6.2 General Reports

6.2.1 Climate Change Adaptation Strategy

Responsible GM: Peter Benazic
Author: Aruna Dias

Recommendation(s)

That Council adopt the attached Climate Change Adaptation Strategy

Attachments

1. Climate Change Adaptation Strategy 2022-33 [**6.2.1.1** - 28 pages]
2. Climate Change Adaptation Strategy - Action plan [**6.2.1.2** - 9 pages]
3. Climate Change Adaptation Strategy - Appendices [**6.2.1.3** - 13 pages]

Executive Summary

The Climate Change Adaptation Strategy 2022-33 (CCAS) provides a strategic and planned approach to increasing the resilience of Cardinia Shire to the adverse impacts of climate change. Adaptation aims to empower people, businesses, infrastructure, the health system, and environment to cope with an increasingly variable and changing climate. Given the potential broad-ranging impacts of climate change in the Shire, adaptation is essential to minimizing future climate related risks to the community and council.

The shire has experienced changes to the intensity of rainfall, an increase in the number of bushfire risk days as well as more severe and frequent storms. The most recent of these events were the severe storm damages in June 2021 and October 2021 storm and flood event. Changes to our climate are predicted to continue, it is therefore important to prepare for these climate impacts by addressing and managing the associated risks. Addressing these risks will support both the Council and community to prepare and respond to the adverse local impacts of climate change. Adaptation planning is therefore fundamental to mitigating the compounding risks associated with the impacts of climate change.

The Climate Change Adaptation Strategy (CCAS) has been developed over a period of 2 years through a rigorous consultation process with the community and internal stakeholders. The strategy calls for the update and review of existing polices to reflect the urgency and prioritise actions across the organisation that strengthen the long-term resilience of the shire to the adverse impacts of climate change. Additionally, the strategy establishes a 10-year action plan to address the priority risks associated with the impacts of climate change in the shire. The actions and initiatives presented in the action plan will address the most urgent climate change risks in the shire for the next 10 years, 2023 to 2033.

Background

Historical weather records show that there have been 18 historic climate related events in the shire between 1971 and 2020 (Appendix D). These events include major floods, storms, and fire incidents that have resulted in loss of life, significant damage to property and agricultural areas. The emission of greenhouse gases from human activities is contributing to rising surface temperatures and accelerating climate change. The frequency and intensity of the associated climate hazard events is increasing as surface temperatures continue to rise. It is therefore fundamentally important to identify the localized climate related risks and prescribe

treatments actions to lessen the sensitivity of local stakeholders to the adverse impacts of climate change in the shire.

The Aspirational Energy Transition Plan (AETP) was endorsed by Council in 2017 and outlines council's emission reduction and climate change mitigation goals. Council does not have an existing strategy to reduce sensitivity to the associated adverse impacts and future-proof the shire to the consequences of climate change. A localised Climate Change Impacts and Risks Assessment (CCIRA) completed by WSP consultancy in 2019/2020. Through a rigorous assessment process fifty-one discrete climate related risks have been identified for Cardinia Shire between 2021 and 2070 (Appendix A). Of these 51 risks there are seven high priority risks that require urgent treatment between now and 2033 (Table 9). These identified priority risks guided the development of the CCAS and linked 10-year action plan.

Council declared a climate emergency in September 2019 in response to the overwhelming scientific consensus on rising global temperature and community interest. This declaration demonstrated the intent of Council to consider climate change adaptation and mitigation as organisational priorities. Funding of a climate action plan was a commitment made in this declaration. Recent updates to the Local Government Act place greater responsibility on Councils to manage the risks of climate change. Local government organisations are responsible for ensuring the transparency of climate change related decisions, actions, and information, as well as developing and delivering locally appropriate adaptation responses, managing climate change risks to council, community services and assets, building the resilience of local assets and services, planning for and providing emergency management, relief and recovery services at the municipal level.

Policy Implications

The strategy is consistent with Council's Liveability Plan 2017-2029, the Sustainable Environment Policy 2018-28, the Aspirational Energy Transition Plan, the Biodiversity Conservation Strategy 2019-2029 and the Council Plan 2021-2025.

The strategy supports progress towards the realisation of Sustainable Development Goals 3, 5, 9, 11, 13 and 15.

Relevance to Council Plan

1.1 We empower our communities to be healthy, connected and resilient

1.1.3 Lead by example in creating an inclusive and welcoming community for all by facilitating community education, capacity building, connection and celebration of our diversity.
1.1.4 Facilitate a partnership approach to create safer communities.
1.1.5 Work closely with the community to deliver programs that build community resilience, relating to a pandemic or other disasters.

2.1 We support the creation of liveable spaces and places

2.1.3 Plan for housing diversity that meets community need, is affordable and delivers environmental sustainability, safety and healthy living outcomes.

3.1 We value our natural assets and support our biodiversity to thrive

3.1.1 Partner with community, business and industry to take action on, and adapt to, climate change.
3.1.5 Facilitate community stewardship to build preparedness for natural threats.

4.1 We support our productive land and employment land to grow local industries

4.1.1 Facilitate better planning for our agricultural land to support industry, innovation, local food economy and local job growth.

5.1 We practise responsible leadership

5.1.1 Build trust through meaningful community engagement and transparent decision-making.

Climate Emergency Consideration

The Climate Change Adaptation Strategy is a direct outcome of commitments made in the council declaration of a climate emergency. This strategy will provide the strategic direction and urgent actions needed to treat risks associated with the adverse impacts of climate change.

Consultation/Communication

Community engagement was undertaken over a period of 6 weeks between February and March 2022. The primary engagement was undertaken via the Creating Cardinia online community engagement platform which held the CCAS documents and engagement survey questionnaire. Additionally, a pop-up stall at the Pakenham library complex in March 2022 was effective in engaged face-to-face with a sample of the community, the members of the U3A and other users of the library complex.

The Environment and Heritage team pop-up stall had information on climate change initiatives and online access to the Creating Cardinia website. Large printed QR codes stuck onto a table for community members to scan with their mobile phones and directly access the CCAS linked “Have Your Say” page. Community respondents were able to complete the survey using their own devices and discuss any points of interest with a council officer as they progressed through the engagement exercise. Those who were unable to respond to the survey in the library foyer were able to scan the QR code and finish the questionnaire at an alternative time. This was a popular option with those attending the scheduled programs delivered in the library.

The survey was developed to enable the community to lead in the identification of priorities amongst the community-facing actions for council to delivery in the short, medium, and long term timeframes. Twenty six responses were received which identified the following action priorities in the 10-year action plan.

Table 1. Community priority actions from survey

Timeframe	Community priority action
Short (next 1-4 years)	• Increase community awareness and preparedness to natural hazards (43%) • Gardens for wildlife and development of an urban forest strategy (39%)
Medium (next 5-6 years)	• Develop a resilient agriculture program (46%) • Inform community on high risk areas for development (43%)
Long (next 6-10 years)	• Encourage the development of coastal management plans for private land (77%)

A written submission was received from the Emerald Village Association (EVA). The submission articulated the EVA's endorsement of the draft CCAS. Specifically, the support for early collaborative community planning and action as ways to reduce the adverse impacts associated with climate change and extreme weather events on social, economic, and natural environmental systems. The EVA is keen to partner with Council in specific actions which will reduce the Emerald community's vulnerability to adverse climate events and promote the resilience of social, ecological and economic systems. The submission also identified several opportunities where Council could work with the EVA and the community on pilot projects that would act as demonstration projects for the Shire.

Financial and Resource Implications

Forty-eight actions have been developed to address the most urgent climate risks in the shire until 2033. These actions aim to reduce exposure to impacts, reduce sensitivity to risks, and increase adaptive capacity to the consequences of climate change.

To embed climate change resilience across the organisation and mitigate the associated compounding risks a costed action plan has been developed and is included within the strategy. Implementing the action plan will enable Council to meet legislative obligations and mitigate the highest rated, most immediate climate change associated risks in the shire. This work compliments the Council Liveability Plan, the Sustainable Environment Policy, the Biodiversity Conversation Strategy, and the Aspirational Energy Transition Plan. A summary of the existing and additional annual costs is detailed below.

Table 2. Annual cost of action plan

Year	Council operational funding per year (existing)	Additional Council operational funding (per year) sought	Additional Council capital funding (per year) sought	Total proposed implementation costs
2023-24	30,000	178,000		208,000
2024-25	30,000	315,300	35,000	380,300
2025-26	30,000	417,146	35,000	482,146
2026-27	30,000	356,039	35,000	421,039
2027-28	30,000	318,480		348,480
2028-29	30,000	317,969		347,969

Year	Council operational funding per year (existing)	Additional Council operational funding (per year) sought	Additional Council capital funding (per year) sought	Total proposed implementation costs
2029-30	30,000	295,509		325,509
2030-31	30,000	333,099		363,099
2031-32	30,000	310,741		340,741
2032-33	30,000	363,436		393,436
Total	**$300,000**	**$3,205,719**	**$105,000**	**$3,610,719**

In total, the action plan requires a budget of $3,610,719 of which $300,000 exists within the recurrent operational budget. Therefore, an additional $3,310,719 is required over the 10-year delivery of the action plan. A cost comparison between the draft action plan and final action plan identifies an increase of $10,000 over the 10-year delivery period.

Conclusion

This strategy establishes an adaptation action plan 2023-2033 that will focus Council's resources and efforts to reducing the urgent risks associated with climate change in the shire. The strategy prescribes risk treatments to manage the priority climate related risks, which are projected to manifest over the next 10 years. The update and review of existing council policies and plans will support the strategy and ensure that long-term adaptation planning prepares council for further changes to the climate and mitigates community risk to the adverse impacts of climate change in the shire.

Delivering the costed 10-year action plan, will meet the statutory obligations by reducing risks related to the adverse impacts of climate change in the shire. The addition of a Climate Resilience Officer role will support the implementation of actions presented in the Strategy. The council adaptation strategy directs initiatives to address the climate change risks and ensures council does its part to support adaptation across the shire to the adverse impacts of natural hazard events.

Cardinia Shire Council

Climate Change Adaptation Strategy 2022—33

August 2022

Prepared by:

Cardinia Shire Council
Environment and Heritage Unit

Published August 2022

ABN: 32 210 906 807
20 Siding Avenue, Officer

PO Box 7, Pakenham Vic 3810
(DX 81006)

Phone: 1300 787 624
Email: mail@cardinia.vic.gov.au
Web: cardinia.vic.gov.au

Contents

List of figures

List of tables

Abbreviations

Abbreviation	Definition
AS	Australian Standard
CCAS	Climate Change Adaption Strategy
CSC	Cardinia Shire Council
CCIR	Climate Impacts and Risks
ERF	Emissions Reduction Fund
IPCC	Intergovernmental Panel on Climate Change
RCPs	Representative Concentration Pathways
VCP	Victorian Climate Projections
EPBC	Environmental Protection and Environmental Conservation Act
FFG	Flora and Fauna Guarantee Act

1 Executive summary

The Climate Change Adaptation Strategy (CCAS) outlines how Cardinia Shire Council will work towards increasing the climate resilience and adaptive capacity across the shire. In response to the strong local community engagement and the scientific consensus on rising global temperatures, Council declared a climate emergency in September 2019. The declaration makes the important commitment of emphasising climate change adaptation and mitigation actions as key priorities in the *Council Plan 2021-25*. Development of this strategy, to address and mitigate the climate change impacts and risks to Cardinia Shire, is a significant action to meet this commitment.

Building on the past initiatives and actions undertaken by Council as outlined in Appendix E, this strategy will direct climate change adaptation planning in the shire between 2023-2033. The development of this strategy has been informed by stakeholder engagement and the latest climate science including projections from the Bureau of Meteorology and the national science body, CSIRO, as well as a climate change impacts and risks (CCRI) assessment for the shire.

This strategy has at its heart an ethos that the best and most cost-effective approach for climate change adaptation is embedding relevant actions into Council's existing service delivery. It includes a 10-year costed action plan that will enable Council to manage identified risks and provide co-benefits.

The four overarching themes of this strategy:

1. Plan for and manage the risks of climate change and the associated extreme weather events.
2. Seek opportunities for partnerships and collaboration with stakeholders and the community that support climate change adaptation.
3. Use the natural environment to build our adaptive capacity
4. Encourage future proofing design – foster places capable of adapting to change and responding to current and future risks.

2 Overview

Cardinia Shire is one of the fastest growing regions of metropolitan Melbourne. Located 45 kilometres east of Melbourne CBD, the shire extends from the Dandenong Ranges in the north to Western Port Bay in the south, the shire comprises of diverse landforms and landscapes. Vegetation types include wet grassland, woodlands, and plains, with the Koo Wee Rup swamp being a dominant landscape feature of the region.

Cardinia Shire Council recognises that the climate is changing, and adaptation planning is fundamental to mitigating the adverse impacts associated with climate change. The shire has experienced changes to the intensity of rainfall, an increase to the number of bushfire risk days as well as more severe and frequent storms. Changes to the climate are predicted to continue, so it is important to understand and plan for these climate impacts to ensure that Council and the community are adequately prepared to respond to the likely risks. The Climate Change Adaption Strategy (CCAS) and the linked 10-year Action Plan focusses on addressing the most urgent climate change risks to council's business continuity and the Cardinia Shire community. This strategy aims to enable our people, businesses, infrastructure, and environment to cope with an increasingly variable climate. Given the potential broad-ranging impacts of climate change in the shire adaptation is essential. The CCAS presents data on the likely extent of future extreme weather events in the Shire as well as pathways to embed adaptation in the community and strengthen the resilience of the council to continue its service delivery despite the localised climate change impacts.

This strategy has been developed through rigorous consultation with community and internal stakeholders to establish a 10-year adaptation action plan. This Action Plan provides a suite of actions that are focused on addressing the priority climate risks between 2023 to 2033. The actions will strengthen the resilience of the community and increase the adaptive capacity of Cardinia Shire to the adverse impacts of climate change.

The CCAS 10-year Action Plan prescribes resources and initiatives to lessen the risks associated with the localised impacts of climate change in Cardinia Shire. The Action Plan is not a plan for community action, however there are several actions focused on the community, as reducing risk and the sensitivity of the community to climate change is fundamental to Council's role. The CCAS Action Plan has a 10 year life and will be reviewed at the 5 year mark. Subsequent action plans will build upon the resilience outcomes achieved and adaptation pathways established in the first 10-year Plan. In response to the strong local community engagement and the overwhelming scientific consensus on rising global temperature, Cardinia Shire Council declared a climate emergency in September 2019. This declaration has demonstrated the intent of Council to consider climate change adaptation and mitigation as organisational priorities.

3 Purpose

Climate change is a global challenge that is caused by the increased concentration of carbon dioxide and other greenhouse gases in the atmosphere. Human activities such as the burning of fossil fuels like coal, gas and oil have fundamentally increased the atmospheric greenhouse gases and contributed to global warming. Since the industrial revolution, these gases have accumulated in the atmosphere creating an insulating layer that inhibits daytime surface heat from dispersing back into the atmosphere at night. Decades of warming across the surface of the earth has manifested in climate change with localised impacts. These impacts have adverse effects on the social, economic and environmental systems we depend on for our livelihoods, recreation and social cohesion. Adapting to this change requires taking actions to lessen the adverse consequences of climate change and increase capacity to withstand the stresses and shocks associated with natural hazards and extreme weather events.

Adaptation in Cardinia Shire presents an opportunity to empower our communities to be healthy, connected, and resilient. Investing in climate change adaption helps to embed economic, social, and environmental resilience to protect the most vulnerable to the consequences of climate change. This strategy supports the creation of liveable spaces and places as well as the protection of the local economy, built and natural assets and biodiversity. Adaptation planning strives to support our community to reduce their vulnerability to climate change whilst boosting the resilience of the local environment, social and economic systems for future generations.

3.1 Vision

Cardinia Shire is climate resilient, while sustaining the community's liveability, biodiversity and financial stability.

3.2 Objectives

This strategy aims to drive actions and initiatives to reduce the sensitivity of the Cardinia shire community to the adverse impacts of climate change. Adapting to climate change will safeguard Cardinia Shire's diverse communities from these adverse impacts whilst managing the natural and built environments for present and future generations.

The objectives for the strategy are to support the community and Council to become more resilient to the localised impacts of climate change by addressing the identified priority risks over the next 10 years.

Objective 1: Communicating the key local impacts of climate change and how this will affect the economic, social, and environmental sustainability

Objective 2: Mainstreaming climate risk considerations and adaptation actions in the Council policies, programs, and service delivery

Objective 3: Identifying action pathways for Council, the community, businesses, environmental groups, private landowners and other stakeholders to increase the adaptive capacity and foster timely opportunities to strengthen climate change resilience across the shire.

4 Climate challenges we face

The severity and frequency of future hazard events such as heatwaves, floods and fire weather are dependent on the extent of climate change. The magnitude of these climate impacts can be mitigated by eliminating greenhouse gas emissions today and keeping global temperatures below 2°C. Therefore, climate change projections are not precise predictions – rather, they present plausible future scenarios based on clearly defined assumptions.

To allow for comparability and consistency between different models, the Intergovernmental Panel on Climate Change (IPCC) published four greenhouse gas concentration trajectories known as Representative Concentration Pathways (RCP). Each RCP reflects different possible future climate scenarios based upon the rate at which efforts to reduce human attributed greenhouse gas emissions will proceed over coming decades. Adapting and planning for the adverse impacts of climate change considers these greenhouse gas emissions trajectories to identify the likely future impacts and risks to the community and Council.

The four concentration pathways are 2.6, 4.5, 6.0 and 8.5 (Table 1). When undertaking a climate change risks assessment for adaptation planning in Cardinia Shire, RCPs 4.5 and 8.5 were considered. These concentration pathways represent an optimistic and extreme emission scenario. RCP 4.5 is considered as this most closely aligns with the goal of the *Paris Climate Change Agreement,* to limit global warming to an average of 2°C by 2050 compared to pre-industrial levels. RCP 4.5 broadly represents an optimistic pathway with temperature increase limited to 1.1 to 2.6 degrees Celsius as the global emissions peak in the year 2040 and then declines.

RCP 8.5 closely represents the current trajectory of unabated emissions from human activities and offers a most conservative approach for climate change risk assessment. Under this "business-as-usual" emission scenario a temperature increase of between 2.6 and 4.8 degrees Celsius by the year 2100 is expected. Both the RCPs 4.5 and 8.5 are considered as a guideline when planning to effectively adapt to the upper and lower extent of the adverse impacts of climate change.

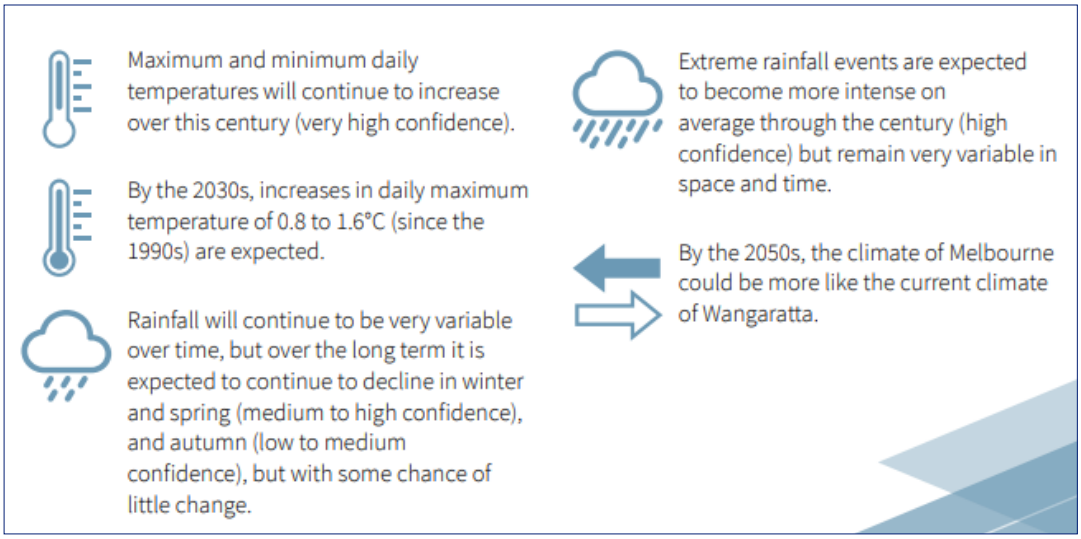
Table 1. Representative concentration pathways (IPCC)

Scenarios		Global warming (mean and likely range ºC)
RCP 2.6	• Significant and rapid efforts to reduce emissions. • Emissions peak by 2020, then decline substantially. • CO2 concentration of 420ppm by 2100.	1.0°C (0.3 to 1.7)
RCP 4.5	• Major efforts to reduce emissions. • Emissions peak around 2040, then decline. • CO2 concentration of 540ppm by 2100.	1.8°C (1.1 to 2.6)
RCP 6.0	• Some efforts to reduce emissions, which peak around 2080. • CO2 concentration of 660pm by 2100.	2.2°C (1.4 to 3.1)
RCP 8.5	• Limited efforts to curb emissions, which continue to rise throughout the 21st century. • CO2 concentration of 940ppm by 2100.	3.7°C (2.6 to 4.8)

4.1 Climate change projections

The *Victorian Climate Projections 2019* (VCP19) developed by the Department of Environment, Land, Water and Planning (DELWP) and Commonwealth Scientific and Industrial Research Organisation (CSIRO) identify changes to the climate of Greater Melbourne. Figure 1 below shows the high-level projected change to temperature and rainfall for Greater Melbourne.

Figure 1. Greater Melbourne Climate Projections 2019[1]



4.2 Temperature

Cardinia Shire experiences mild to warm summers with an average temperature of around 23.8°C. Projections for temperature related variables in Table 2 indicate a median increase in maximum daily temperature of 1.97°C by 2070 under a moderate RCP 4.5 emissions scenario, while an increase of over 4°C cannot be ruled out under a high RCP 8.5 scenario.

Community feedback gathered through responses to the 2021 Liveability Plan Survey found that around 38% of the community felt that they were extremely or very prepared for a heatwave while 23% of the community were extremely or very prepared for a drought. The highest recognised preparedness to heatwaves and drought was in Bunyip Ward with 59% and 39% of respondents from this area feeling like they were extremely or very prepared for a heatwave or drought.

[1] VCP19 Regions (CSIRO and DELWP, 2019)

Table 2. Projections for temperature-related variables – RCP 4.5 and RCP 8.5

Variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Maximum Daily Temperature (°C)	Annual average: 19.5°C	+0.92°C (+0.79 to +1.30)	+1.19°C (+0.98 to +1.55)	+1.97°C (+1.61 to +2.37)	+2.94°C (+2.41 to +4.02)
Maximum Daily Temperature (°C) - Summer	Summer average: 23.8°C	+0.93°C (+0.56 to +1.96)	+1.13°C (+0.78 to +1.91)	+1.96°C (+1.63 to +2.81)	+2.95°C (+2.19 to +4.54)
Average Days over 35°C	8.6 days per year (based on 30-years of daily data from 1981-2010)	11.57 days/yr (10.83 to 12.9)	11.77 days/yr (10.5 to 13.27)	14.37 days days/yr (13.37 to 16) 2090: 14.99 (13.07 to 16.9)	18.22 days/yr (14.77 to 21.83) 2090: 23.56 (18.23 to 30.03)
1-in-20-year Hottest Day (°C) - Summer	44.3°C in January 2003 (highest recorded temperature over baseline period) 46.7°C in February 2009 (highest recorded temperature since 1971)[2]	+0.42°C (-0.62 to +2.89)	+0.28°C (-0.91 to +3.93)	+1.83°C (+0.85 to +3.50)	+3.47°C (+1.28 to +4.36)
1 in 20-year Coldest Day (°C) - Winter	-3.8°C in July 1997 (lowest daily temperature recorded over baseline period)	+0.36°C (-0.35 to +1.06)	+0.46°C (+0.09 to +0.57)	+1.01°C (0.36 to +1.14)	+1.37°C (+1.12 to +2.05)

Under RCP 4.5 scenario, a warming climate is likely to increase the intensity and frequency of heatwaves, drought, bushfire danger days, storm events and the extent of sea level rise. The impacts associated with these natural hazard events will affect the built and natural environments, with the flow-on effects often disproportionally affecting socio-economically disadvantaged communities as well as vulnerable individuals and households. Higher temperatures also impact the future viability of soil quality, water resources, vegetation cover as well as activities already vulnerable to hotter conditions, such as summer sports and certain types of agriculture. A warmer climate may also present opportunities to grow new crops not previously produced in the region.

Under RCP 8.5 scenario, climate models show that the number of days above 35°C may more than double in the century (2090). An increased occurrence of days above 35ºC and heatwaves will have compounding negative implications for the Shire. In addition to the impacts under RCP 4.5, the extreme heat events and consecutive days above 35ºC in a RCP 8.5 scenario, will increase the

[2] Recorded on Saturday 7 February 2009, Victoria's Black Saturday bushfires

energy and water demands, placing energy security concerns and additional financial burden on households, industries, business and building operators. A climate reality of RCP 8.5 would also place additional pressure on health services, which are disproportionately used by residents with underlying vulnerabilities and health conditions.

4.2.1 Rainfall and flooding

Under a moderate RCP 4.5 and high RCP 8.5 scenario the intensity of 1-in-20 heavy rainfall events is likely to increase even when the average annual rainfall is projected to decline. The projections for rainfall related variable are presented in Table 3. The 2021 Liveability Plan Survey found that around 21% of the community felt that they were extremely or very prepared for a flood. The highest recognised community preparedness to flood was in Beacon Hills Ward with 35% of respondents responding that they were extremely or very prepared for this event.

Table 3. Projections for precipitation-related variables – RCP 4.5 and RCP 8.5

Variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Annual Rainfall Average (%)	789.0mm	-4.14% (-12.70 to +1.95)	-8.60% (-13.71 to -2.23)	-9.20% (-11.96 to -4.27)	-11.08% (-28.36 to -3.89)
Summer Average (%)	171.5mm	-4.69% (-11.06 to +4.15)	4.07% (-9.22 to +11.98)	-7.73% (-21.99 to +19.17)	-0.52% (-26.75 to +11.38)
Autumn Average (%)	163.6mm	-1.69% (-19.20 to +9.35)	-8.18% (-27.92 to +2.05)	-6.39% (-13.74 to +1.94)	-14.78% (-28.56 to -4.04)
Winter Average (%)	218.5mm	-6.36% (-9.58 to -0.02)	-10.64% (-13.20 to -2.15)	-6.90% (-11.91 to +0.90)	-14.24% (-22.01 to +0.30)
Spring Average (%)	236.8mm	-9.13% (-16.37 to +12.90)	-15.29% (-19.68 to +1.72)	-14.54% (-19.67 to -4.08)	-17.94% (-41.47 to +4.62)

An increased occurrence of intense rainfall can lead to disruption of essential infrastructure and property (e.g. roads and rail, energy supply, water and sewerage, communications) due to inundation of stormwater infrastructure and the potential damage of electrical infrastructure. Future intense rainfall and flooding events can also impact road network access, potentially limiting emergency response.

4.2.2 Bushfire

According to CSIRO analysis, there is high confidence that climate change will result in more incidences of severe bushfire danger. By 2090, severe fire danger days are projected to become twice as frequent under an RCP 8.5 high emissions scenario. Table 4 presents bushfire projections based on an increase in the number of fire danger index days.

Community response to the 2021 Liveability Plan Survey, identified that around 24% of the community felt that they were extremely or very prepared for a bushfire. The highest recognised preparedness to bushfire was in Bunyip Ward with 47% of respondents from this area feeling like they were extremely or very prepared for this event.

Table 4. Projections for bushfire (Severe Forest Fire Danger Index days) – RCP 4.5 and RCP 8.5

Specific variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Severe Fire Danger Days (FFDI > 50)	2.7 days (1995 baseline)	3 to 4.2 days per year + 11% to +55% (over baseline)	2.8 to 3.5 days per year +19% to +30%	3.5 to 3.9 days per year +30% to +44%	3.7 to 5.8 days per year +37% to +115%

Increased incidence of bushfire weather and the number of severe fire weather days could result in loss of life and injury, direct damage to essential infrastructure, increased bushfire-related air pollution and dust impacting building ventilation systems and as well as the long-term health and safety of the Cardinia Shire community.

4.2.3 Coastal hazards

Rising sea levels are expected to result in an increased risk of coastal erosion and inundation. Table 5 illustrates that in the upper range of projections, under an RCP 8.5 scenario, sea level is projected to increase by 0.81m by the end of the century, potentially affecting large coastal agricultural areas. A rise of such magnitude could lead to salt-water intrusion and increase soil salinity across coastal agricultural land. It can also reduce the capacity of low-lying drainage networks, leading to inundation events and potential disruption of transport link services.

Table 5. Projections for coastal variables – RCP 4.5 and RCP 8.5

Specific variable	Baseline	Near future 2030 (2020-2039)		Far future 2070 (2060-2079)	
		RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
Sea Level Rise (m)	-	+0.11 m (+0.07 to +0.16)	+0.12m (+0.08 to +0.17)	+0.44m (+0.27 to +0.61)	+0.58m (+0.38 to +0.81)
Sea Surface Temperature (°C)	Annual average (1961-1990): approx. 16°C	+0.5°C (+0.4 to +0.7)	+0.6 °C (+0.3 to + 0.9)	+1.1°C (+0.8 to +1.7)	+ 2.3°C (+1.9 to +3.8)

4.2.4 Projection data

Climate projections have been prepared using Victorian Climate Projection 2019 results. The climate data used in this risk assessment represents the projected changes relative to 1986-2005 (1995) baseline for on the Greater Melbourne region.

Two greenhouse gas emissions scenarios were used as the context to identify potential impacts and assess risks to Council from changes in climate. These were the same emissions scenarios used in the Victorian Climate Projection 2019 project and describes how the climate of Victoria may respond to global warming under the IPCC's medium and high emissions scenarios (RCP 4.5 and 8.5). These scenarios were chosen to provide a range of possible futures to assess the risks of climate change and inform appropriate adaptation decisions for the context of Cardinia Shire.

A medium 2030 emissions scenario (RCP 4.5) assumes growth in global annual carbon emissions to remain steady. A high 2070 emissions scenario (RCP 8.5) assumes a business as usual approach to mitigating carbon emissions with considerable growth in global annual carbon emissions by the year 2070. Information on the climate data sources, including weather stations, is found in Appendix A and E. Additionally, maps of bushfire, flood and heat threat in Cardinia Shire are contained in Appendix C.

5 Policy context

5.1 International response

Changes in the earth's climate has been observed in every region and across the whole global climate system. According to the intergovernmental panel on climate change (IPCC) report released in August 2021, the global levels of CO2 emissions were higher in 2019 than any time in at least two million years. Moreover, levels of methane and nitrous oxide, second and third-highest contributors of climate change, behind CO2, were higher in 2019 than at any time in at least 800,000 years.

The IPCC report demonstrates that the emission of greenhouse gases from human activities are responsible for approximately 1.1°C of warming between 1850-1900. Therefore, unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming close to 1.5°C or 2°C will be beyond reach.

The IPCC report projects that in the coming decades, climate changes will increase in all regions. For 1.5°C of global warming, there will be an increase in heat waves, longer warm seasons, and shorter cold seasons. At 2°C of global warming, heat extremes would likely reach critical tolerance limits for health and agriculture resulting in the decline in yields of maize, rice, wheat, and potentially other cereal crops. The evidence in the IPCC report makes it clear that carbon dioxide is the main driver of climate change and that human actions to mitigate emissions still has the potential to determine the future course of climate and lessen the adverse effects of climate change.

5.2 Australian Government policies

Australia is already experiencing the impacts of climate change, which vary across the country. Australia's climate is projected to continue to change into the future due to the historic and ongoing emission of greenhouse gases.

Under international climate agreements, Australia has two targets to reduce greenhouse gas emissions.

- 5% below 2000 levels by 2020 (under the *Kyoto Protocol*) and
- 26-28% below 2005 levels by 2030 (under the *Paris Agreement*)

The emissions reduction fund (ERF) is the centrepiece of the Australian Government's current policies to limit greenhouse gas emissions. The Government is relying on the ERF, as well as several other policies, to reduce our greenhouse gas emissions, and meet the 2030 climate target. These policies are designed to reduce emissions, increase energy productivity, and boost the uptake of renewable energy.

The Australian Government has released the *National Climate Resilience and Adaptation Strategy* in late 2021. The Climate Resilience and Adaptation Strategy recognises that adaptation is a shared responsibility that requires sustained and ongoing action. The strategy operates across four domains, natural, built, social and economic and provides pathways for a resilient Australia by:

- setting out what the Australian Government will do to support efforts across all levels of government, businesses, and the community to manage physical climate impacts (such as floods, bushfires, droughts, sea level rise and marine heatwaves)
- showcasing national adaptation and resilience efforts

5.3 Victorian Government policies

The Victoria Government's *Climate Change Strategy* provides the pathway for reducing emissions and building resilience to the impacts of climate change. The *Climate Change Strategy* is a roadmap to net-zero emissions and a climate resilient Victoria by 2050.

The initiatives of the *Climate Change Strategy* will support communities and businesses to make the changes needed to reduce the impacts of climate change and continue to support sustainable economic growth. Victoria's Climate Change Strategy has identified the following climate resilience objectives for 2050:

1. Climate-resilient built and natural environments
2. Prosperous, liveable, and healthy communities
3. An orderly and just adaptation process

Prior to Victoria's *Climate Change Strategy*, the *State Adaptation Plan 2017-2020* identified roles and responsibilities for all sectors of the Victorian economy. The preceding *State Adaptation Plan 2017-2020* prescribed the following roles and responsibilities, identified in Table 6, specific to local government as well as the community and individuals.

Table 6. Roles and responsibilities- Victorian Climate Change Adaptation Plan 2017-2020

Agency	Role and responsibilities
Local governments	• Provide leadership and good governance, represent the needs and values of local communities, and foster community cohesion • Manage climate change risks to council community services and assets, with support from the Victorian Government. • Identify the needs and priorities of the municipality and communicate these to Victorian Government where needed. • Develop and deliver locally appropriate adaptation responses. • Build the resilience of local assets and services. • Plan for emergency management at the municipal level, provide relief and recovery services, and support emergency response operations. • Help the Victorian Government understand localised impacts and responses. • Work with the community to help people understand and get involved in climate change adaptation. • Help connect the Victorian Government with the community
Communities and individuals	• Understand and actively manage their own risks: • Plan and act responsibly to reduce the exposure of their own person, families, private property and livelihoods to risks caused by climate change impacts. • Develop innovative local responses to climate change risks. • Explain to government and decision-makers what the community needs and values. • Support and encourage adaptation efforts on the ground.

5.4 Local environmental policies, strategies, and plans

Council has developed a framework of environmental plans and strategies over the last 8 years that focus on biodiversity, climate change, waste and water. **Error! Reference source not found.** outlines the framework of the *Sustainable Environment Policy 2018-29* and how it links back to both the *Liveability Plan* and *Council Plan.*

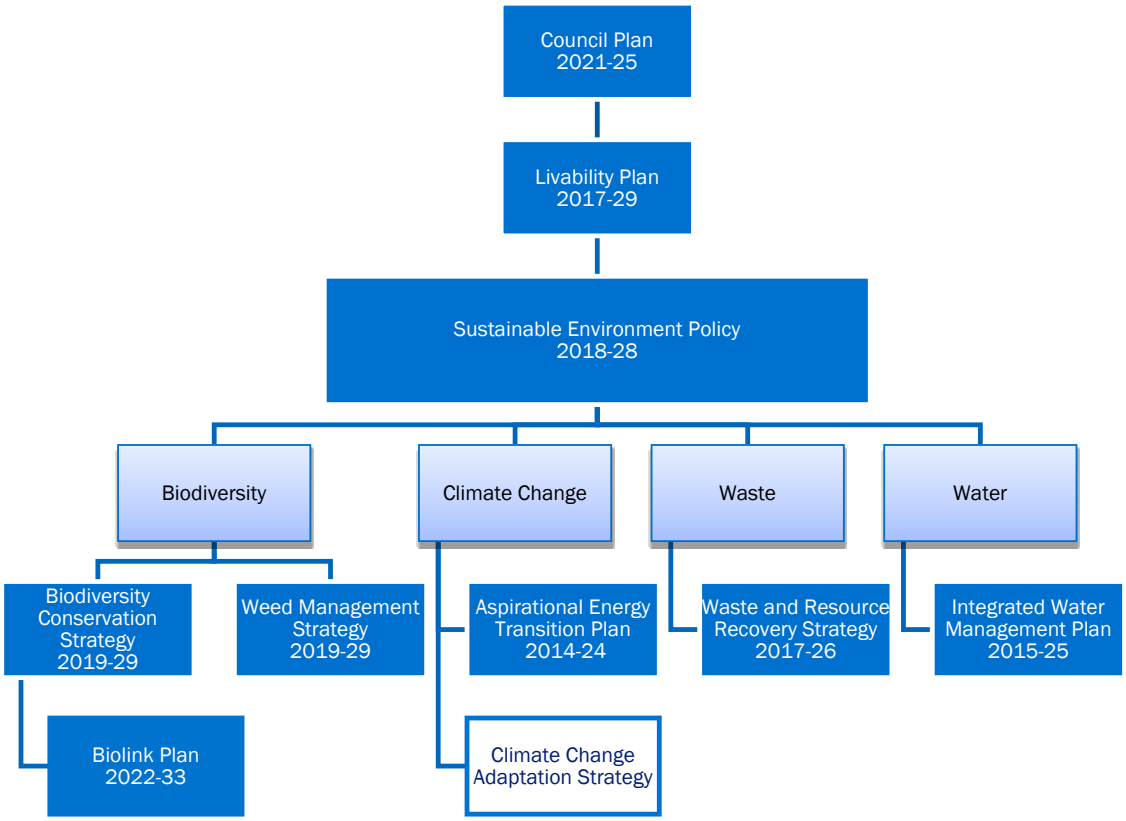
Responding to the overwhelming scientific consensus on rising global temperatures, council declared a climate emergency in September 2019. The declaration made the important commitment of 'ensuring climate change adaptation and mitigation actions are emphasised as key priorities in the *Council Plan 2021-25*. Developing a Climate Change Adaptation Strategy to address the localised climate change impacts and risks to Council and the Cardinia shire community is a critical step in meeting Council's commitments, as well as meeting its legislative obligation under the Local Government Act 2020 to plan for climate change risks.

The *Council Plan 2021-25* commits Council to develop an Environmentally Sustainable Design (ESD) Policy and incorporate ESD into the planning scheme. This Council Plan initiative will support long term adaptation benefits by raising the resilience of the built environment system to the accelerating impacts of climate change. Furthermore, climate change is a fundamental feature of the *Liveability Plan* as managing the natural environment, and mitigating the adverse impacts of climate change, is regarded as an underlying element to support a healthy and resilient community in the Shire.

Council's *Aspirational Energy Transition Plan* was endorsed in 2014. The 10-year plan sets the emission reduction targets for Council and the community to mitigate the severity of climate change and rising global temperatures. These targets include a 36% reduction in per capita community emissions based on levels in 2012 and a net zero emission goal for Council emissions by 2024. Council initiatives prescribed through the Plan are continuously mitigating greenhouse gases to reduce council's role in generating further emissions. By limiting organisational emissions council has aligned itself with the global initiative to reduce greenhouse gases to net zero and limit the severity of future extreme weather events.

Council has committed over $13m of funding through the *Biodiversity Conservation Strategy, Weed Management Strategy* and the *Biolink Plan* to improve the health of the biodiversity in the shire, directly addressing risk 7: the decline and loss of environment protection and biodiversity conservation. Appendix H outlines the environmental strategies and plans and how they align with climate change adaptation.

Figure 2. Sustainable Environment Policy framework



6 Climate change risks and opportunities

The dynamic nature of climate change means that some risks can apply across several categories. Organisational sensitivity and existing community vulnerabilities are only exacerbated by climate change; the stresses and shocks associated with disasters, extreme weather and pandemics are compounding. Strategically addressing these climate change risks will reduce the adverse impacts of climate change on the economic, social, and environmental systems in Cardinia Shire.

6.1 Identification of climate risks

Council carried out a climate change impacts and risks (CCIR) assessment to determine how projected climate change would impact the community as well as Council's assets, and service delivery. The assessment aligned with Australian Standard (AS) 5334-2013 Climate change adaptation for settlements and infrastructure—a risk-based approach. The CCIR assessment identified that in the coming decades, Cardinia Shire can expect increasingly hotter and drier conditions with impacts under the categories described in Table 7.

Table 7. Categorising climate risks

Topic	Issue	Projected climate
Heat	Increased frequency, duration, and severity of heatwaves	• Number of hot days increase • Frequency of warm nights will increase
Bushfire	Significant increase in bushfire danger days and fuel loads	• Fire season to start earlier and end later • Extreme fire days increase by 12-38% by 2020 and 20-135% by 2050.
Flood and storm	Less frequent but more intense storm and rainfall events	• More extreme rainfall events • Change in flood patterns • High wind events
Drought	Decreased average rainfall with more severe, prolonged drought conditions	• Decrease in average rainfall • Increase in severity and duration of droughts
Sea-level rise	Rising sea levels resulting in coastal erosion and inundation	• Salt-water intrusion and increase soil salinity • Reduced capacity of low-lying drainage networks

The findings of the CCIR assessment are based on a mixture of desktop research, focus groups with key Council staff, spatial analysis of existing hazard and Council asset datasets, and two risk workshops attended respectively by Council staff and community representatives. Through this assessment a total of 51 discrete risks linked to climate change were identified across Cardinia Shire. Of these 51 risks 7 risks have been identified as a priority for immediate action in the next 10-years.

6.2 Climate impacts and risk- what does the evidence reveal?

The CCIR assessment identified local risks associated with climate change for both near-future (2030) and far-future (2070) time horizons. A risk rating category consisting of, extreme, high, medium, and low was used to categorise identified climate risks. The final CCIR report presents 51 risks across the shire in 2070. Table 8 summarises the results of the assessment and the distribution of the identified risks for both near-future (2030) and far-future (2070) time horizons.

Table 8. Number of risks identified per risk rating and time horizon

Risk rating	Recommendation	Number of risks	
		2030	2070
Extreme	An action plan to reduce the risk is to be developed immediately.	0	1
High	An action plan to reduce the risk is to be developed.	7	31
Medium	A risk treatment may be used.	35	19
Low	Monitor and review risk annually	9	0

The 7 risks identified with a high risk rating for near future (2030) identified through the CCIR assessment have been central to the development this Climate Change Adaptation Strategy and the connected 10-year Action Plan (2023-2033). The CCIR assessment identified that hotter and drier conditions combined with an increase in the frequency, severity and extent of extreme weather events is likely to multiply existing risks faced by Council and the community. Some risks have broader impacts and require a coordinated response across council, the community, partner organisations, and intergovernmental agencies.

Adaptation planning and the associated actions to reduce the shire's vulnerability to these climate related risks will increase community preparedness and organisational resilience to the adverse impacts of climate change. The 2021 Liveability Plan Survey identified the major community perceived impact of climate change was directed toward damage to public infrastructure, while 63% of respondents selected a human-health related impact and 25% identified a mental health impact attributed to climate change and extreme weather. Appendix G provides data on the community responses to council survey questions focused on climate change and extreme weather completed in 2019 and 2021.

Seven of the 51 climate related risks have been identified as a priority for action by 2030. The 7 risks associated with a high-risk rating in 2030, as well as Council's level of influence in treating each risk are outlined in Table 9. The compounding impacts of climate hazard events demonstrates the urgent need for coordinated efforts to reduce Council sensitivity and community vulnerability to these risks and the adverse impacts of climate change. To address these risks a costed 10-year action plan has been developed, with adaptation actions or initiatives to treat each of the 7 highly rated risks for 2030. Prescribing risk treatment actions for these 7 high risks pathways is likely to lessen the risk ratings of the other 44 locally identified risks for 2030.

Table 9. Risks rated high in 2030 and Council's sphere of influence

No.	Risk	Description	Hazard	2030 risk rating	CSC sphere of influence
1.	Increased demand on Council to respond to climate related hazard events resulting in disruption to service delivery	Increased demand on Council emergency response function results in delays to usual service delivery and health impacts to vulnerable community members	Bushfire; heatwaves; storm; floods	High	Control
2.	Adverse climate impacts resulting in loss of life or physical injury among Council staff and/or community members	Increased incidence of loss of life or physical injury among Council staff and/or community members due to extreme events and population growth in at-risk areas	Bushfire; flood; storm; heatwaves	High	Influence
3.	Mental stress and illness among community and Council staff	Increased incidence of mental illness for community and Council staff due to trauma from preparing for, and dealing with the impact of, extreme event(s)	Bushfire; heatwaves; flood; storms; drought	High	Influence
4.	Increased incidence of family violence influenced by climate and weather	Family violence following natural disasters due to trauma and pressures from extreme events and the increase in hot days when alcohol consumption rises	Bushfire; heatwaves; flood; storms	High	Influence (White Ribbon campaign)
5.	The increased incidence of bushfire or dust storm related pollution	Increased incidence of bushfire-related pollution and/or dust storms, resulting in adverse health impacts for residents, particularly those with underlying health issues	Bushfire; drought	High	Influence
6.	Contamination of tank water supplies during and following major bushfires	Prolonged disruption to domestic water supplies due to pollution of household tank water supplies during and following major bushfires	Bushfire	High	Concern
7.	The decline and loss of Environment Protection and Biodiversity Conservation (EPBC) Act 1999 and Flora and Fauna Guarantee (FFG) Act – listed populations and species	Decline/loss of EPBC and FFG Act-listed populations and species, resulting in fewer populations and greater emphasis on protecting remaining populations. Species conservation status may be raised, resulting in stricter controls and higher costs associated with managing surviving populations within the shire.	All	High	Limited influence

7 Adaptation planning

Early planning and action help to reduce the adverse consequences associated with climate change and extreme weather events on the social, economic, built and natural environment systems. Reducing exposure to impacts and the sensitivity of the community and Council to the adverse effects of climate change will significantly support positive adaptation outcomes across the shire. Adaptation planning begins with the identification of climate impacts and risks in order to consider potential action options and their co-benefits. Adaptation options can range from actions that build general adaptive capacity to other specific actions that directly address key climate related risks.

7.1 Guiding principles for adaptation action

There are 3 key guiding principles for adaptation as outlined in Table 10. These focus on specific aspects attributed to climate risk and its mitigation. Reducing the exposure to climate hazards ensures that priority services and functions of the community and Council can continue to function. Reducing the sensitivity of specific sectors, industries, communities, individuals, and organisations reduces the susceptibility to the adverse effects of climate hazards, while increasing the adaptive capacity raises the ability to cope with and adjust to the consequences of climate related hazard events.

Table 10. Guiding principles for adaptation

Approach	Description	Examples
Reducing exposure	Ensuring that key activities, resources, products, services and assets are located out of hazard zones.	• Relocating valuable items, assets and resources to somewhere not at risk
Reducing sensitivity	If it is not practical to eliminate exposure to a risk, we can often take measures to reduce susceptibility to harm.	• Behavioural change programs • Improving asset management and maintenance regimes • Nature-based solutions, such as greening to reduce urban heat island effect
Increasing adaptive capacity	Improving the ability to cope with and adjust to change	• Backup power systems • Purchasing insurance, which provides council with recovery options in the event of an impactful event

7.2 Embedding adaptation

Through the CCIR assessment 51 climate related risks have been identified from now till 2070. A risk rating classification consisting of, extreme, high, medium and low was used to categorise the 51 climate risks (2070). These risks have been considered for both near-future (2030) and far-future (2070) time horizons as well as the level of influence Council has in addressing each specific risk.

Adaptation calls for increasing resilience to the adverse effects of climate change. Council will address climate sensitivities to successfully adapt to the unprecedented stresses and shocks associated with climate change. In the review of the 51 risks, the following themes were identified: drainage and flooding, financial impacts, asset damage, health and wellbeing, open space, biodiversity, water security, service demand, service disruption and insurance. These themes provide a way to consider and address Council's long-term risk profile.

When the next opportunity arises, consideration should be given to updating all council policies to ensure the inclusion of climate change adaptation measures and supporting climate resilience across the organisation and community. Table 11 lists the existing Council policies to be considered

for priority updating based on climate risks theme. Reducing the climate sensitivity of the community and Council will lessen the adverse effects of climate change on service delivery and liveability across the shire.

Table 11. Council climate change risk themes and associated Council policies

Theme	Description	Council policy
Financial impacts	Financial impacts, including increasing maintenance and operating costs and reduce asset lifespans	• *Financial Plan 2021-31* • *Asset Management Policy*
Drainage and flooding	Key risk areas for Council around stormwater runoff and flooding, including rainfall and flooding cause infrastructure damage and pollution	• *Asset Management Strategy* • *Cardinia Shire Planning Scheme* • *Community Safety Plan* • *Municipal Strom and Flood Plan*
Asset damage	Current building design standards are not adequate for projected climate conditions, including for assets that provide the most critical services to the community.	• *Cardinia Shire Planning Scheme* • *Enhanced Standard: Sustainable Buildings 2020-2026*
Insurance and business continuity	Rising insurance premiums and liability issues for local government.	• Council Risk Register • *Risk Management Policy* • *Business Continuity Planning Policy*
Health and wellbeing	Direct and indirect health impacts to Council staff and community. Direct health impacts occur at the same time and place as a weather event – for example, floods may cause injury, and heatwaves can cause physiological effects.	• *Cardinia Shire Planning Scheme* • *Liveability Plan* • *Municipal Heat Health Plan*
Open space	Increasing heat exposure poses risks to people using Council sport facilities and active outdoor spaces such as hardening of sportsgrounds	• *Open Space Asset Management Plan* • *Cardinia Shire Planning Scheme* • *Precinct Structure Plans*
Water security	Reduced water availability leads to greater demand for and costs of irrigation.	• *Integrated Water Management Plan* • *Precinct Structure Plans*
Natural Environment	Indigenous flora and fauna become more threatened or extinct.	• *Biodiversity Conservation Strategy* • *Biolink Plan* • *Weed Management Strategy*
Bushfire	Increase in hot dry weather increases fuel loads along with increased in bushfire danger days. Risk to human life, also risk to loss of biodiversity through fire prevention management on public and private land.	• *Cardinia Planning Scheme* • *Municipal Fire Management Plan* • *Biodiversity Conservation Strategy* • *Biolink Plan* • *Shelterbelt guidelines* • *Community Safety Plan*

Planning Scheme and Municipal Strategic Statement (MSS)

The Victorian Planning Provisions (VPP) set the state-wide reference framework for the development of all local government planning schemes and Municipal Strategic Statements (MSS). Specific Strategies presented in the VPP are a reference for inclusion through the planning policy updates of local governments to minimise the impacts of natural hazards and climate change at a local level.

Forthcoming versions of the Cardinia Shire Planning Scheme and MSS will integrate the strategic framework provided by the VPP that aims to lessen the impacts of natural hazards and climate change on current and future generations of the Shire. As directed by the VPP, these updates to the Cardinia Shire Planning Scheme and Municipal Strategic Strategy will embed risk-based planning, which prioritises the protection of human life from natural hazards and climate change.

Municipal Environmentally Sustainable Design (ESD) Policy

Decision making and actions taken today are fundamental to building the long-term capacity of the Shire to adapt to climate change. A local ESD policy represents planning policy reform that will increase the standard and performance requirements for new buildings in the Shire. Improving these requirements will raise the capability of a building to withstand harsher future weather conditions, deliver health benefits, slashes energy bills, as well as making homes and officers more comfortable. The future development of a Municipal ESD Policy and incorporation into the Cardinia Shire planning scheme would support the long term sustainability and longevity for new buildings, subdivisions, and precincts.

A future Municipal ESD policy will strengthen the climate change resilience of the community by requiring the submission of permit applications that demonstrate higher levels of insulation, energy and water efficiency, renewable energy generation, urban ecology, stormwater management, double glazing, and airtightness. These are some examples of ESD considerations that will ensure an improved level of internal thermal comfort for occupants, reduced operational costs and the increased uptake of renewable energy through the integration of solar photovoltaic and battery technology. The future incorporation of an ESD policy into the local Planning Scheme will increase the capability of buildings to provide adequate protection for inhabitants from the physical impacts of climate change.

Through the future development of an ESD policy, risk based planning for adaptation to the localised impacts of climate change can be integrated into the planning, design, and development of new subdivisions and across the built environment of Cardinia Shire. A municipal ESD policy is therefore an underlying resource for Cardinia Shire's planners, urban designers, developers, and those engaged in creating sustainable communities in the context of the localised climate change impacts.

8 Action planning

Developing a 10-year costed action plan that incorporates the evaluation, review and assessment of the delivered initiatives will ensure Council remains flexible in its approach to adapting the systems in the shire to climate change. The dynamic nature of climate change is determinant on the increase or reduction in the concentration of atmospheric greenhouse gases emissions. It is appropriate that a midterm review of progress towards the action plan be completed to ensure the adaptation planning considers the most up to date and accurate data available in identifying the most urgent risks and adaptation priorities for both the community and Council.

A priority suite of actions has been identified to address the most urgent climate risks to Council and the community. The actions address the risks identified in the CCIR assessment that have a high rating for 2030. Table 12 summarises the action pathways to address each of the 7 high risk categories. These pathways were developed through the stakeholder deliberation at the workshop and during the consultation meetings. The pathways identify themes to mitigate the highest rated risks in Cardinia Shire.

Table 12. Summary: consultation adaptation action planning

No	Risk	Treatment objectives	Adaptation action pathway
1.	Increased demand on Council to respond to climate related hazard events resulting in disruption to service delivery	• Improve ability for Council to respond • limit service disruptions	• Build and design new council buildings to a high standard ESD • Increase resilience of the built environment • Plan and prepare for increasing frequency of climate hazard events • Dedicated resilience role • Emergency response training, planning and procedure
2.	Adverse climate impacts resulting in loss of life or physical injury among Council staff and/or community members	• No loss of life/injury • Reduce risk of casualty • Limit climate impact	• Partner with other organisations • Increase the resilience of community use facilities • Urban greening • Community education and awareness workshops • Development in high risk areas
3.	Mental stress and illness among community and Council staff	• Reduce trauma and pressure from extreme events & natural disasters • Reduce climate related stress	• Training of key staff in specific roles • Access and promote use of open space and bushland reserves • Relief and support for those involved– consideration of PTSD and triggers • Disaster awareness and preparedness • Increase mental health services • Financial coaching or assistance programs
4.	Increased incidence of family violence	• Reduce trauma and pressure from extreme events and natural disasters • Reduce climate related stress	• Access to community use facilities • Flexibility around service change decisions and primary contact • Council's White Ribbon campaign and initiatives

No	Risk	Treatment objectives	Adaptation action pathway
5.	The increased incidence of bushfire-related pollution	• Reduce sensitivity of council facilities • Reduce the sensitivity of community and vulnerable groups	• Education and awareness • Alternatives techniques for burning off • facilities capable of functioning despite smoke/pollution
6.	Contamination of tank water supplies during and following major bushfires	• Reduce the effects of pollution on water supply and storage • Improve water security for all sectors	• Water storage infrastructure- disconnection points, flush system • Community information and design solutions • Increased ability for facilities to capture and store water • Rural properties- best practice rainwater storage tanks with flush design
7.	The decline and loss of EPBC and FFG Act – listed populations and species	• Halt the decline/loss of biodiversity • Increase adaptive capacity of remanent populations and ecosystems	• Identify, protect and enhance key ecosystems and habitats • Reduce the use of single use plastics • Enhance and protect natural assets • Address pest animals and ecosystem degradation • Future proof open space and councils' natural reserves e.g. seedbank • Protect and enhance blue, teal and soil carbon ecosystems • Foster partnerships with other organisations • Protect habitat of threatened species

The 10-year costed action plan has been developed to address the most urgent climate risks. Delivering the action plan over a period of 10 years will strengthen the adaptive capacity of the community and Council to the immediate and imminent localised risks associated with the intensifying impacts of climate change.

9 Monitoring and evaluation

As this is Council's first adaptation strategy much of its focus is on 10-year action plan and integrating long term adaptation and climate resilience through the update of existing Council policies and plans in Table 11.

A mid-term review of the strategy will be undertaken in year 5 to monitor implementation progress, evaluate actions and continuously improve delivery of the action plan.

In year 10 a more detailed review of the entire strategy will take place, including a climate change impact and risks assessment to identify new and emerging climate risks for the next 10 years. This assessment is in preparation for the development of an updated climate change adaption strategy for the subsequent 10-year period.

Table 13 outlines the adaptation indicators that will be used to monitor the progress of the strategy and the strategy objectives the risk relates to.

Table 13. Adaptation indicators

Risk	Indicators	Objectives
1. Increased demand on Council to respond to climate related hazard events resulting in disruption to service delivery	• Number of days with electricity service interruptions to council facilities • Number of assets strengthened and/or better managed to withstand the effects of climate change • Number of training sessions targeting staff and number of attendees	• Objective 2
2. Adverse climate impacts resulting in loss of life or physical injury among Council staff and/or community members	• Number of awareness-raising events targeting community and number of attendees • Number of SECCCA adaptation and resilience projects participated in • Number of school's education programs delivered at Deep Creek that focuses on climate change	• Objective 1 • Objective 2 • Objective 3
3. Mental stress and illness among community and Council staff	• Number of financial coaching and debt assistance sessions held • The extent to which a climate resilient agriculture program has developed and implemented •	• Objective 1 • Objective 2 • Objective 3
4. The increased incidence of family violence	• no indicator	• Objective 2
5. The increased incidence of bushfire-related pollution	• Number of smoke related disruptions to Council facilities • Suitability of alternatives techniques for burning off in bushland reserves	• Objective 1 • Objective 2

Risk	Indicators	Objectives
6. Contamination of tank water supplies during and following major bushfires	• The extent to which the investigation into best practice flush system have been completed •	• Objective 3
7. The decline and loss of Environment Protection and Biodiversity Conservation Act 1999 and Flora and Fauna Guarantee Act – listed populations and species	• Number of coastal management plans developed on a voluntary basis for private land • Number of vulnerable ecosystems identified in bushland reserves • Identification of teal, blue and soil carbon assets in the Shire • The uptake of the gardens for wildlife program in growth areas • The number of local pest animal plans developed	• Objective 2 • Objective 3

10 Bibliography

Annika Dean / 21 August 2019. “Deforestation and Climate Change.” Climate Council, 9 Feb. 2021, https://www.climatecouncil.org.au/deforestation/

Bernie Commins. “Climate Alarm: Global Temperature Goals Getting 'beyond Reach' - IPCC Report.” *Agriland.ie*, 9 Aug. 2021, www.agriland.ie/farming-news/climate-alarm-global-temperature-goals-getting-beyond-reach-ipcc-report/
“The Causes of Climate Change.” NASA, NASA, 30 Aug. 2021, https://climate.nasa.gov/causes/.

Climate Change. “Victorian Climate Projections 2019.” Climate Change, Climate Change, 26 Aug. 2020, https://www.climatechange.vic.gov.au/adapting-to-climate-change-impacts/victorian-climate-projections-2019.

Coastadapt, 24 Feb. 2021, https://coastadapt.com.au/climate-change-and-sea-level-rise-based-observed-data.

DELWP. Climate Change Adaptation Resources, Climate Change, 2 Oct. 2020, https://www.climatechange.vic.gov.au/climate-change-adaptation-resources.

DELWP. Victoria's Climate Change Strategy, Climate Change, 28 May 2021, https://www.climatechange.vic.gov.au/victorias-climate-change-strategy.

DELWP. Victoria’s Climate Change Adaptation Plan 2017-2020, https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0024/60729/Victorias-Climate-Change-Adaptation-Plan-2017-2020.pdf.

DELWP. “Victorian Climate Projections 2019.” Climate Change. Climate Change, August 26, 2020. https://www.climatechange.vic.gov.au/adapting-to-climate-change-impacts/victorian-climate-projections-2019

DISER. International Climate Change Commitments, Department of Industry, Science, Energy and Resources, 27 July 2020, https://www.industry.gov.au/policies-and-initiatives/australias-climate-change-strategies/international-climate-change-commitments.

Grose, M. Southern Slops Cluster Report: Climate Change in Australia Projections for Australia's NRM Regions. CSIRO, 2015.

IPCC. AR6 Climate c/Change 2021: The Physical Science Basis, https://www.ipcc.ch/report/ar6/wg1/.

Lieberman, Bruce. “1.5 Or 2 Degrees Celsius of Additional Global Warming: Does It Make a Difference? " Yale Climate Connections.” Yale Climate Connections, 8 Nov. 2021, https://yaleclimateconnections.org/2021/08/1-5-or-2-degrees-celsius-of-additional-global-warming-does-it-make-a-difference/.
“National Climate Resilience and Adaptation Strategy.” Department of Agriculture, Water and the Environment, http://www.environment.gov.au/climate-change/adaptation/strategy.

PRI. “Environmental and Social Consequences of Climate Change.” PRI, 30 Apr. 2014, https://www.unpri.org/research/environmental-and-social-consequences-of-climate-change/3028.article.

11 Action plan

12 Appendices

Action plan

Table 1. Annual cost of action plan

Year	Council operational funding per year (existing)	Additional Council operational funding (per year) sought	Additional Council capital funding (per year) sought	Total proposed implementation costs
2023-24	30,000	178,000		208,000
2024-25	30,000	315,300	35,000	380,300
2025-26	30,000	417,146	35,000	482,146
2026-27	30,000	356,039	35,000	421,039
2027-28	30,000	318,480		348,480
2028-29	30,000	317,969		347,969
2029-30	30,000	295,509		325,509
2030-31	30,000	333,099		363,099
2031-32	30,000	310,741		340,741
2032-33	30,000	363,436		393,436
Total	**$300,000**	**$3,205,719**	**$105,000**	**$3,610,719**

Table 2. Human resourcing requirements

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
1.	Climate Resilience Officer role	Ongoing	2023-24 onwards	Environment and Heritage			115,000*	115,000	1,259,219		1,259,219	Subject to the annual budget process and approval

* first year of salary is $115,000, with 2% added each year to give total of $1,259,218 over the life of the strategy

Table 3. Increased demand on Council to respond to climate related hazard events resulting in disruption to service delivery

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
2.	New Council buildings designed and built to a high ESD standard as per the Council Buildings Enhanced Standards Policy	Ongoing	2023-24 onwards	Building and Facilities								The Enhanced Council Standard – Sustainable Buildings is adopted as part of the consultants' brief and requirements when designing new facilities. Funding for this requirement as part of project overall budget.
3.	Asset Management Plans updates to consider the Asset Vulnerability Assessment and adverse effects of climate change	Ongoing	2023-24 onwards	Infrastructure Services (Asset Management)								
4.	Capture relevant information for climate sensitivity as part of asset condition auditing and review processes	Ongoing	2023-24 onwards	Infrastructure Services (Asset Management)								
5.	Training for staff on roles and responsibilities in response to hazard event	4 years	2025-26 2027-28 2029-30 2031-32	Regulatory Services (Emergency Management)	People and Culture		10,000	10,000	40,000		40,000	
6.	Run climate hazard scenarios, drills and response manoeuvres bi-annually to identify priority works for staff involved in response/ relief and recovery, strengthen internal capacity in carrying out business-as-usual	4 years	2025-26 2027-28 2029-30 2031-32	Regulatory Services (Emergency Management)			15,000	15,000	60000		60,000	

Table 4. Adverse climate impacts resulting in loss of life or physical injury among Council staff and/or community members

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
7.	Raise community awareness and increase preparedness for climate hazards amongst different age groups (eg: website updates, workshops, targeted newsletters etc)	9 years	2024-25 onwards	Environment and Heritage			5,000	5,000	45,000		45,000	Subject to creation of climate resilience officer This action is also relevant to Table 6 & 7of this action plan
8.	Identify high-risk areas for development and develop resources to assist the community	2 years	2024-25 to 2025-26	Planning and Design (Planning Strategy and Urban Design)			7,000	7,000	14,000		14,000	This action is also relevant to Table 5 of this action plan
9.	Inform community on high-risk areas for development	6 years	2026-27 onwards	Planning and Design (Planning Strategy and Urban Design and Growth Area Planning and Subdivisions)								This action is also relevant to Table 5 of this action plan
10.	Participate in regional climate adaption and resilience projects through SECCCA	Ongoing	2023-24 onwards	Environment and Heritage		30,000	15,000	45,000	450,000		450,000	Subject to creation of climate resilience officer
11.	Development of an Urban Forest Strategy	2 years	Active and Connected Communities (Parks Planning)	Environment and Heritage and Operations		50,000	50,000	100,000	100,000		100,000	
12.	Support school's education programs at Deep Creek focusing on climate change	Ongoing	2023-24 onwards	Environment and Heritage			7,000	7,000	70,000		70,000	
13.	Explore the suitability of membership to Climate Emergency Australia	Ongoing	2023-24 onwards	Environment and Heritage			3,000	3,000	30,000		30,000	Budget subject to outcome of investigation.

Table 5. Mental stress and illness among community and Council staff

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
14.	Activate and encourage the community to use outdoor, open space areas including bushland reserves	8 years	2025-26 onwards	Active and Connected Communities (Recreation and Parks Planning)	Environment and Heritage		5,000	5,000	40,000		40,000	
15.	Investigate suitability to subscribe to “How Well Are We Adapting Tool”	1 years	2023-24	Environment and Heritage								
16.	Attract mental health services that fill identified gaps including outreach and satellite services in rural townships	Ongoing	2023-24 to onwards	Community Infrastructure and Service Planning								
17.	Provide support for staff directly affected by climate hazard events or involved in relief and recovery efforts	Ongoing	2023-24 onwards	People and Culture (Learning and Organisational Development)								
18.	Increase community access to financial coaching and debt assistance programs	7 years	2026-27 onwards	Community and Family Services (Community Safety and Inclusion)			5,000	5,000	35,000		35,000	
19.	Develop and deliver a Climate Resilient Agriculture program	8 years	2025-26 onwards	Future Communities	Arts, Advocacy and Economy		30,000	30,000	240,000		240,000	Subject to creation of climate resilience officer Years 1 and 2 to investigate and develop. Year 2 onwards delivery of program
20.	Investigate and advocate for an adult mental health centre in the shire in partnership with relevant organisations and groups	Ongoing	2023-24 onwards	Community Infrastructure and Service Planning								

Table 6. The increased incidence of family violence

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
21.	Improve all-ability access to community use facilities in areas at a high risk of climate hazard events (identified in the asset vulnerability risk assessment)	3 years	2024-25 to 2026-27	Buildings and facilities						35, 000	105,000	Council's Enhanced Standard Universal Design is incorporated as part of the annual disability access works and can adopt the required action as part of the criteria when assessing annual works to be completed.

Table 7. The increased incidence of bushfire-related pollution

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
22.	Investigate options to improve ability for Council facilities to function despite high levels of smoke/dust in the air	2 years	2023-24 to 2024-25	Buildings and Facilities			20,000	20,000	40,000		40,000	
23.	Develop an education campaign on the alternatives to burning off	1 years	2025-26	Environment and Heritage	Infrastructure Services (Waste team)		10,000	10,000	10,000		10,000	Subject to creation of climate resilience officer
24.	Review availability, appropriateness and take up of/demand for green waste management options	2 years	2026-27to 2027-28	Infrastructure Services (Waste Services)			18,000	18,000	36,000		36,000	
25.	Investigate the suitability of cultural burning techniques to be carried out in collaboration with traditional owners in bushland reserves	1 year	2026-27	Regulatory Services (Emergency Management)	Environment and Heritage Operations (Bushland crew)		15,000	15,000	15,000		15,000	Subject to creation of climate resilience officer

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
26.	Identify opportunities to reduce burning off	2 years	2029-30 to 2031-32	Regulatory Services (Emergency Management)	Environment and Heritage							

Table 8. Contamination of tank water supplies during and following major bushfires

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
27.	Investigate best practice design to allow for flush systems to be included in water capture and storage systems (eg water tanks) for Council facilities	1 years	2025-26	Buildings and Facilities	Environment and Heritage		4,500	4,500	4,500		4,500	
28.	Develop community information on flush systems for water capture and storage systems (eg water tanks) to be used after a bushfire to minimise contamination of water storage tanks	1 years	2026-27	Environment and Heritage								Subject to creation of climate resilience officer

Table 9. The decline and loss of Environment Protection and Biodiversity Conservation Act 1999 and Flora and Fauna Guarantee Act – listed populations and species

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
29.	Develop a local pest animal action plan (deer, cats, foxes, Indian myna, etc)	4 years	2026-27 to 2027-28 and 2030-31 to 2031-32-	Environment and Heritage			10,000	10,000	40,000		40,000	Contingent on employment of Land Management Officer (developing one action plan per year)
30.	Identify climate vulnerable ecosystems in bushland reserves and roadsides of conservation significance	2 years	2024-25 to 2025-26	Environment and Heritage	Operations (Bushland crew)		30,000	30,000	60,000		60,000	Subject to creation of climate resilience officer
31.	Observe the phenology of climate vulnerable plant species by seeking data on seed production rates from indigenous plant nurseries	Ongoing	2023-24 onwards	Environment and Heritage								Reliance on indigenous plant nurseries
32.	Support Indigenous seed bank initiatives as opportunities arise	Ongoing	2023-24 onwards	Environment and Heritage	Operations (Bushland crew)							External funding
33.	Monitor climate vulnerable ecosystems in bushland reserves to inform Asset Management Plans	4 years	2026-27, 2028-29, 2030-31, 2032-33	Operations (Bushland crew)	Environment and Heritage		25,000	25,000	100,000		100,000	
34.	Identify climate resilient plant species to revegetate open space and the natural reserve system	9 years	2024-25	Operations (Open Space)	Environment and Heritage			10,000	90,000		90,000	
35.	Support the expansion of the gardens for wildlife program into growth areas, focusing on urban properties and developments	Ongoing	2023-24 onwards	Environment and Heritage			8,000	8,000	80,000		80,000	
36.	Promote the creation of shelterbelts to increase native habitat in line with the Shelterbelt Design Guidelines for Climate Change	9 years	2024-25 onwards	Environment and Heritage	Regulatory Services (Emergency Management)		3,000	3,000	27,000		27,000	Subject to creation of climate resilience officer
37.	Undertaken an investigation to identify teal and soil carbon assets in the shire	1 years	2025-26	Environment and Heritage			30,000	30,000	30,000		30,000	Subject to creation of climate resilience officer
38.	Protect and enhance blue, teal and soil carbon assets	3 years	2026-27 2028-29 2030-31	Environment and Heritage			25,000	25,000	75,000		75,000	Subject to creation of climate resilience officer

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
39.	Tactical firebreaks - study and understand locations to increase resilience to bushfire threat on townships	1 year	2024- 25	Regulatory Services (Emergency Management)			25,000	25,000	25,000		25,000	Subject to creation of climate resilience officer
40.	Support the helmeted honey eater (climate threatened/ critically endangered) recovery team to secure recovery sites in the shire	Ongoing	2023-24 onwards	Environment and Heritage								
41.	Works to protect habitat of threatened/indicator species (as per action plans developed in Biodiversity Conservation Strategy)	8 years	2025-26 onwards	Environment and Heritage	Planning and Design (Planning Strategy and Urban Design and Growth Area Planning and Subdivisions)		40,000	40,000	320,000		320,000	
42.	Support environmental groups and organisations working to establish and protect seagrass and mangrove communities and other threatened Ecological Vegetation Communities found in the council area	Ongoing	2023-24 onwards	Environment and Heritage			10,000	10,000	100,000		100,000	Subject to creation of climate resilience officer
43.	Support the creation of a demonstration garden for climate tolerant plant species at Deep Creek Reserve and other sites throughout shire	2 years	2024-25 to 2025-26	Environment and Heritage	Cardinia Environment Coalition (CEC)		5,000	10,000	10,000		10,000	Subject to creation of climate resilience officer
44.	Encourage landowners to develop voluntary costal land management plans on private land	6 years	2027-28 onwards	Environment and Heritage								Subject to creation of climate resilience officer
45.	Advocate for and reduce the use of single use plastics	Ongoing	2023- 24 onwards	Infrastructure Services (Waste Services)								
46.	Seek partnership with tertiary education providers to undertake studies and assessments to improve the understanding of species and habitat loss due to climate change	Ongoing	2023- 24 onwards	Environment and Heritage								

Table 10. Advocacy, monitoring and evaluation

No	Action	Action duration	Timeframe	Lead	Partner	Council operational funding per year (existing)	Council operational funding per year (additional)	Total Council operational funding per year	Total Council operational funding over the life of 10-year strategy	Council capital funding per year (additional)	Total funding over the life of 10-year strategy	Comments
47.	Advocate for climate change adaptation initiatives from all levels of government that increases resilience to climate change	Ongoing	2023-24	Environment and Heritage	Arts, Advocacy and Economy							Subject to creation of climate resilience officer
48.	Midterm review of action plan	1 year	2027-28	Environment and Heritage								
49.	Undertake a climate change risk impact and risk assessment in preparation for development of new strategy	1 year	2032-33	Environment and Heritage			60,000	60,000	60,000		60,000	

List of appendices

Appendix A. Climate data sources

Table A1. Data sources

Hazard category	Variables	Historic data sources	Projected data sources
Temperature	• Maximum annual daily temperature average • Maximum summer daily temperature average • 1-in-20-year hottest day (summer) • 1 in 20-year coldest day (winter) • Average days over 35°C	Moorabbin Airport weather station	Victorian Climate Projections 2019 (VCP19) Southern Slopes Cluster Report (CSIRO & BOM, 2015)
Precipitation and flooding	• Maximum rainfall average	BOM 6.1.2Online – Koo Wee Rup weather station	VCP19
Bushfire	• Severe Fire Danger Days	Baseline from CSIRO & BOM - Southern Slopes Report 2015	Southern Slopes Cluster Report
Coastal hazards	• Sea Level Rise • Sea surface temperature • Coastal erosion	Observed sea level rise from: Southern Slopes Cluster Report	Coast Adapt, 2017
Storms, wind and hail	• Annual average wind speed	BOM Climate Data Online – Moorabbin Airport weather station	VCP19
Solar radiation	• Annual solar radiation • Spring solar radiation		VCP19

Appendix B. Flood, bushfire and sea level rise maps

Figure A1.Figure B1Figure A1.Figure B2 and Figure A1.Figure B3 have taken Council asset data and overlayed the LSIO, BMO and sea-level rise layers (respectively) over the top to demonstrate the effect the impact these climate change events have on Council assets.

Figure B1. Land subject to inundation (LSIO)

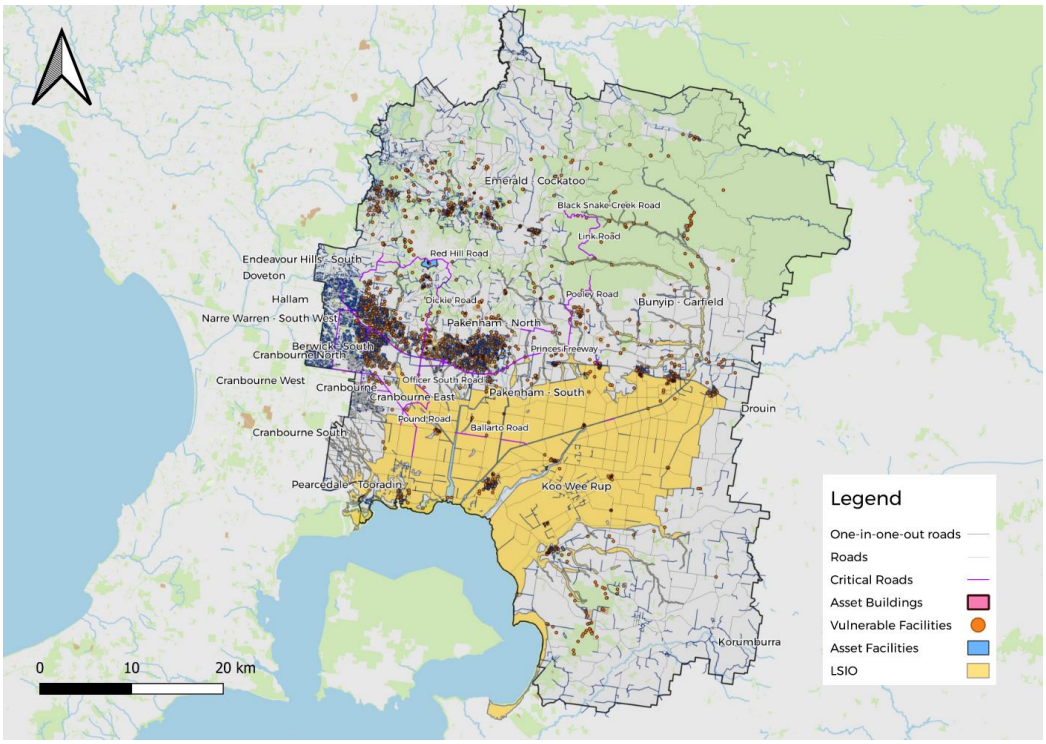


Figure B2. Bushfire management overlay (BMO)

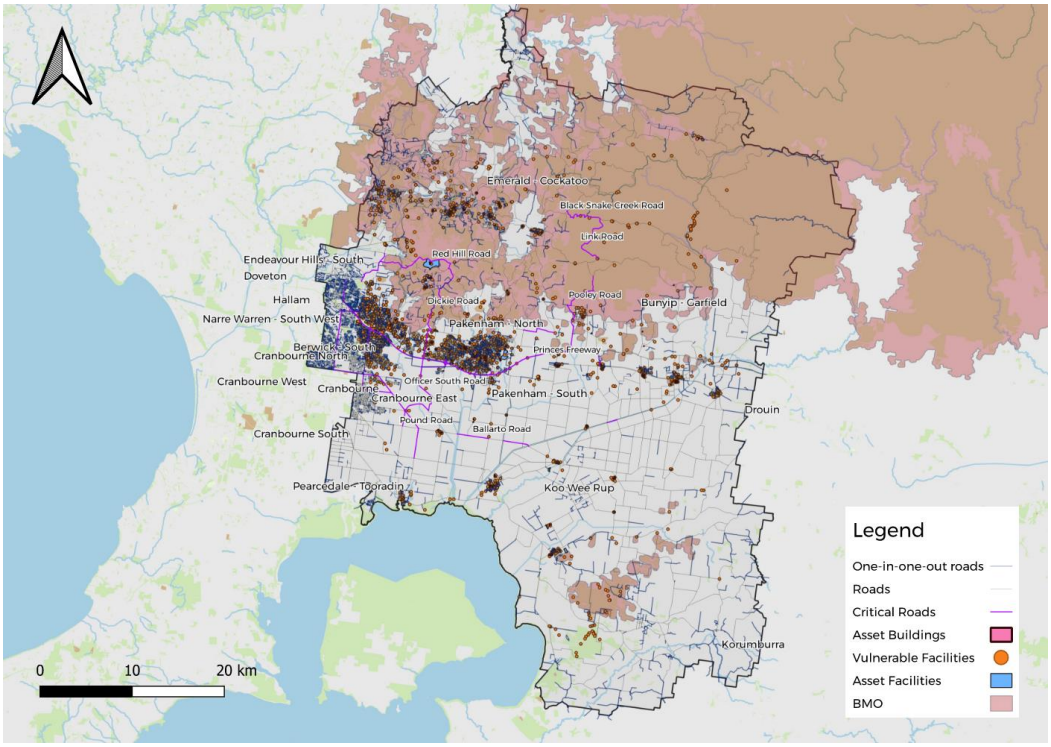
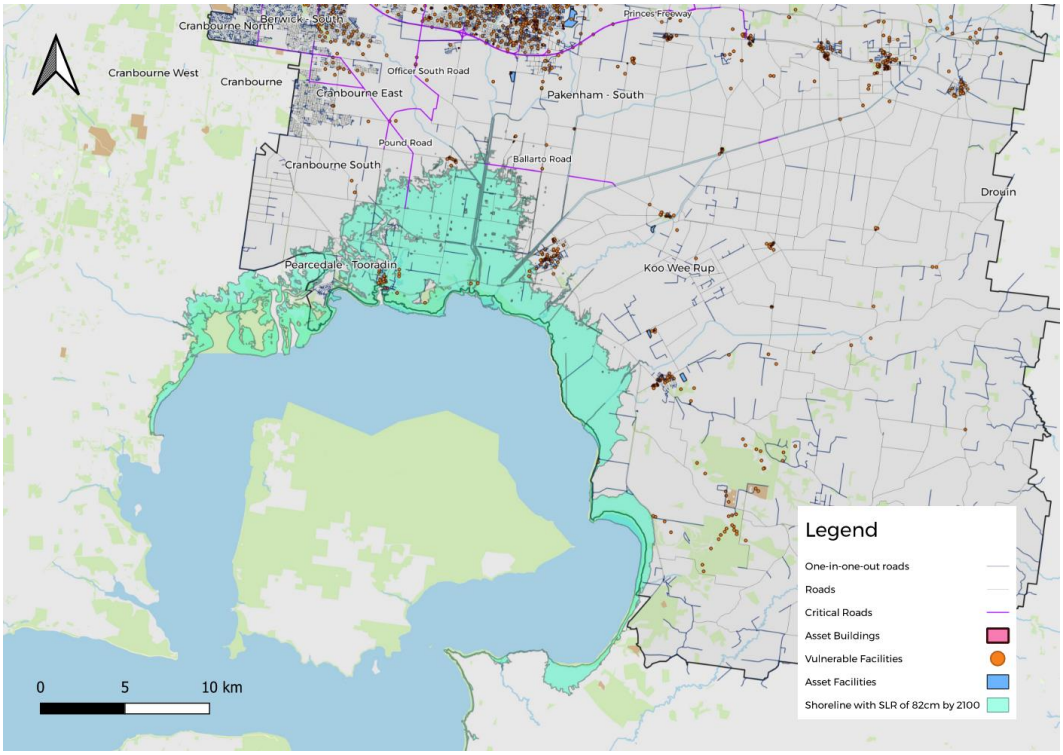


Figure B3. Change to shoreline with a sea rise level of 82cm by 2100



Appendix C. Historic climate – related events with major impacts

Table C1. Historic climate events in Cardinia Shire

Year	Location	Indecent	Impact	Source
1891	Regional	Major rainfall and flooding	Major flooding	Municipal Emergency Management Plan (MEMP)
1900	Koo Wee Rup	Two-day period of rainfall	Crop loss and inundation	MEMP
1901	Koo Wee Rup	Three-day period of rainfall	Extensive flooding	MEMP
1911	Upper Catchments	Heavy rainfall	Flooding to depth of 1.5m Koo Wee Rup	MEMP
1923	Cora Lynn	Flood event	Crops destroyed and inundation 2m at Cora Lynn	MEMP
1924	Koo Wee Rup	Heavy rainfall	300mm most of Koo Wee Rup Swamp over 2 metres	MEMP
1934	Koo Wee Rup	Flooding	Major flooding	MEMP
1937	Koo Wee Rup	Heavy rainfall	Excess rainfall over 152.4mm. Koo Wee Rup flooding	MEMP
1939	Eastern Victoria	Bushfire (Black Friday)	2 million hectares/71 deceased	MEMP
1956	Cardinia Shire	Heavy rainfall	Heavy rain and flooding	MEMP
1959	Cardinia Shire	Heavy rainfall	Widespread flooding / upper catchments	MEMP
1971	Swamp area	Flooding	Significant flooding	MEMP
1978	Pakenham	Heavy rainfall	Widespread flooding in Pakenham CBD	MEMP
1983	Cardinia Shire	Bushfire (Ash Wednesday)	180 homes destroyed/21 deceased	MEMP
1991	Koo Wee Rup	Extensive flooding	Flooding of the Koo Wee Rup swamp	MEMP
1996	Koo Wee Rup	Widespread flooding	Damage to crops, riverbanks overflowing Iona	MEMP
2008	Cardinia Shire	Severe Windstorm	Widespread damage across Southern metro region	MEMP
2009	Bunyip State Park	Bushfire (Black Saturday)	45% of park burnt by wildfire	MEMP

Year	Location	Indecent	Impact	Source
2009	Lakeside/ Pakenham	1-in-100-year storm event	180 mm rainfall in 24 hours 4–5 Feb 2009	MEMP
2010	Cardinia Shire	Hailstorm	Heavy rain, large hail and flash flooding over 6th and 7th of March 2010	MEMP
2011	Pakenham/Officer	Heavy rainfall	Over 150mm in eight hours causing extensive flooding	MEMP
2012	Koo Wee Rup area	Heavy rainfall/flooding	Widespread flooding Koo Wee Rup and surrounds	MEMP
2016	Cardinia Shire wide	Significant storm event	Severe wind event leaving 40,000 homes without power across the 3 Metro regions	MEMP
2016	Metropolitan areas	Thunderstorm Asthma	21-22nd November, unprecedented surge in respiratory and asthma related illness affected thousands of Victorians	MEMP
2016	Cardinia Shire wide	Flood event	Widespread rainfall up to 80mm in a short period of time causing flash flooding, landslips and traffic management concern	MEMP
2019	Bunyip State Park	Bushfire	29 houses destroyed and 2 houses damaged, over 100,000 ha burned	ABC News 2019, Cardinia Shire Council (CSC) records
2019	Cardinia Shire wide	Flood event	Flooding of multiple facilities requiring repair works	CSC records
2020	Cardinia Shire wide	Storm event	Jan & Feb storm events 14 Council owned facilities affected	CSC records
2020	Cardinia Shire wide	Flood event	Flooding of multiple facilities requiring some repair works	CSC records

Appendix D. Weather stations used for baseline climate data

Table D1. Weather stations used for baseline data

Observed weather data	Weather station	Rationale
Daily temperature and wind	Moorabbin airport	The Moorabbin Airport location and CSC are in the same climate zone: Zone 6. This zone is characteristically mild in temperature and ranges from low diurnal temperature variation near the coast to high diurnal variation inland. Despite being further away to the CSC than other weather stations, the Moorabbin station represents similar conditions to the large percentage of the Shire whilst providing the most appropriate data set for historic climate data analysis. This weather station is also the closest station to the Cardinia Shire (reference point) with a consecutive year-to-year record of daily temperature over the baseline. Other temperature weather stations near the Shire lack full temperature records for the baseline period used in the assessment.
Daily rain	Koo Wee Rup	Koo Wee Rup is the nearest weather station with daily precipitation data for the baseline period and appropriate representation of environmental conditions for a large proportion of the Shire. Suitable baseline precipitation data for other localities in the Shire is not available, although it can be concluded anecdotally that more mountainous areas receive greater annual rainfall on average.

Appendix E. Past and present adaptation initiatives and actions undertaken by Council

1. Council Climate Emergency Declaration
2. Council Climate Pledges
3. Council asset climate vulnerability assessment
4. Bushfire vulnerability council asset case study
5. Domestic violence awareness and training for staff to identify and response to family and domestic violence
6. Cardinia Coast Defence Project
7. Financial Risk Adaptation Planning
8. Enhance natural buffers and structures such as shelterbelts and bio links
9. Train council staff in first aid and mental health
10. Establish emergency management/ evacuation plans for councils' facilities in high threat areas
11. Formalise internal processes and procedures in response to specific hazard events
12. Raise community disaster Awareness and Preparedness
13. Strengthen existing partnership and foster new ones with support organisations and community groups
14. Engagement of the broader community (networks, clubs, sporting associations, committees) to demonstrate an understanding that everyone is responsible for promoting awareness on domestic violence
15. Gardens for wildlife program
16. Update of open-air burning laws to reduce instances with low levels of smoke
17. Advice and inform community with up-to-date information
18. Deliver community tree planting and giveaway events
19. Direct development away from away of high bushfire risk with important biodiversity
20. Direct development away from away of high flood risk with important biodiversity
21. Biodiversity Conservation Strategy
22. Biolink Plan
23. Integrated Water Management Plan
24. Weed Management Plan
25. Aspirational Energy Transition Plan
26. Sustainable Environment Strategy
27. Climate Risk in Governance speaker
28. Liveability Plan
29. Heat Health Action Plan
30. The Food Circles program
31. Metal health training for staff
32. Emergency Procurement Policy
33. Financing Physical Risk Infrastructure

Appendix F. Existing strategies and plans

The Council plans and strategies in Table F1 were used as references in the preparation of this strategy, to ensure consistency with existing strategies and regional plans.

Table F1. Council plans and strategies

Document title	Description
Council Plan 2021-25	**Aim** Directs Councils approach to tackling and preparing for the challenges while maximising the opportunities for the shire to thrive in the long term. **Objective** • tackle climate change as it continues to be one of the greatest challenges of our time • foster strong communities, liveable places, thriving environments and proposers' economies.
Liveability Plan 2017-29 (Cardinia Shire Council 2017)	**Aim** Strategically planning and maintaining opens spaces and places – ensure safety, accessibility, appealing and connected. **Objectives:** • Plan for the effects of climate change on the health and wellbeing of the community • Protecting and enhancing the environmental quality of open spaces and places. • Identify and address community concerns in relation to climate change impacts on liveability
*Sustainable Environment Policy 2018-28 (*Cardinia Shire Council 2018)	**Aim** Identifies the challenges facing the municipality, and outlines the plans and strategies already in place and those required to address them. **Objectives:** • Provides the roadmap for the future direction of Council's environmental and sustainability strategies, plans and activities • Plan for the adverse effects of climate change and take the appropriate action to prevent or minimise the damage it may cause • Support the community to adapt to climate change
Aspirational Energy Transition Plan 2014-24 (Cardinia Shire Council)	**Aim** Direct Council actions to mitigate climate change and accomplish pre-set targets for emission reduction. **Objectives:** • Recue council emissions and limit the onset of severe climate change • Achieve carbon neutrality for council activities by 2024

Document title	Description
Biodiversity Conservation Strategy 2019-29 (Cardinia Shire Council 2019)	**Aim** Strategic and planned approach to sustainably manage the shire's natural environment, so it is resilient, healthy and valued by the community **Objectives:** • Protect native flora, fauna and habitats (i.e. waterways); • Enhance the quantity and quality of indigenous flora and fauna on private and public land; • Connect native flora and fauna across landscape through Biolink corridors and steppingstones; and • Engage and educate the local communities to safeguard and project natural assets.
Biolink Plan 2022-33 (Cardinia Shire Council)	**Aim** Increase the connectivity across the natural assets and structures to support movement of biodiversity across the landscape **Objectives:** • Create vegetation corridors • Link pockets of vegetation to improve the ability for species to disperse • Support biodiversity to inhabit best quality habitats • Connectivity of habitats supports resilience of threatened species
Weed Management Strategy 2019-29 (Cardinia Shire Council 2019)	**Aim:** Council, agencies and community working collaboratively to protect Cardinia Shire's landscape, biodiversity and agriculture from the negative impacts of weeds **Objectives:** • Protect Cardinia Shire's landscape, biodiversity and agriculture from the threat of invasive weeds • Manage – strategically allocate resources to local weed priorities consistent with regional, state and national priorities • Engage and empower our community to motivate them to collectively address weed issues
Integrated Water Management Plan 2015-25 (CSC 2015)	**Aim** Deliver a framework to guide Council towards a more sustainable approach to water management to decrease the reliance on potable water and enhance ecological health of receiving waterways. **Objectives:** • Quantify and minimise stormwater flows, and pollutant loads to waterways • Ensure efficient use of potable water within Council facilities and encourage community to reduce usage • Reduce Councils reliability on potable water by identifying and using alternative water sources • Contribute to sustainable groundwater management (including exploring the option of alternative sources for agriculture) • Reduce the impact on the environment • Protect the shires waterway values and open these assets up to the community.

Appendix G. Community feedback

Significant community engagement was undertaken in the preparation of a CCIR assessment and the CCAS. This was done through a range of methods including:

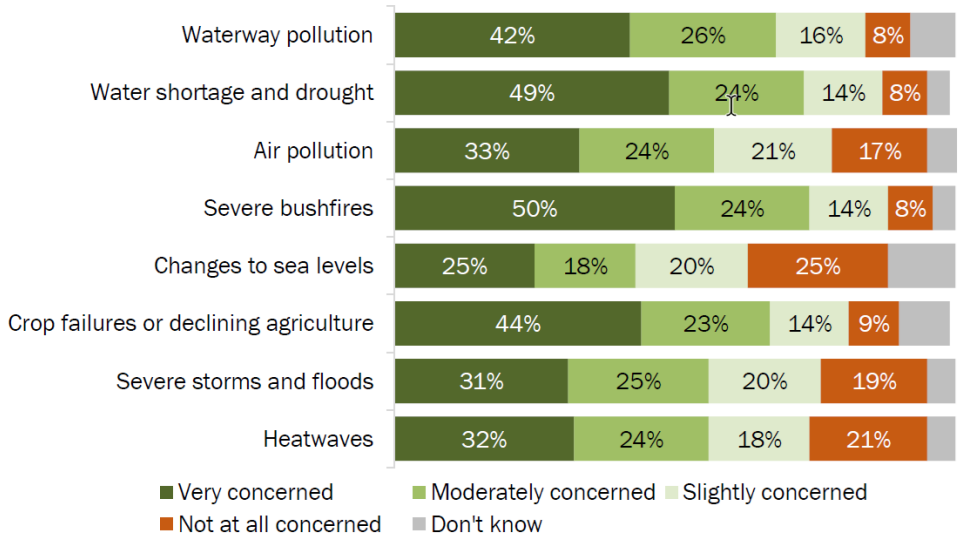
- Online surveys and questionnaires
- Climate risk workshop with community representatives
- A CCIR assessment drawing on community and stakeholder identification of risks and an analysis of weather data on climate change in Cardinia Shire.

Liveability Plan survey 2019

Climate change is an underlying determinant to the liveability of our communities. Understanding the adverse impacts of climate change on the community is key to successfully addressing climate risks. The Liveability Plan survey conducted by Council in 2019, identified community concerns on climate change. Through the engagement process for the *Liveability Plan* trends in community perception of climate impacts and risks emerged.

The survey results show a greater concern for bushfires over the next ten years amongst the shire's population, with 74% of respondents in the shire having concerns about severe bushfires, compared to only 68% across Victoria. This sentiment can likely be attributed to the large areas of bushfire-prone land in the shire and the recent Bunyip Complex Bushfires. **Error! Reference source not found.** represents a snapshot of the community's climate concerns for the next 10 years.

Figure H1. Snapshot of the community's concerns over next 10-years



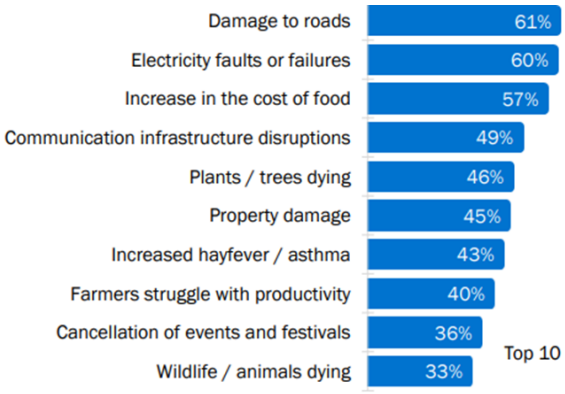
Liveability Plan survey 2021

The Liveability Plan survey conducted by Council in 2021, gathered responses to the community's perception on the impacts of extreme weather in the Shire.

Figure H2. Snapshot of the community's perception of extreme weather impacts

Impacts

Only 5% think extreme weather will have no impacts (currently or in the next 5 years).
The main perceived impacts are related to public infrastructure.
63% selected a human-health related item, including 25% who said mental health.
Those in Ranges ward more commonly cited road and property damage, and electricity failures.



Community risk workshop

A community workshop held in February 2021 included external stakeholders representing community interests, such as township committees, local health services, community support groups an environmental interest group, and a major local business.

The workshop attendees were introduced to the assumptions that underpin the use of climate projections, followed by a summary suite of projections depicting the conditions Cardinia Shire may face in 2030 and 2070. Participants then undertook a structured discussion to validate, refine and build upon the list of 41 risk descriptors based on their personal knowledge of the shire and Council operations. This activity was followed by a group exercise to prioritise top risks by 2070 based on likelihood and consequence.

The external workshop provided opportunity for community representatives to articulate the following:

- Values: aspects of life in Cardinia Shire that are important to communities (e.g. industries, natural assets, mental wellbeing), with the potential to be affected by climate change
- Vulnerabilities: characteristics of communities within Cardinia Shire that may increase their susceptibility to adverse impacts from climate-related hazards
- Strengths: characteristics of communities within Cardinia Shire that may assist in them in surviving and thriving when faced with climate-related hazards (i.e. reducing vulnerability).