take of actions currently underway and helped identify and select further actions for the future.

Many CMAs, local governments, rural water corporations and urban water corporations have their own climate change resilience plans which focus primarily on their operations, assets, businesses and how they work with their local communities and stakeholders. This WSAAP complements this other work and has been developed in conjunction with these stakeholders.

Collaboration with these stakeholders will continue throughout the life of the WSAAP, to align with State and regional-level adaptation actions already occurring. This will reduce the likelihood of duplication and increase alignment and shared benefit opportunities.

DELWP would like to acknowledge and thank the following for contributing to the development of this WSAAP.

Representatives from these local government organisations:

- City of Melbourne
- City of Port Phillip
- Greater Shepparton City Council
- Manningham City Council
- Municipal Association of Victoria
- Wyndham City Council

Representatives from these CMAs:

- Glenelg Hopkins Catchment Management Authority
- Goulburn Broken Catchment Management Authority
- Mallee Catchment Management Authority
- North Central Catchment Management Authority
- West Gippsland Catchment Management Authority

Representatives from these water corporations:

- Barwon Water
- Central Highlands Water
- City West Water
- Coliban Water
- East Gippsland Water
- Gippsland Water
- Goulburn Valley Water
- Goulburn Murray Water
- Grampians Wimmera Mallee Water
- Lower Murray Water
- Melbourne Water
- North East Water
- South East Water
- South Gippsland Water
- Southern Rural Water
- Wannon Water
- Western Water
- Westernport Water
- Yarra Valley Water

Background papers

Research into existing climate change adaptation actions was undertaken, in three parts.

• Review of existing climate change adaptation

A review was conducted of climate change adaptation actions undertaken across the Victorian water sector in water, sewerage, drainage and flood management. This desktop study was prepared by DELWP, drawing on documents by DELWP, local governments, CMAs and water corporations. It was circulated to the water sector for review and feedback. It highlighted that extensive climate change adaptation work has been undertaken over the last 15 years and forms the basis for the gap analysis and new actions in the WSAAP.

• Review of leading practice in adaptation

An online review of leading practice, supplemented with interviews of selected specialists, was used to collate case studies in adaptation, both nationally and internationally. It was circulated to stakeholders who contributed to developing this WSAAP. Its purpose was to prompt new ideas before developing the actions for this WSAAP.

• Gap and opportunity analysis

A gap and opportunity analysis was led by DELWP and involved phone conversations with Victorian water corporations, CMAs, local government organisations and DELWP staff. These conversations were focused on existing adaptation activities, current challenges, and how DELWP could assist. This was summarised, documented and circulated to the stakeholders involved in developing this WSAAP.

Workshop and working groups

Following circulation of the three background papers, a large industry workshop provided feedback, identified the adaptation challenges, and generated ideas for actions. The ideas were then reviewed by four specialist working groups, consisting of water sector members, that used them to develop the actions that are presented in this WSAAP.

Peer review and feedback on the consultation draft

Written and verbal feedback was received on the consultation draft from the two peer reviewers:

Dr. Paul Pretto, Mind the Curve Consulting.

Dr Karyn Bosomworth, RMIT University

Additional feedback was received from:

Water corporations, CMAs, Municipal Association of Victoria, Kingston City Council, DTF, DHHS, DEDJTR, DTF, ESC, VEWH, DPC, EPA, University of Technology, Sydney, Water Services Association of Australia, Water Research Australia, Victorian Aboriginal Heritage Council and Dja Dja Wurrung Clans Aboriginal Council.

DELWP thanks everyone for their positive feedback and their suggestions, and has made many revisions in response to the feedback.

Forward process – tracking delivery

Timely delivery of the actions against the three short-term objectives will be tracked, to ensure actions are delivered on time and on budget. It links with the Monitoring and Evaluation Framework that was established for *Victoria's Climate Change Adaptation Plan 2017–2020*. This program level monitoring and reporting will be used to track progress of the sector towards better adaptation over successive WSAAPs.

Monitoring, evaluation and reporting for each individual action are also specified in an implementation plan for this WSAAP and in the project management of each of those actions. This level of monitoring, evaluation and reporting is useful for water sector organisations that are linking the actions undertaken into their business activities and decisions. Action-specific indicators and targets will be developed during the detailed scoping of each action.

There is also an 'improvement' component of the implementation of this Plan, where there will be an evaluation of the implementation of the actions in the Plan and demonstration how new knowledge will inform adaptation. This will set in place an adaptive planning cycle, to inform future WSAAPs and further adaptation in the sector.

Funding and in-kind contributions are different for each action, and most of the funding is through DELWP. Water sector organisations, government departments, research organisations and regulators are collaborators and engaged on various projects. The separate implementation plan details the funding and stakeholder details for each project.

Preparation and research for the 2018 *State of the Environment* report is underway, with an interim report released in July 2018, led by the Commissioner for Environmental Sustainability. The final version will be released in early 2019. The interim report has some high-level indicators relating to climate change adaptation, which align well with the objectives set in the WSAAP. Monitoring, evaluation and reporting is aligned as much as possible with the interim report. Upon release of the final State of Environment report we will consider opportunities to align the monitoring, evaluation and reporting for this WSAAP to it and other reporting frameworks applicable to the Victorian Government context, including a future Victorian State of Climate Change Adaptation report, or similar from the Commissioner for Environmental Sustainability.

Appendix 2 – Summary of water entitlement and water resource planning frameworks

In Victoria, water is shared and managed in a way that provides both certainty and flexibility in an increasingly variable climate. Our robust water entitlement and water resource planning frameworks provide certainty of legal rights and obligations, and flexibility for entitlement holders to manage their own risks and make decisions about how they use water to meet their needs.

Long-term planning

Victoria's long-term planning arrangements, as set out in the *Water Act 1989*, have been designed to:

- Acknowledge and cater for regional variability in water availability
- Ensure stakeholders have tools available to make the most effective decisions about their water resources and to allow intervention if assumptions about water availability are no longer valid
- Ensure stakeholders have tools available to make the most effective decisions about their water resources and to allow intervention if assumptions about water availability are no longer valid
- Ensure appropriate governance for independent oversight of resource assessment and the need for any corrective action, and
- Involve community and stakeholders in all stages of long-term planning

Water markets

Victoria's water entitlement and planning framework underpins its water markets. Victoria's water markets allow farmers, the Victorian Environmental Water Holder (VEWH), and water corporations to buy and sell water entitlements and seasonal allocations, allowing water to move to where it is most valued. Water markets enable them to share water security benefits in ways that are equitable, responsive and transparent.

The government provides accessible and transparent information for water users, planners and managers. Good information is essential if all potential and existing market participants are to understand water markets. Good information builds market participants' capability, and it builds community literacy about markets. Clear and accessible information is critical to the efficient operation of water markets and to efficient investment in the infrastructure of the water grid.

The regulated surface water market in northern Victoria is the longest established market in the State. It has a value of over \$4 billion and it is highly sophisticated with interstate connections. Similar markets operate on much smaller scales in southern Victoria, such as in the Macalister and Werribee systems. Western Victoria has water markets that have operated for many years. *Water for Victoria* outlines a range of actions for improving market effectiveness throughout Victoria.

The South Central Market Trial

The *South Central Market Trial* is a major government initiative. As a potential benefit, developing the south-central water market may provide opportunities to delay or avoid costly additions to the water grid, free up water trading within the southern irrigation districts and water for environmental outcomes. The implications of different market settings under different climate change scenarios and during periods of water scarcity will be investigated as part of the trial, as will the role of the grid in creating opportunities for water to move where it is needed and most valued.

The Victorian Water Register

The Victorian Water Register provides water users with essential information about water entitlements, seasonal allocations, trade and transfers. The water register is the authoritative record of water entitlements, and facilitates the transactions that are the basis of Victoria's water markets. The government is working to make better use of that information by strengthening the reporting framework for water register information.

Long-Term Water Resource Assessment

The *Long-Term Water Resource Assessment* (LTWRA) is an opportunity for the Government to adjust water entitlements to share more equitably the impact of a long-term reduction in water availability caused by climate change. A review is required if the robust technical assessment shows a decline in water availability that has resulted in a disproportionate impact on water available for consumptive use or the environment. The review will determine how to restore the balance between consumptive and environmental use in an open and consultative manner that considers social, environmental and economic matters. LTWRAs are required every 15 years and the first assessment commenced in August 2018.

In Victoria, water is shared and managed in a way that provides both certainty and flexibility in an increasingly variable climate. Our robust water entitlement and water resource planning frameworks provide certainty of legal rights and obligations.

Role in climate change adaptation of water supply

The strength of Victoria's water entitlement and planning frameworks was reinforced during Victoria's driest 13 years, the Millennium Drought. The effects of climate change on droughts and lower average rainfall mean that it is important to understand, manage, and plan for changing water availability and changing patterns of demand and use.

Secure rights to water and a responsive planning framework:

- Enable Victorians to adapt to climate change and the changing values and uses of water
- Enable agricultural production and future industry growth
- Enable protection of the water-related values of Traditional Owners
- Help protect the environment by providing sufficient water to maintain the health of river systems
- Help deliver liveability and recreational outcomes

Together with the water market and water supply infrastructure, these entitlement and planning frameworks provide security and create confidence for communities, the environment, and business, industry and investment growth. Good quality and timely water resource management information provides a strong foundation for those planning frameworks.

Strengthening our frameworks

While Victoria's water entitlement and planning frameworks are robust, the Government is helping to strengthen them to deal with the challenges ahead. DELWP is working with water corporations and the Victorian Environmental Water Holder to review and streamline regulatory instruments to improve transparency, to clarify roles and responsibilities, to reduce red tape and to improve water literacy.

Appendix 3 – Other related work underway

The Government, water corporations and CMAs have been actively investing in water infrastructure and efficiency programs to make Victoria more resilient to climate change. Reducing water loss through evaporation and leakage and using less water through efficiency programs means that water users will need less water during dry times and delays augmentations to our water supply assets.

The Victorian Government will also improve rural water supply planning processes by reviewing the reserve rules in regulated water systems, as part of the Sustainable Water Strategies. Rural water system operators are using an appropriate range of climate scenarios to develop low-flow contingency plans in consultation with other entitlement holders and the community. Rural water corporations are also improving the provision of water resource availability information to all water entitlement holders, such as their Annual Water Outlooks, to make their forecast water availability easier to understand and more readily available to the broader community.

Water quality

Deterioration of water quality as a result of climate change poses serious risks to human health. Infection risks may occur from a variety of sources such as drinking water, water bodies used for recreational purposes, alternative water sources, waterways, or marine waters. The latter two are out of scope of this AAP. Exposure to contaminated water not only exposes Victorians to the risk of gastrointestinal illness, and in some cases death, but other infections such as ear, nose and throat infections and dermatitis.

Increased temperatures can lead to a risk in the prevalence of harmful algae, weeds or pest animals, expansion of the range of previously climatically restricted pathogens and vectors, and may increase biofilm formation and growth of pathogens. Higher temperatures may lead to more frequent bushfires, which can impact on water supply catchment areas over many years. Storm events can have a significant impact on water quality and overwhelm the capacity of treatment barriers. Storm surges can overwhelm the sewerage system and increase contaminant runoff from catchments, polluting water supplies and waterways, with impacts on humans (both drinking water and recreational water) and environmental and agricultural uses. Floods can wash sediment, nutrients, human and animal waste and chemicals into water supplies and receiving waters, in some extreme cases rendering drinking water sources unusable for months to years. Heavy rainfall events are particularly bad following a drought or fire, where vegetation is limited and soil is dry, as more sediment washes into the water body.

The Department of Health and Human Services Water Program aims to improve water quality and protect Victorians from waterborne illness. They administer drinking water regulation, inform state and national policy, and raise awareness. The Water Program:

- ensures drinking water is delivered to Victorians by water businesses in accordance with the requirements of the *Safe Drinking Water Act 2003* and the *Safe Drinking Water Regulations 2015*
- endorses Class A recycled water schemes
- conducts technical appraisal of fluoridation plants
- informs policy as it relates to the public health aspects of water quality
- oversees the Victorian water fluoridation program under the *Health (Fluoridation) Act 1973*, and
- supports the Chief Health Officer in administering the *Public Health and Wellbeing Act 2008* as it pertains to blue-green algae, aquatic facilities, recreational water and private drinking water supplies.

Health of waterways and catchments

As described in *Water for Victoria*, the Government is investing \$222 million to improve and monitor the health of our waterways and catchments (waterway health will be covered in the Natural Environment AAP). Waterway water quality suitable for environmental, biological and ecological purposes is also an important consideration that is in the scope of the Natural Environment Adaptation Action Plan.

- The health of our rivers, wetlands, floodplains, estuaries and catchments is at risk from a range of factors, including extreme weather events. The majority of the \$222 million expenditure will go towards on the ground investment in waterways and managing and delivering environmental water.
- The Victorian Catchment Management Council prepares a Catchment Condition and Management Report every five years. This report presents stream condition mapping. The mapping has been prepared at about five-yearly intervals since 1999 and can be used to monitor the combined impact of climate change, investment in waterway restoration and other factors.

Water use management programs

- Water corporations deliver programs to reduce water demand and losses. These are extensive and include programs such as community education, more rapid leak identification and repair, installation of intelligent metering, varying infrastructure operations to reduce losses, rural infrastructure modernisation to reduce water loss through channel cracks and evaporation, and use of alternative water sources such as rainwater and stormwater.
- The Government has revived the *Target 155* and *Target Your Water Use* efficiency programs, and is expanding the *Schools Water Efficiency Program*. These programs improve our ability to adapt to climate change and reduce the pressure on our water resources by improving water efficiency. By using less water now, our storages will be fuller when the next drought occurs.

Improving irrigation

- There is a policy framework that supports sustainable allocation of water to irrigators and is applied in all years including years of low water availability (e.g. during drought) as well as those of average or high water availability.
- The *Sustainable Irrigation Program* reduces adverse impacts of irrigation on the environment and third parties, whilst improving water use efficiency. The program makes irrigation less vulnerable to climate change by reducing water leakage and evaporation, which means that there is more water available during normal years and during times of drought. The Victorian Government is investing \$59.5 million in this over the next four years.
- Victoria is investing \$2.4 billion in irrigation modernisation and other water infrastructure projects. It includes contributions from the Victorian Government, Commonwealth Government and water corporations. The government is currently investing in the Sunraysia region, Werribee Irrigation District, Bacchus Marsh Irrigation District and Macalister Irrigation District modernisation projects, and the Goulburn Murray Water Connections Project.

As described in Water for Victoria, the Government is investing \$222 million to improve and monitor the health of our waterways and catchments.

Drought preparedness and response

- *Drought Preparedness Plans* (DPP) set out how the community, local government and water corporations will ensure the health of our priority parks, gardens and sporting fields, particularly during drier times. DPPs are developed in consultation with local government and recognise that droughts are likely to be more frequent and severe under climate change. DPPs are currently being prepared.
- The Annual Water Outlook for Victoria is a summary of water corporations' outlooks for the State's water supplies over the coming year. It informs Victorians how water corporations will manage water for drinking, commercial and agricultural uses under forecast weather and catchment conditions. The Outlook also summarises the key challenges for ensuring safe, secure water for communities.

Emergency preparedness and response

- The *Victorian Preparedness Framework* was released by Emergency Management Victoria (EMV) in June 2017. The framework provides a model to assist the emergency management sector in understanding its capability to respond to major emergencies, including natural hazards such as storms, heatwaves, bushfires, and floods. Work has been underway to develop targets for the 21 core capabilities that were first identified in the *Victorian Preparedness Goal* and then developed in the framework. Core capabilities have been based on the biggest threats facing the state according to outcomes of the *Emergency Risks in Victoria: Report of the 2012–13 State Emergency Risk Assessment*. This work will allow us to leverage assistance from Government, business and community in increasing Victoria's capability. Consultation has occurred across the emergency management sector since 2015, involving over 30 departments, agencies, organisations and local council representatives. An assessment phase of the capability targets will commence by 2018.
- The *Critical Infrastructure Resilience Strategy* recognises that while it is impossible to prevent the occurrence of natural disasters, it is possible to mitigate risks and consequences through effective planning. It provides industry with a transparent and consistent method for assessing the 'criticality' of infrastructure. The strategy notes the interdependencies between infrastructure and how telecommunications, power, oil, gas and transportation infrastructure relies on water.

Assessing climate change impacts on coasts

- The *Victorian Coastal Inundation Dataset* is a digital dataset consisting of eight spatial layers modelling the extent of land subject to coastal inundation due to projected sea level rise from 2009 to 2100. This dataset is not suitable for inundation assessments at a property level, but provides information that water corporations could use to assess the impacts of sea level rise on larger assets.
- *Coastal Hazard Assessments* map coastal inundation at a higher resolution. These have been completed for four locations: Western Port, Gippsland Lakes, Port Fairy and Bellarine Peninsula.

Appendix 4 – Greenhouse gas emissions of the actions

Few of the actions in this plan have any significant impact on greenhouse gas emissions of the water sector. There are three that may have a potential influence on emissions from the sector.

Undertake a water grid stress test

The water grid provides opportunities for water to move where it is needed and most valued. This process draws on different water sources and pumps them between different locations. Different sources of water have different energy footprints in terms of the water source, its treatment, and its delivery via pumping stations to the water user. If grid energy is used from non-renewable energy sources there will be a carbon footprint. However, if renewable energy sources are used, there will not. Currently the water sector uses a mix of renewable and non-renewable energy sources, and is set on a path to zero net emissions by 2050 (and for the four metropolitan water corporations, by 2030).

Improve management of the potential impacts of climate change on drinking water quality

The treatment of water to drinking quality involves use of energy, and where that energy is not renewable, greenhouse gas emissions will be generated. It is possible that further examination of management of water quality under climate change through this action will reveal that more extensive treatment is needed in some water treatment plants, using more energy. But it is also possible that modifying existing water treatment plant management will be sufficient.

These two actions are examples of possible trade-offs between emissions reduction and adaptation. While it is always best to undertake adaptation activities that reduce emissions, the treatment of drinking water to a high standard is necessary to protect public health. Delivering water through the grid to those people experiencing severe water shortage is also vital, to meet basic human needs. As the water sector transitions towards zero net emissions, these activities will increasingly be powered by renewable energy and not contribute to greenhouse gas emissions.

Identify impact of climate change on Traditional Owner values associated with water and how to adapt to them, and

Consider the changing sewerage, drainage and flood management risks under climate change in Integrated Water Management Forums

These actions in themselves are not expected to significantly alter greenhouse gas emissions, unless they lead to a lot more revegetation, such as planting in water supply catchments or integrated water management revegetation activities. Plants sequester carbon dioxide, which will lead to a reduction in net greenhouse gas emissions. Under the national and international reporting standards for greenhouse gas emissions, however, there are strict rules around when and how vegetation can be recognised as carbon sinks. Some of the activity under these actions may be ineligible.

Key terms and acronyms

AAP – a system Adaptation Action Plan, as specified under the Victorian *Climate Change Act 2017*.

Adaptation – changes in natural or human systems to prepare for actual or expected changes in the climate in order to minimise harm, act on opportunities or cope with the consequences.

ARR – Australian Rainfall and Runoff: A guide to flood estimation.

BAU – business as usual.

BOM – Bureau of Meteorology.

Climate Change – changes in the state of the climate, including increases in extreme weather events, long-term changes in weather patterns and sea level rise, attributed directly or indirectly to human activity.

CMA – Catchment Management Authority.

Consequence – the impact arising from a climate change incident, e.g. water operators become severely dehydrated in a heatwave.

CSIRO – Commonwealth Scientific and Industrial Research Organisation.

DEWLP – Department of Environment, Land, Water and Planning.

DHHS – Department of Health and Human Services.

DPC – Department of Premier and Cabinet.

DPP – Drought Preparedness Plans

DTF – Department of Treasury and Finance.

Drainage – The works and functions related to the collection and removal of local rainfall runoff from land prone to natural water-logging.

Dryland rural drainage – The works and functions related to the collection, and timely removal, of excess water generated by high rainfall to support agriculture production. It involves enhancing the hydraulic capacity of drainage lines and soils to ensure water will flow off (or through) and away from land, to support increased agricultural production in dryland areas.

Emission Reduction – actions taken to reduce greenhouse gas emissions, leading to a reduction in climate change related events. Some climate change specialists refer to these actions as climate change mitigation.

EMV – Emergency Management Victoria.

EPA – Environment Protection Authority.

ESC – Essential Services Commission.

Events – the intrinsic source of a climate change related risk that may result in an undesirable outcome. Events include, for example, drought, storms and sea level rise.

Floodplain – Low-lying land adjacent to a river or stream with unique ecosystems dependent on inundation from flood events.

Hazard – a potential or contained threat.

Incidents – happen when a desired outcome is not achieved because of climate change. It occurs when an event leads to a consequence, e.g. a flood event becomes an incident when it destroys valuable crops that were ready for harvest.

IPCC – Intergovernmental Panel on Climate Change.

IWN – Intelligent Water Network.

IWM – Integrated Water Management.

Likelihood – is the probability that a climate change-related event or incident might happen, e.g. heatwaves will be more common (likely) because of climate change.

LTWRA – Long-Term Water Resource Assessment.

MDBA – Murray Darlin Basin Authority.

MLDRIN – Murray Lower Darling River Indigenous Nations.

NPV – net present value.

RCS – Regional Catchment Strategies.

Resilience – the capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from disruption.

Risk – The chance of something happening that will have an impact on an objective, system, sector, asset, activity or community. A risk is often discussed in terms of the event (for example, a weather event or climatic change), the consequence of the event (positive or negative), and the likelihood it will happen. Residual risk is the remaining chance of something happening after action has been taken to reduce the risk.

Runoff – The amount of rainfall that drains into the surface drainage network to become stream flow; also known as rainfall excess.

Sewerage – the network of pipes, pumps and equipment that transfers all our wastewater from our homes and businesses to a treatment plant.

Recycled water – wastewater that has been collected and treated to a higher standard so that it can be used for a variety of purposes.

Stormwater – Runoff from urban areas. There is a net increase in runoff from urban development due to water not being able to seep into the ground because of impervious surfaces, such as roofs and roads.

SWS – Sustainable Water Strategy.

Threat – a hazard in a state that it is harmful to people, infrastructure or the environment.

UWS – Urban Water Strategy.

VDP – Victorian Desalination Plant.

VEWH – Victorian Environmental Water Holder.

VFMS – Victorian Floodplain Management Strategy.

VicCI – Victorian Climate Initiative.

Vulnerability – the degree to which the water sector is unable to cope with the adverse potential impacts of climate change. Residual vulnerability is the degree to which it is unable to cope after taking into account adaptation actions that are being implemented.

Wastewater – Water that has had its quality affected by human influence, deriving from industrial, domestic, agricultural or commercial activities.

Water cycle – the cycle of processes by which water circulates between the earth's oceans, atmosphere, and land, involving precipitation as rain and snow, drainage in streams and rivers, and return to the atmosphere by evaporation and transpiration.

Water cycle system – a term defined in the *Climate Change Act 2017*, which means—

- (a) the collection, storage, treatment, delivery and supply of water, including recycled water; and
- (b) sewerage services, including the collection, treatment and disposal of wastewater through sewerage systems and wastewater treatment plants; and
- (c) drainage services, including the operation of drainage systems; and
- (d) flood management services, including the operation and maintenance of infrastructure to mitigate floods.

Water sector – The broad range of entities with a stake or role in water management. For example, water corporations, catchment management authorities, local government and environmental water holders.

WMIS – Water Measurement Information System.

WSAA – Water Services Association of Australia.

WSAAP – Pilot Water Sector Climate Change Adaptation Action Plan, which is the water cycle system adaptation action plan as specified in the Victorian *Climate Change Act 2017*.

Lake Marma Murtoa.
Photographer Craig Moodie.



