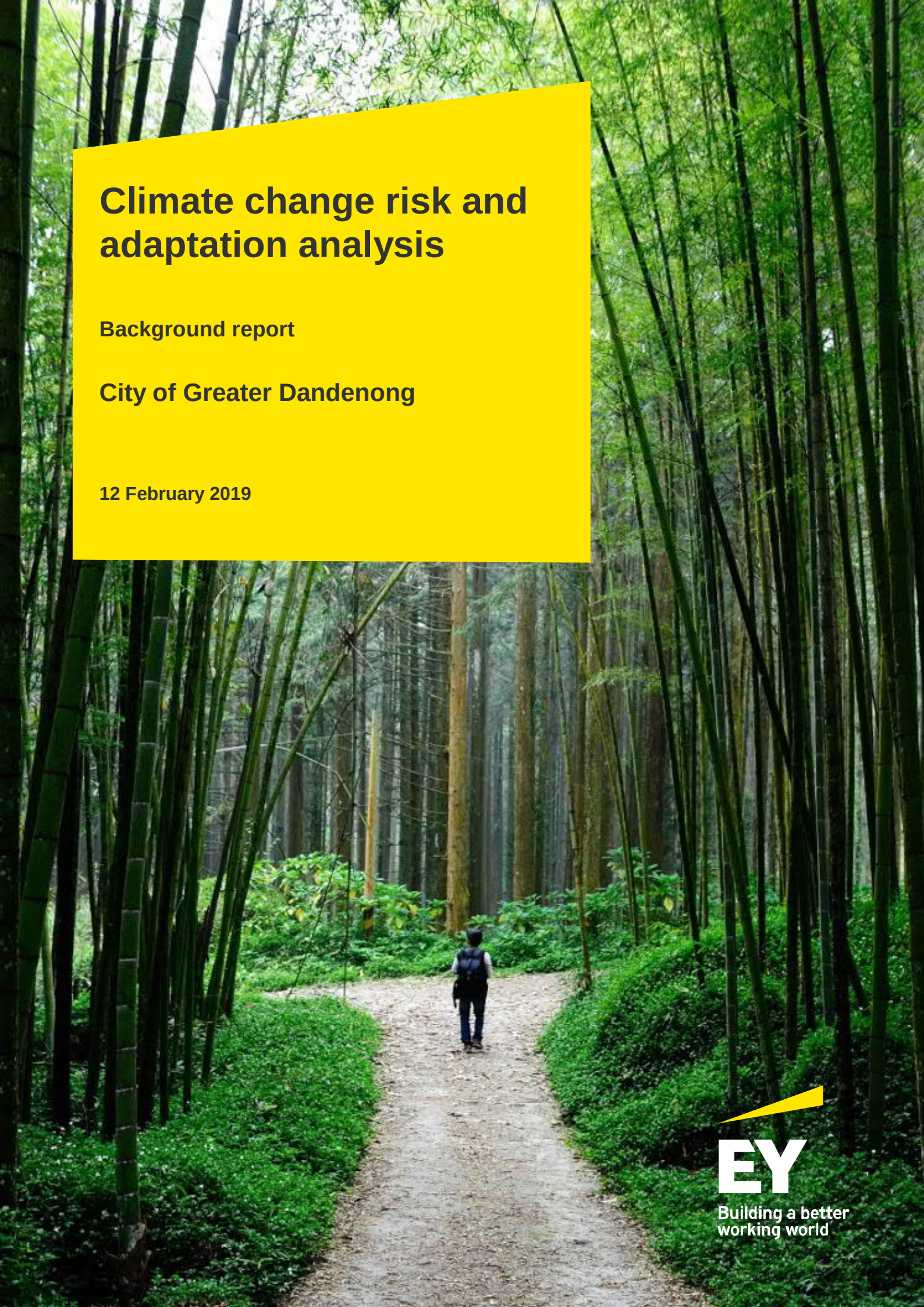
Climate change risk and adaptation analysis

Background report

City of Greater Dandenong

12 February 2019



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Glossary

Term	Definition
Anthropogenic climate change	Changes in the climate resulting from or produced by human activities.
Climate change	Any change in climate over time, whether due to natural variability or as a result of human activity.
Climate change adaptation	Actions in response to actual or projected climate change and impacts that lead to a reduction in risks or a realisation of benefits. A distinction can be made between a planned or anticipatory approach to adaptation (i.e. risk treatments) and an approach that relies on unplanned or reactive adjustments[1]
Climate change mitigation	Response measures that reduce the emission of greenhouse gases into the atmosphere or enhance any process, activity or mechanism which removes a greenhouse gas, aimed at reducing their atmospheric concentrations and therefore the probability of reaching a given level of climate change[2]
Climate change scenario	Means a coherent, plausible but often simplified description of a possible future state of the climate. A climate scenario should not be viewed as a prediction of the future climate. Rather, it provides a means of understanding the potential impacts of climate change, and identifying the potential risks and opportunities to an organisation created by an uncertain future climate. A 'climate change scenario' can be defined as the difference between a climate scenario and the current climate[3]
Consequence	Outcome or impact of an event. The level of consequence is assesses on whether, if each criteria identified failed, what level of consequence would be expected[4]
Control	An existing process, policy, project, device, practice or other action that acts to minimise negative risk or enhance positive opportunities. The word control may also be applied to a process designed to provide reasonable assurance regarding the achievement of objectives[5]
Council	The City of Greater Dandenong as an individual entity, with its own workforce, services assets and infrastructure.
Event	Occurrence of a particular set of circumstances. The event can be certain or uncertain. The event can be a single occurrence or a series of occurrences[6]
Extreme weather event	Weather conditions that are rare for a particular place and/or time such as an intense storm or heat wave[7]
Frequency	A measure of the number of occurrences per unit of time.
Likelihood	Used as a general description of probability or frequency. Expressed as the level of likelihood of suffering the consequence given the current controls in place for each identified risk.
Risk	The chance of something happening that will have an impact on a set of objectives. The risk specified in terms of the event and the consequences that stem from it and is measured in terms of a combination of the consequence and likelihood. A risk may have a positive or negative impact[8]
Risk assessment	The overall process of risk identification, risk analysis and risk evaluation.
Risk rating	The likelihood and consequence of a risk.
Resilience	The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganising in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation[9]
Stakeholders	Those people and organisations who may affect, be affected by, or perceive themselves to be affected by a decision, activity or risk.
Vulnerability	The extent to which a system or organisation can cope with the negative impacts of climate change, variability and extremes. It is a function of risk and adaptive capacity[10]

[1] Department of the Environment and Heritage; Australian Greenhouse Office, *Climate Change Impacts & Risk Management: A Guide for Business and Government*
[2] Ibid
[3] Ibid
[4] Ibid
[5] Ibid
[6] Ibid
[7] Ibid
[8] Department of the Environment and Heritage; Australian Greenhouse Office, Climate Change Impacts & Risk Management: A Guide for Business and Government
[9] National Climate Change Adaptation Research Facility, Climate Change Adaptation Plan for the Emergency Management Sector 2018
[10] Department of the Environment and Heritage; Australian Greenhouse Office, Climate Change Impacts & Risk Management: A Guide for Business and Government

1. Executive summary

1. Executive summary

The City of Greater Dandenong (CoGD) is a Local Government Area located in the south-east region of Melbourne, Victoria. The CoGD municipality has one of the most culturally and linguistically diverse communities in Australia, with residents from over 160 different countries, with over half of the population being born overseas[11]. With recent state policy changes associated with climate change and climate change adaptation, including the proposed *Local Government Bill 2018* that sees Council responsibilities' to act in the long term interest of residents in relation to climate change embedded within the legislation, the CoGD Council (the Council) engaged EY to develop the CoGD Climate Change Strategy and Action Plan to help CoGD take a leadership role in climate change mitigation and adaptation.

The Council commissioned EY to prepare this Climate Change Risk Analysis and Adaptation Report as part of the wider Climate Change Strategy and Action Plan's four background reports (outlined in Figure 1). The Climate Change Risk Analysis and Adaptation report aims to identify, analyse and evaluate the economic, environmental and social risks posed by climate change to the Council's operations and the wider community and identify associated adaptation actions to address these risks.

Figure 1 - Key background reports to be delivered as part of the development of CoGD's Climate change Strategy and Action Plan

This report explores how climate-related risks could affect the Council and wider community, and presents an adaptation framework to manage and respond to the economic, environmental and social risks posed by climate change. This framework has been developed in line with leading standards and guidance, such as *ISO 31000 Risk Management*[12] and the Australian Government's *Climate Change Impacts & Risk Management: A* Guide *for Business and Government*[13] as outlined in Figure 2. The risk assessment process that was administered for the CoGD was in alignment with the Council's internal risk management procedure.

[11] City of Greater Dandenong, *Community Profile*
[12] International Standards Organisation (ISO), *ISO 31000:2009 Risk management - Principles and guidelines*
[13] Department of the Environment and Heritage; Australian Greenhouse Office, *Climate Change Impacts & Risk Management: A Guide for Business and Government*

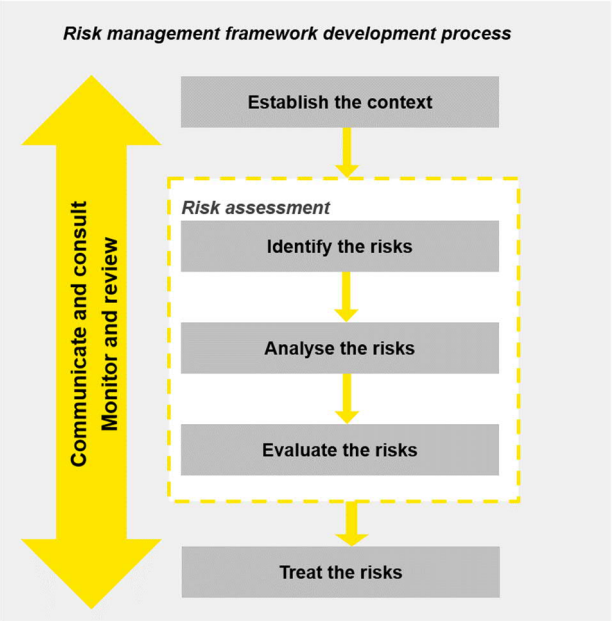


Figure 2 - Risk management process in alignment with ISO 31000 and Commonwealth Government guidance on the integration of climate change into risk management

Key findings from the risk assessment

Extensive stakeholder engagement was undertaken via interviews and the conduct of a Climate Change Risk Assessment workshop with over 20 Council staff members. The purpose of this workshop was to identify and allocate consequence and likelihood ratings to the environmental, economic and social risks posed by climate change that could impact on the delivery of key Council services and the wider community. A comprehensive literature review was also undertaken alongside stakeholder interviews to identify the climatic and legislative conditions for climate action within the CoGD.

As per Figure 3, the standardised results from the Climate Change Risk Assessment identified 44 inherent risks (prior to consideration of existing controls) where 10 of the 44 risks received an overall risk rating of "extreme", requiring immediate action. The majority of these risks were in relation to the projected increase in extreme temperatures (days above 35^{o}C) leading to intense heatwaves and the projected increase in frequency and intensity of extreme storm events. Approximately 57% of the risks were corporate related risks affecting the Council while the remaining 43% were community risks. The top three risks impacting CoGD were:

- Increased frequency of extreme hot days (above 35^{o}C) and increased frequency, intensity and duration of heatwaves, leading to extreme hot weather conditions, impacting ***public health and wellbeing through heat related stress and illness***.
- Increased frequency and/or intensity of extreme rainfall events causing ***damage to, and loss of, utilities and transport infrastructure.***
- Increase in mean annual and seasonal (summer and winter) temperatures leading to an ***increase in demand and use of electricity and water for cooling residential and commercial properties.***

Risk register

44 Risks identified for CoGD as a result of future climate change projections

57% related to CoGD specific Corproate risks

43% related to CoGD's wider community

Identified risks have been grouped into 3 categories:

27% Economic related risks

21% Social related risks

7% Environment related risks

45% Combination of two categories

Outcomes from the risk assessment workshop:

10 'Extreme' rated risk priority (critical risk that requires immediate action)

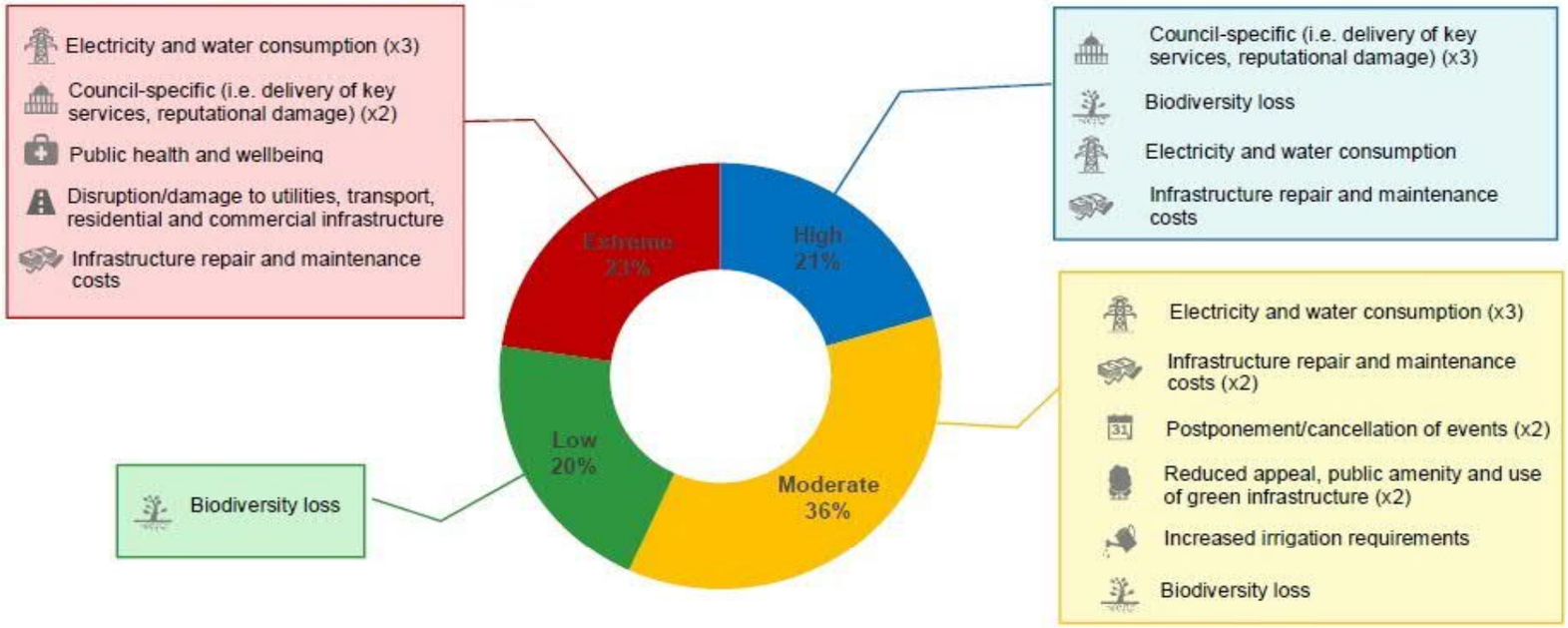
9 'High' rated risk priority (significant risk that requires management attention)

16 'Medium' rated risk priority (risks that require management resposibilities to be specified)

9 'Low' rated risk priority (risks that can managed by routine procedures)

Analysis of identified risks

Below is a distribution of the standardised risk priority levels that were agreed at the Climate Change Risk Assessment workshop based on the overall grouping of key impacts and breakdown of key climate variable assessed.



Risk breakdown against selected climate variables for CoGD

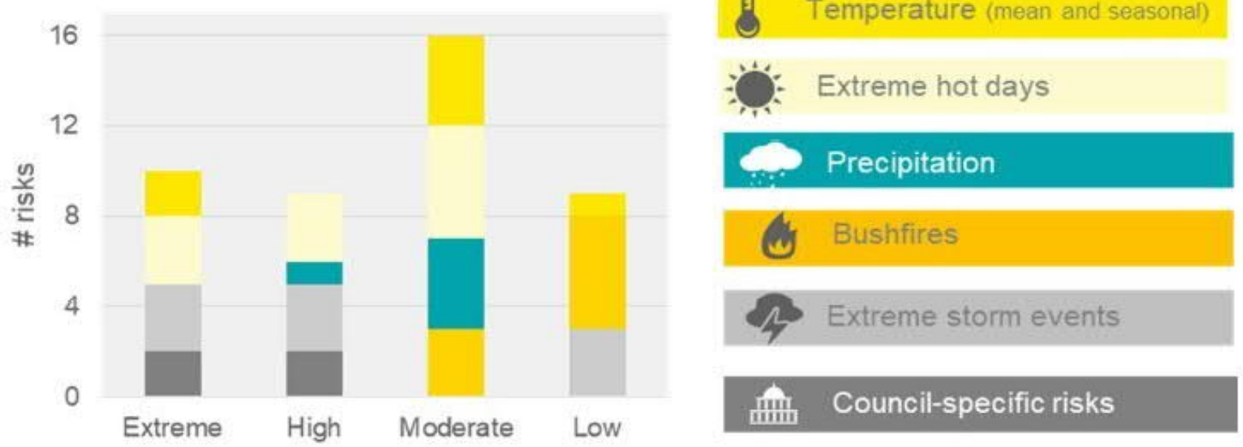


Figure 3 - Summary of the risk assessment workshop results

Nine “high” priority risks (from the total of 44 inherent risks) were identified that required the next highest level of priority actioning with the remaining risks rated as either ‘medium’ or ‘low’. The climate variables that resulted in the highest risk priority levels were in relation to increased mean annual and seasonal temperature, extreme temperatures, extreme storm events; with bushfires receiving on average the lowest risk ratings. The former is in line with climatic events experienced in CoGD historically, such as the 2009 Victorian heat wave[14] and the 2011 extreme storm event[15] with associated flooding where both events had significant economic, social and environmental impacts for the Council and community.

Climate change adaptation

A climate change adaptation workshop was held to identify existing controls/actions that are in place to reduce the identified risks (from Figure 3) and determine its effectiveness in alignment with CoGD’s risk management framework. Based on the discussions at the workshop on existing controls, a number of CoGD policies, strategies and plans were identified as critical to addressing multiple identified risks across different climate variables. These included (among others):

- Asset Management Plan and Strategy
- Emergency Management Plan
- Flood Management Plan 2018
- Municipal Fire Management Plan 2015
- Urban Street Tree Strategy 2018.

It was noted during the risk assessment process and climate change adaptation workshop that while the CoGD does have several policies in place to manage climate-related risks, there was a gap between the policy design and implementation. Stakeholder feedback indicated that this was an organisation-wide shortcoming, where multiple plans and strategies exist without detailed oversight and tracking of the responsibilities of individuals and teams tasked to implement them. Stakeholder discussions further reinforced this issue where it was identified that although CoGD had policies and strategies in place, there was a lack of understanding of whether the associated actions were being implemented across the Council. As part of the climate change adaptation workshop, the effectiveness of CoGD’s existing controls (such as existing actions, plans and policies) was discussed with the internal stakeholders, and were mostly found to be, on average, not adequate to control the climate impacts.

It is important to note that the climate change risk and adaptation assessment has a number of limitations in its findings. Firstly, the Council’s existing risk register indicates a minimal level of identification and disclosure on climate-related risks indicating that the Council is not accurately identifying and managing its climate-related risks. During the stakeholder workshops, discussions evaluating the climate risk register indicated that in some instances there was a lack of relevant expertise to identify controls/ adaptation actions, mainly due to personnel being unable to attend these workshops. In addition, time constraints of the workshops led to limited discussions (in some aspects of the risk register), where stakeholder input could not be received in the level of detail that was desired for some of the identified risks and associated adaptation actions. Finally, it is important to note that only direct impacts are considered in the climate change risk and adaptation assessment, and while indirect (or flow on effects) impacts of climate change, such as food security, environmental refugees etc. are important, they have not been considered as part of this project.

The proposed climate change adaptation framework will assist decision-makers within the CoGD to understand and incorporate climate change risks and associated impacts into policies, plans, strategies and operational decisions across all key areas of Council operations. This framework is designed to assist the CoGD to identify, assess and evaluate climate change risks to its business operations and the wider community in which it serves, and treat these risks through the implementation of associated adaptation actions to control, thus further reduce these risks. It is important that this framework is developed and implemented in conjunction with key stakeholders within local government and the community to develop practical strategies to manage the risks posed by climate change.

[14] City of Greater Dandenong, *Heatwave Plan 2015 - 2017*
[15] City of Greater Dandenong, *Flood Management Plan for City of Greater Dandenong, 2018*

Structure of this report

This Climate Risk and Adaptation Analysis background report is structured as follows:

- Section 2 provides an **introduction** to the report including the key reasons for CoGD undertaking this project.

- Section 3 outlines the **CoGD's environmental and socioeconomic profile** that provides the contextual basis for undertaking the CoGD's Climate Risk and Adaptation Analysis as part of the development of its Climate Change Strategy and Action Plan.

- Section 4 describes the **climate trends** observed across the Australian subcontinent including the greater Melbourne region, within which the CoGD is located. This Section also outlines **long-term projected climate trends** for Australia. This information has then been used to determine the likely climatic changes and impacts for the CoGD guided by selected climate change scenarios and time horizons.

- Section 5 discusses the process that was undertaken to conduct **a climate change risk assessment** for the CoGD through the identification, evaluation and analysis of risks posed by climate change. This section describes the activities that were undertaken in alignment with the *ISO 31000 Risk Management* standards as well as CoGD's internal risk management framework. Furthermore, it includes a summary of the literature review that identified environmental, social and economic risks posed by climate change for the CoGD and its wider community.

    - Appendix A outlines the raw results (non-standardised) from the risk assessment taken from the Resolver Ballot system, an anonymous voting system used for voting on risk ratings with multiple stakeholders. These risks have been divided into community and Council-related risks.

- Section 6 provides an overview to the key concepts, issues and terminology related to **climate change adaptation** including the risk assessment process that was followed to treat the identified risks from Section 5, through the conduct of a climate change adaptation workshop. This Section also presents a climate change adaptation framework for the CoGD centred on the implementation of adaptation actions to address the risks identified through the prior processes.

    - Appendix B includes a list of best practices examples of climate change adaptation and implementation of plans.

- Section 7 outlines **next steps** in the application of the risk assessment and adaptation analysis for consideration by the CoGD and sets the scene for the incorporation of key findings into the CoGD's Climate Change Strategy and Action Plan.

2. Introduction

2. Introduction

The CoGD engaged Ernst & Young (hereafter EY) to develop a Climate Change Strategy and associated Action Plan for the Council and community, extending to both mitigation and adaptation. This was driven by the Council's commitment in the Sustainability Strategy (2016-2030) to demonstrating its leadership in emissions reduction, and its desire to support the CoGD community to adapt to the risks, liabilities and costs associated with climate change.

As part of the development of the Climate Change Strategy, a detailed Climate Change Risk Assessment and associated Adaptation analysis was undertaken. This report (Climate Change Risk Analysis and Adaptation report) is one of four background reports within the Climate Change Strategy and Action plan project.

This report provides the summary and results of this component of the project which is aimed at:

- Identifying, analysing and evaluating the economic, environmental and social risks affecting the Council and the wider community as a result of projected climate change.
- Responding to these risks through the identification of associated adaptation actions that the Council can implement to minimise the impact of climate change on Council operations and the wider community.

A key reason for further action on climate change has been through the recent introduction and increasing uptake of legislative requirements within Australia and the state of Victoria. The *Victorian Climate Change Act* (2017)[16] is aligned to the commitments set out in the Paris Agreement (limiting global warming to 1.5^{o}C), which provides a legislative foundation for managing climate-related risks and opportunities; and the *Victorian Climate Change Adaptation Plan 2017-2020*[17] outlining Victoria's efforts to increase resilience against the short, medium and long term effects of climate change.

The *Local Government Act of Victoria* (1989)[18] is the premier legislation in the State that support and govern the new and existing councils in the State of Victoria. This *Act* provides a framework for Victoria's 78 councils to operate and include provisions for important functions such as council governance and decision making, council rate levy setting and payment and the council's ability to make and enforce laws in their municipality[19]. It is noted that the '*Local Government Bill*' (2018)[20] currently in Victorian Parliament will replace the *Local Government Act of Victoria* (1989)[21], once it is passed. Under the new legislation, there will be increased governance and reporting requirements for city Councils and the expectation of local government to act in the long-term interests of the community including in relation to increasing the community 's resilience to climate change impacts.

In terms of adaptation, the *National Climate Resilient and Adaptation Strategy*, released in December 2015[22], outlines the principles for effective adaptation practices and resilience-building activities including the establishment of priority areas for national engagement. Similarly, the *Victorian Climate Change Adaptation Plan 2017-2020*[23] outlines the State's approach to climate change adaptation until 2020 and its efforts to increase resilience in Victorian communities to the short, medium and long term impacts of climate change. It includes projections of climate change impacts on the State and analysis of potential impacts to the State, the economy and the community. The Adaptation Plan includes measures to build relationships within the State and more broadly, nationally, to effectively respond to climate change risks and opportunities and prioritises actions to mitigate and adapt to climate-related risks. Furthermore, the Plan looks at impacts and actions across all policy areas and sectors of the community, including at the Council level[24].

[16] Department of Environment, Land, Water and Planning, *Climate Change Act 2017*
[17] Department of Environment, Land, Water and Planning*, Victoria's Climate Change Adaptation Plan 2017-2020*
[18] Parliament of Victoria, *Local Government Act 1989*
[19] Department of Environment, Land, Water and Planning, *Acts and regulations*
[20] Local Government Victoria*, Local Government Bill*
[21] Parliament of Victoria, *Local Government Act 1989*
[22] Australian Government, *National Climate Resilience and Adaptation Strategy*
[23] Department of Environment, Land, Water and Planning, *Victorian Climate Change Adaptation Plan 2017-2020*
[24] Parliament of Victoria, *Local Government Act 1989*

Globally, there are a number of groups supporting climate change adaptation at the local city level. The C40 Climate Action Planning Framework[25] promotes consideration of mitigation and adaption in an integrated way to maximise efficiencies through interdependencies and synergy. The framework has considerations for adaptation embedded throughout, including setting adaptation goals and milestones to track and monitor progress in building resilience against climate risks within the locality. The C40 Framework provides guidance on the evaluation of climate actions and their ability to adequately build resilience to climate risks now and in future scenarios[26]. The City Resilience Framework, released by 100 Resilient Cities, also provides a framework for global cities around climate change adaptation, with 12 key goals for cities to work towards in relation to building resilience to the different types of climate risks [27].

[25] C40, *Climate Action Planning Framework*
[26] Ibid
[27] The Rockefeller Foundation & Arup, *City Resilience Framework*

3. City of Greater Dandenong

3. City of Greater Dandenong profile

The CoGD is a vibrant city, both in relation to its cultural diversity and the provision of unique cultural opportunities for its residents and visitors. It is recognised as one of Victoria's most multicultural and diversity municipalities which further supports its vibrancy and dynamic profile.

3.1 Geographic location

The CoGD is a local government area located 24 km south east of Melbourne and encompasses 129 km^2 of area; it shares a boundary with the governance areas of Monash and Knox in the north, Casey in the east, Frankston in the south, and Kingston to the west (Figure 4).There are several waterways and seven main creeks that run through the CoGD region with the primary being Dandenong Creek which discharges to Patterson River at the southern end of the municipality[28].

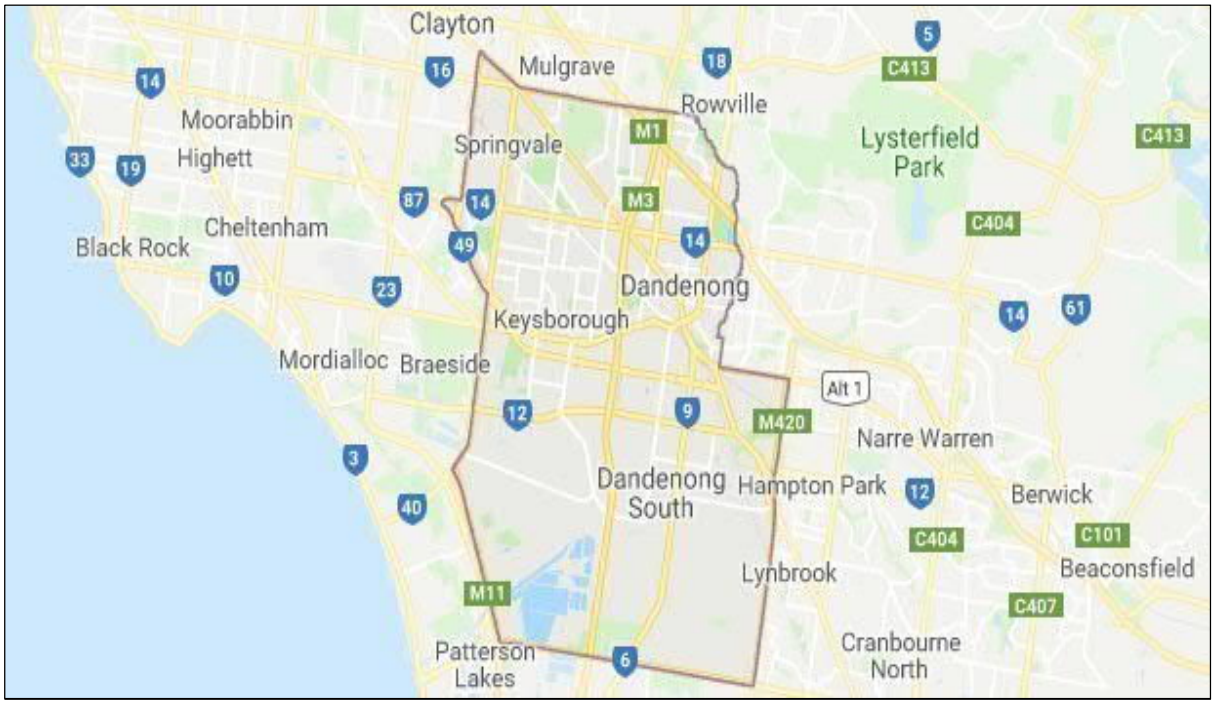


Figure 4 - A map of the CoGD region (Source: Google maps)

3.2 Socioeconomic profile

The municipality contains a mixture of suburban residential areas, an extensive industrial precinct and the Green Wedge in the south. Manufacturing is the largest industry in the CoGD region and accounts for over half the total region's output and 30% of all jobs. This is followed by Health Care, Retail Trade, Wholesale trade, and Transport and Warehousing[29] as shown in Figure 5. The CoGD's gross regional product per capita is $75,000, 31 per cent higher than Victoria's gross state product per capita of $57,000, making it a key source of economic value for Victoria[30].The CoGD is a net exporter of jobs to the surrounding municipalities with approximately 80% of all employment in the region coming from workers who reside in other municipalities[31]. This indicates that travel, whether by car or public transport, is essential for the continued economic wellbeing of the region.

[28] City of Greater Dandenong, *Flood Management Plan for City of Greater Dandenong (2018)*
[29] Ibid
[30] City of Greater Dandenong, *Our Economy*
[31] City of Greater Dandenong, *Our Workers*

While the average income for workers who are employed in the CoGD is comparable to the Victorian average, this is in contrast to the income of the residents who earn substantially less, likely due to a lack of qualifications and language barriers[32].

This is in some-ways a result of the Municipality being home to successive waves of migrants and those seeking asylum, resulting in a distinctly diverse and vibrant cultural mix. With a population of approximately 168,000 residents from 157 different birth places and 78 spoken languages, the CoGD is the most diverse municipality in Australia[33]. Furthermore, this population is forecasted to grow by 22% by 2028 as shown in Figure 5. Over a quarter of Victoria's asylum-seekers live in the CoGD – the largest in any Victorian municipality[34]. On average, one in five residents have limited fluency in spoken English, which is four times the Melbourne metropolitan level[35].

Greater Dandenong is widely recognised for its low socio-economic status relative to other Victorian municipalities[36]. This is illustrated by the following extracts from the 2018 Greater Dandenong Profile of Health and Wellbeing[37]:

- In 2016, the median individual weekly gross income in Greater Dandenong was $476 – the lowest level in Melbourne.
- Unemployment rates in Greater Dandenong in mid-2017 was 10.2% – the highest level in Victoria and nearly twice the metropolitan average of 5.9%.
- In 2016, 31% of families with children in Greater Dandenong had no parent in paid employment – the highest level in metropolitan Melbourne and substantially more than the State level of 19%.
- In 2018 the number of Health Care Card holders in Greater Dandenong was the third highest level in Melbourne.
- Young people in Greater Dandenong experience less favourable early school development, leave school earlier, less often attend university, are more often disengaged from employment and education, and are more likely to be unemployed later in life, than those throughout Melbourne.

Furthermore, climate change is expected to disproportionally affect lower socio-economic areas due to economic and social barriers, with socio-economic vulnerability expected to increase in areas with a projected increase in average annual temperature and decrease in average annual precipitation.

The combination of culturally and linguistically diverse population, lower socio-economic areas, a high proportion of residents over the age of 65 suggests that this region has a number of vulnerable communities especially susceptive to the impacts of climate change. Older populations are vulnerable through natural changes in the body associated with aging, which can limit mobility and communication or increase risk of chronic health conditions. Furthermore, these factors mean that the CoGD's socioeconomic profile differs from other Victorian municipalities and that any potential adaptive measures to climate change must take a holistic approach to the identification, evaluation and treatment of associated risks.

[32] Ibid
[33] City of Greater Dandenong, Health and Wellbeing Profile (2018)
[34] Ibid
[35] Ibid
[36] https://www.communityprofile.com.au/greaterdandenong/wellbeing/seifa#!seifabar;i=0
[37] City of Greater Dandenong, Health and Wellbeing Profile (2018)

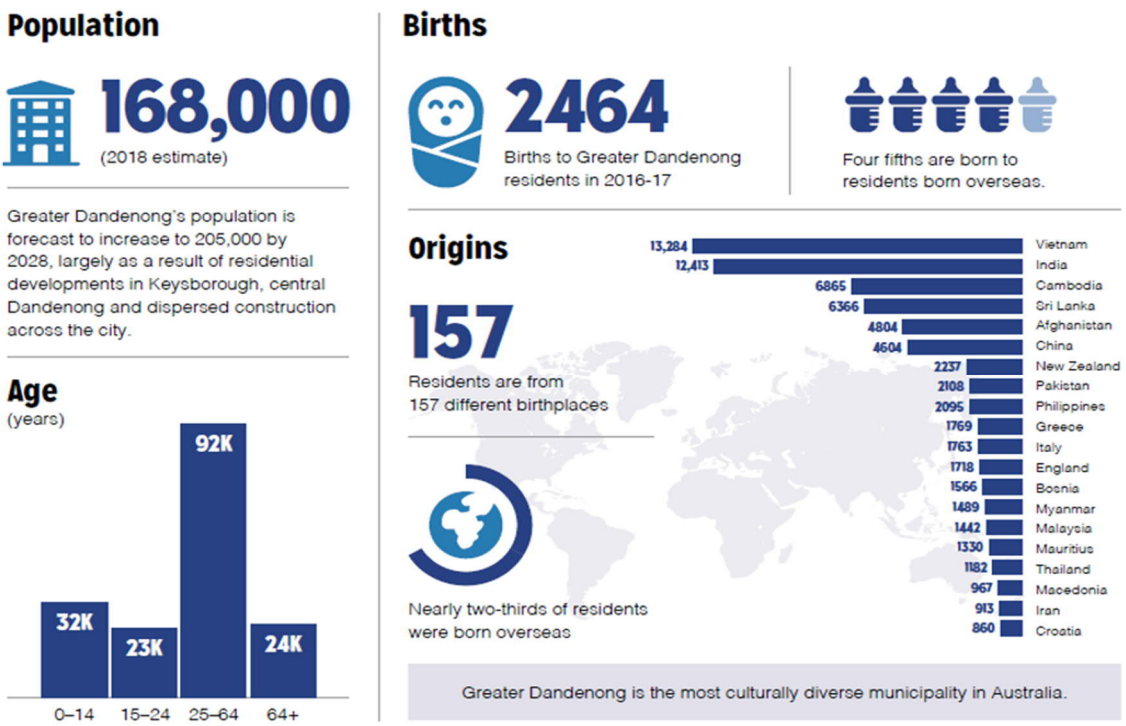


Figure 5 - Snapshot of CoGD's socioeconomic profile[38] [39]

[38] City of Greater Dandenong, *Our People*
[39] City of Greater Dandenong, *Council Plan 2017-2030*

3.3 Environmental profile

In addition to the residential, commercial and industrial areas, a large portion of Melbourne's South East Green Wedge is located in the CoGD. The Green Wedge (which covers over 3,700 hectares, or 29% of Greater Dandenong) is an open landscape used for recreation, preservation of flora and fauna, agriculture, water treatment, and pastoral purposes[40]. Consultation with the community in 2013 and 2014 (for Council's Sustainability Strategy and Green Wedge Management Plan) found that the protection and enhancement of local biodiversity was important to the local residents. Recognising this, one of the main themes and key strategic priorities for CoGD outlined in its Sustainability Strategy is *Biodiversity and Open Space* that relates to[41]:

> *"Imagine a Greener City that places a value on its natural assets, protects existing levels of biodiversity and works hard to enhance biodiversity levels for the future".*

It is recognised that open spaces can contribute to public appeal and amenity values as well as to the liveability and sustainability of an urban environment (Figure 6). This also has significance for both the mental and physical health and wellbeing of those residents who access these open spaces[42]. Despite the Green Wedge, a recent assessment of public open space across Greater Melbourne by Victorian Environmental Assessment Council, Metropolitan Melbourne identified CoGD as one of the lowest-ranked municipalities in relation to its canopy cover and public open space per person as shown in Figure 6 below [43]. Council's existing Open Space Strategy (currently under review), includes consideration of opportunities to increase the amount of open space in the region to take advantage of the health, economic, environmental and social benefits that come with increased open space.

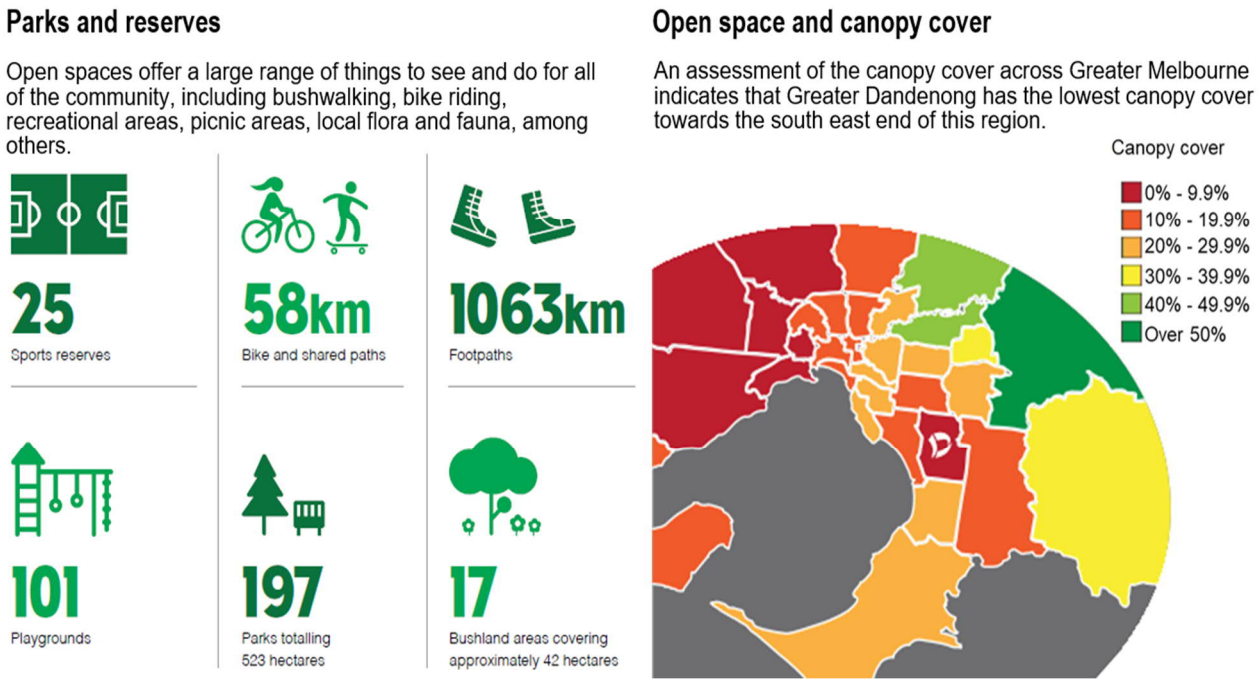


Figure 6 - Snapshot of CoGD's environmental profile[44]

[40] City of Greater Dandenong, Green Wedge Management Plan (2017)
[41] City of Greater Dandenong, Sustainability Strategy: Towards an environmentally sustainable city 2016-2030
[42] City of Greater Dandenong, Annual Report 2014/15
[43] City of Greater Dandenong, Sustainability Strategy: Towards an environmentally sustainable city 2016-2030
[44] City of Greater Dandenong, Council Plan 2017-2030

The Green Wedge Management Plan recognises the benefits the Green Wedge provides to the community and aims to preserve it while also expanding and diversifying agricultural activity in the area such as horticulture and livestock production[45]. As some parts of the Green Wedge are in low lying areas, the region is susceptible to flooding and has been subjected to inundation in the past. Furthermore, existing native and non-native flora and fauna species will be at risk as a result of projected increase in extreme temperatures as a result of climate change, which can place severe pressure on ecosystem health and impact on the biodiversity of these terrestrial and marine ecosystems.

3.4 Roles and responsibilities

Local governments often have the primary responsibility in preparing and responding to risks that threaten its function as well as the community it serves. As such, it plays a vital role in shaping the communities and businesses that operate in its municipality. While the role of councils is extensive, their ability to influence climate change adaptation can vary as they are only one of the key stakeholders with roles and responsibility towards creating change. In its role as a governing body, the CoGD is responsible for the planning and delivery of a range of services to its community and by doing so, taking a precautionary approach to anticipate any threats to its business continuity, to then mitigate and avoid any associated consequences is important. Table 1 below summaries some of the activities undertaken by the Council[46]:

Table 1 - A snapshot of local government's roles[46]

Children and families	Health and Wellbeing	Residential & Business	Sports and Leisure	Roads and Safety	Community
► Childcare ► Kindergartens ► Maternal and child health ► Playgroups ► Immunisation	► Disability services ► Home maintenance ► Home and community care ► Meals on wheels ► Food safety	► Planning & building permits ► Stormwater management ► Pet registration ► Rubbish and recycling ► Graffiti removal	► Sportsground ► Swimming pools ► Leisure centres ► Parks and gardens ► Festival and events	► Roads and footpaths ► Car parks ► Street lighting ► School crossing supervision ► Emergency Management	► Libraries ► Volunteering ► Theatres and the arts ► Grants ► Community centres

Planning for the future of the CoGD is a vital priority for the continuity of the Council and the wellbeing of the community. Recognising this, the Council have set a vision for the CoGD in consultation with the community through the "Imagine 2030 Community Plan" initiative. This initiative provides an overarching strategic direction for the Council and guides the Corporate Planning Framework and the community by focusing on three broad areas: People, Place and Opportunity[47]. The areas of focus for 'People' include the common goals of a vibrant, connected and safe community and a creative city that respects and embraces its diversity. For 'Place', the CoGD's objectives are to promote a healthy, liveable and sustainable city and a city planned for the future; and for 'Opportunity', it is about the recognition that the CoGD is a diverse and growing economy and an open and effective Council. These objectives inform Council's policy design and Council Plan; however it must be recognised that impacts of climate change can impede on the achievement of the key strategic objectives outlined in these key plans and strategies. As a result, work undertaken through this Climate Change Risk and Adaptation Analysis has taken these into account, specifically in the delivery of the Council's key services to its community along with existing plans, strategies and community consultations published by the Council.

[45] City of Greater Dandenong, Green Wedge Management Plan (2017)
[46] The City of Greater Dandenong, The Role of Local Government
[47] The City of Greater Dandenong, Council Plan 2017 – 2021

4. City of Greater Dandenong’s dynamic climate and associated risks

4. City of Greater Dandenong's dynamic climate and associated risks

Australia finds itself at the centre of the climate change challenge both in terms of mitigation and adaptation. It is one of the highest GHG emitting nations on a per capita basis and one of the most exposed nations to the impacts of climate change, considering its climate, geography, coastal infrastructure and the trade-exposed nature of key commodity exports.

The Intergovernmental Panel on Climate Change (IPCC)'s released special report on global warming of 1.5ºC[48] and its Fifth Assessment Report[49] have established with a high level of confidence that the Earth's climate has warmed significantly since the industrial revolution. This is supported by research from the CSIRO and Bureau of Meteorology (BOM) setting the long-term trends in Australia's climate.

Key findings from IPCC's latest special report on the impacts of *global warming of 1.5ºC* (released in October 2018)[48]

- Human influences are likely to have caused an increase in global average temperatures by approximately 1.0ºC since the pre-industrial period.
- There is high confidence that global warming will lead to an overall increase in global temperature to 1.5ºC between 2030 and 2052, at the current rate of increase.
- Climate-related risks to health, livelihoods, food security, water supply, human security and economic growth are projected to increase with global warming of 1.5ºC and increase further with 2ºC.
- Warming from anthropogenic activities from the pre-industrial times to the present will remain for centuries to millennia and will "*continue to cause further long-term changes in the climate system, such as sea level rise*".

Key findings from IPCC's Fifth Assessment Report (2014)[49]

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia"

- The last three decades have recorded successively warmer surface temperatures than any other decade since 1850.
- Increases in atmospheric concentrations of GHG have reached unprecedented levels compared to the last 800,000 years.
- Carbon dioxide concentrations since pre-industrial times have increased by 40%, largely due to emissions from fossil fuels and land use change.
- Increasing ocean acidification due to the world's oceans absorbing 30% of the emitted anthropogenic CO_2 emissions.
- Human influences are linked to warming of the atmosphere and the ocean and changes in global mean sea levels, reductions in snow and ice, and changes in some climate extremes.
- Sea level rise has accelerated in the last century with global mean sea level rising by 0.19 m.

[48] Intergovernmental Panel on Climate change (IPCC), Global warming of 1.5ºC Special report; Summary for Policymakers
[49] Intergovernmental Panel on Climate change (IPCC), Contribution of Working Groups I, II and III to the Fifth Assessment Report

4.1 Observed historic climate trends

Australia's climate has changed rapidly over the past five decades. The 2018 State of the Climate report published by the BOM and CSIRO indicates that the Australian region has experienced further warming in the atmosphere and surrounding oceans, with rainfall being variable over time[50].This report further outlines that Australia has experienced an increase in extreme fire weather fuelled by increasing temperatures and drying conditions, since the 1970s. In terms of sea level, there has been a general increasing trend across the Australian continent which in turn amplifies the effects of storm surge and high tides[51].

Figure 7 summarises the key climate trends observed in Victoria and the wider Melbourne region within which the CoGD is located. The CoGD region has been directly impacted by extreme weather events in the past, notably through extreme storm events and heatwaves. The widespread flash flooding that occurred in 2011 across Victoria as a result of prolonged and high intensity rainfall significantly impacted the CoGD. The total cost of damages from this flooding event amounted to approximately $2 billion for the State of Victoria including $1.28 million worth of damage to the CoGD's assets[52]. More than 51 communities were impacted across the State which resulted in two fatalities. In the CoGD locality, there was significant damage and disruption to its public transport network as a result of Dandenong train station being flooded. In January 2009, the State of Victoria experienced one of Australia's most severe heatwaves which coincided with the 'Black Saturday' bushfires. The CoGD locality was impacted by this heatwave that resulted in localised power outages, disruptions and cancellations to transport services and a surge in requests for emergency response services that placed severe strain and pressure on the delivery of these services[53].

[50] Bureau of Meteorology (BOM) and CSIRO; *State of the Climate 2018*
[51] Ibid
[52] City of Greater Dandenong, *Info for Risk Workshop - 15th November 2018 - Flood Damage*
[53] City of Greater Dandenong, *Heatwave Plan 2015-2017*

Historic climate trends experienced in Victoria[54] [55] [56] [57]

Temperature and extreme heat

- Global surface air temperatures have increased on average by 1°C in the past 100 years. In Victoria, the rate of warming since 1950 has increased between 0.6°C to 1.6°C. Specifically in the Greater Melbourne Region, the rate of warming has been between 1.0 °C and 1.6 °C since 1950.
- Since 1950, the average annual frequency of days with a mean temperature of 30°C or above has increased significantly in Victoria.
- Two of the worst recoded heatwaves (in Victoria) in history have occurred in the past 10 years: January/ February 2009 (Black Saturday) and January 2014.
- The above long term trend towards hotter weather in Victoria has contributed to an increase in frequency and severity of bushfires.

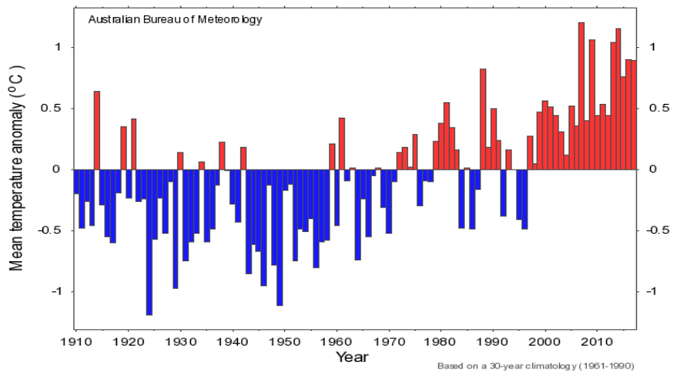
Rainfall

- Victoria has experienced an overall decline in total annual rainfall since the 1950s which coincided with the Millennium Drought that occurred between 1996 and 2009.
- On average, annual rainfall in the Greater Melbourne region has decreased between 100 and 200mm since 1950.
- Overall rainfall reduction trends have been apparent across autumn in line with trends experiences in other regions of southern Australia.

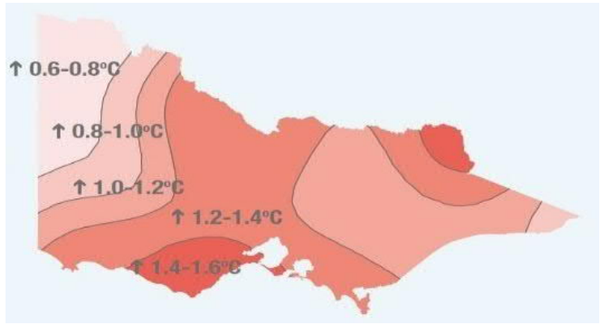
Sea level rise

- Global average sea level has risen by about 20cm since the late 1800s. There has been a general trend of increasing sea levels across Australia which in turn amplifies the effects of storm surge and high tides.
- Sea levels has risen approximately 2.8mm/year between 1990 and 2010 over wider Victoria. This is similar to the global average of 3.2mm per year, but with significant variability on an annual basis.

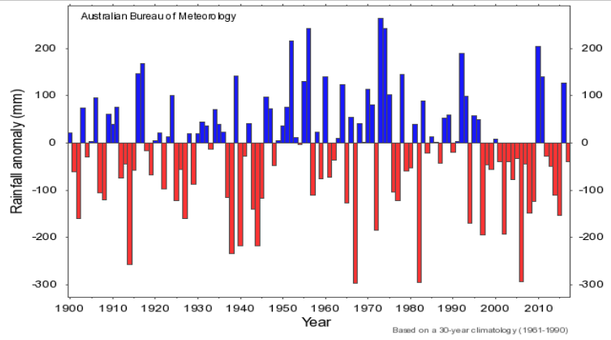
Annual mean temperature anomaly (°C) in Victoria from 1910 to 2017[56]



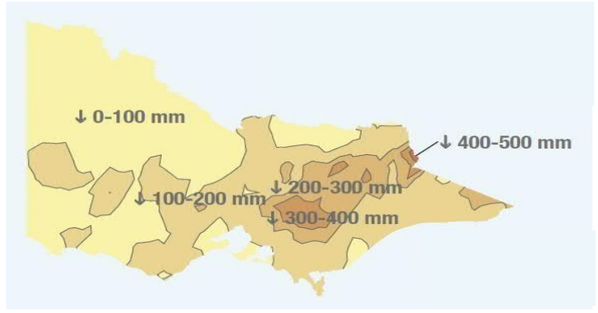
Temperature change in Victoria since 1950[54]



Annual rainfall anomaly (mm) in Victoria from 1900 to 2017[56]



Rainfall change in Victoria since 1950[54]



Australian localised sea level rise in mm/year between 1990s to 2010[57]

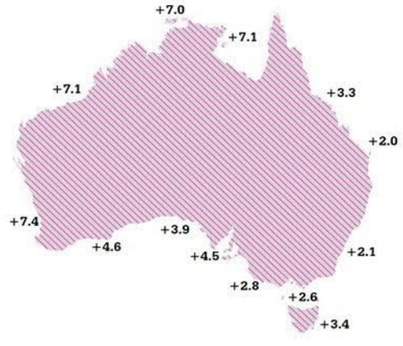


Figure 7 - Overview of the historic climate trends experienced in Victoria

[54] Victorian Government- Department of Environment, Land, Water and Planning; Climate-ready Victoria: *Victoria; How climate change will affect Victoria and how you can be climate-ready.*
[55] Victorian Government- Department of Environment, Land, Water and Planning; Climate-ready Victoria: *Greater Melbourne; How climate change will affect the Greater Melbourne region and how you can be climate-ready.*
[56] Bureau of Meteorology (BOM*); Climate change and variability online tool*
[57] Climate Commission. The Critical Decade: *Western Australia climate change impacts*

4.2 Climate projections for City of Greater Dandenong

The 2018 State of the Climate Report indicates with a high level of certainty that mean temperatures across Australia will continue to increase with an overall decline in winter and spring rainfall projected across southern continental Australia[58]. On the other hand, extreme storm events are projected to increase in intensity by the end of the century over the Australian continent. Sea level is projected to continue to rise across coastal Australia. The extent to which the above climate variables will change in the future is highly dependent on the overall level of GHG emissions and associated emissions-reduction activities and policy mechanisms that will come into play in the future.

On a local scale, the climate of the 'Southern Slopes' Natural Resource Management (NRM) region, which encompasses majority of Victoria, thus the CoGD region, is projected to become hotter in terms of increased mean, daily maximum and daily minimum temperatures, with increased frequency of hotter days, more extreme rainfall events and sea level rise contributing to an increased risk of flooding[59].

The IPCC's latest Fifth Assessment Report articulated various climate scenarios through Representative Concentration Pathways (RCPs) each of which indicates a pathway, or trajectory driven by specified future GHG concentrations and is underpinned by socio-economic narratives, including population, GDP, energy consumption and land use[60].

Climate scenarios and RCPs[60]

IPCC's RCPs are referred to as "pathways" to emphasise their primary purpose in providing time-dependent projections of atmospheric GHG concentrations.

"Pathway" also emphasises that it is not only the long-term concentration that is of interest but also the trajectory that is taken over time to reach that outcome. They are "representative" in that they are derived from a cluster of General Circulation Models, based on similar underlying socioeconomic characteristics of a future scenario (Figure 8).

The BOM and CSIRO used the same General Climate Models that incorporated IPCC's emissions scenarios to develop long-term climate projections for Australia. This information was then used to select and apply appropriate climate projections for this Climate Change Risk and Adaptation Analysis.

The scenario considered for the CoGD included:

- **RCP 8.5, a 'high emissions' scenario**, to represent a Business As Usual (BAU) situation (worst case scenario) with limited to low global mitigation ambition. This scenario is based on greater projected temperature rises at the highest end of the scale (akin to a global mean temperature rise greater than 4ºC by 2100) with significant impacts and higher costs associated with inaction.

Reasons for selecting this climate scenario included:

- The Council's wish to explore a high range emissions scenario as society is currently progressing towards this range based on BAU activities.
- Allowing a conservative planning approach (noting care will be required to avoid maladaptation).

A time horizon that takes into account the short and long term implications for strategic planning and associated impacts on the CoGD's operations was selected and the associated rationale is outlined below:

- **2030** was selected to align with the CoGD's current strategies and planning horizons, including the Imagine 2030 Community Plan and Sustainability Strategy.

[58] Bureau of Meteorology (BOM) and CSIRO; *State of the Climate 2016*
[59] BOM and CSIRO*; Climate Change in Australia Information for Australia's Natural Resource Management Regions, Southern Slopes (Cluster Report).*
[60] Intergovernmental Panel on Climate change (IPCC), *Contribution of Working Groups I, II and III to the Fifth Assessment Report*

► **2050** was selected to align with longer term planning initiatives such as infrastructure development and planning activities.

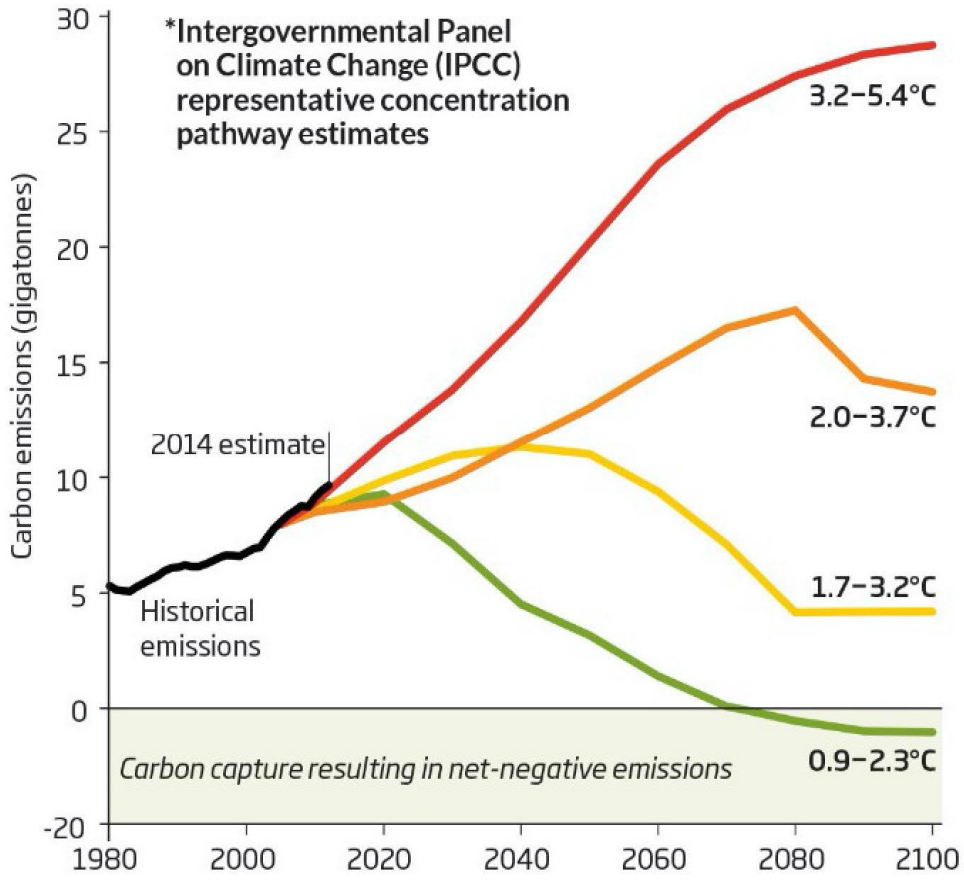


Figure 8 - Global average temperature projections corresponding to each RCP and related GHG emission projections to 2100[61]

[61] CLIMSystems, *Defining a Representative Concentration Pathway for Application (https://www.climsystems.com/docs/simclimdesktop/DefiningaRepresentativeConcentra.html)*

Figure 9 outlines the projected climate trends specifically for the CoGD in relation to five key climate variables: temperature, extreme heat days/ heatwaves, precipitation, extreme storm events (including rainfall, wind and hail) and bushfires. The data were selected based on an initial analysis to determine the relevant projection scenarios and time horizons outlined above that are applicable to CoGD.

It should be noted that these climate change projections are used solely to guide CoGD's internal decision-making and planning frameworks as there is a degree of uncertainty associated with climate modelling. Global climate models are based on assumptions regarding future GHG concentrations in the atmosphere based on current practice and expected future practices and there are varying levels of uncertainty associated with these models. Globally, as more governments and organisations move towards a low carbon economy, the associated changes in enacting global and local level mandates, policies and mitigation strategies need to be accounted for in future projections.

Temperature

- Average temperatures are expected increase across all seasons in the Greater Melbourne region.
- An increase in annual average temperatures by approximately 0.8°C in 2030 and 1.5°C by 2050 (high emissions scenario), compared to a baseline temperature of 20.5°C between 1986 and 2005.

Extreme hot days

- An increase in the frequency and duration of hot days and warm spells. A corresponding decrease in the frequency of frost-risk days.
- An increase in the number of annual days where the maximum daily temperature is greater than 35°C is projected to increase in 2030 and 2050.
- The above conditions can lead to an increase in the frequency and duration of heatwaves.

Extreme storm events

- Increase in the intensity and frequency of heavy rainfall events that (has the potential to) lead to flooding and storm surge.

Rainfall

- Overall decline in annual rainfall projected compared to the 1986-2005 baseline.

Bushfires

- The frequency and intensity of 'extreme' and 'very high' fire danger days to increase, defined as days where the Forest Fire Danger Index is greater than 25.

Figure 9 - Overview of climate trends projected for CoGD[62] [63]

[62] BOM and CSIRO; *Climate Change in Australia Information for Australia's Natural Resource Management Regions, Southern Slopes (Cluster Report).*
[63] CSIRO, *Climate Change in Australia (https://www.climatechangeinaustralia.gov.au/en/climate-projections/)*

4.3 Projected climate impacts and associated risks

Climate change stands to impact many different aspects of CoGD's economy and community, especially in relation to the climate variables that were identified in Section 4.2. As shown in Figure 10 the different global warming scenarios that have been set out by IPCC will have varying levels of impact across multiple and interrelated ecosystems such as global food supply and security, water security and ecosystem health, among others[64]. Figure 10 indicates how the magnitude of temperature change will impact the severity of consequence. For example, an increase in temperature of 0.5ºC will lead to significant loss of coral cover in tropical areas and restricting global warming to 1.5ºC will see between 70 – 90% decline in coral cover by 2050. However, if global temperatures increase by 2ºC, total loss of coral reefs such as the Great Barrier Reef is projected[65]. Limiting global temperature increases to 1.5ºC is projected to significantly reduce the probability of extreme drought events occurring. Furthermore, a temperature increases of 0.5 ºC, will affect human health in predominantly detrimental ways where there is a lower risk of undernutrition predicted when warming is restricted to 1.5 ºC compared to 2 ºC[66]. All the above examples including those outlined in Figure 10 highlight the need for governments to act now and limit global rise in temperatures to 1.5ºC.

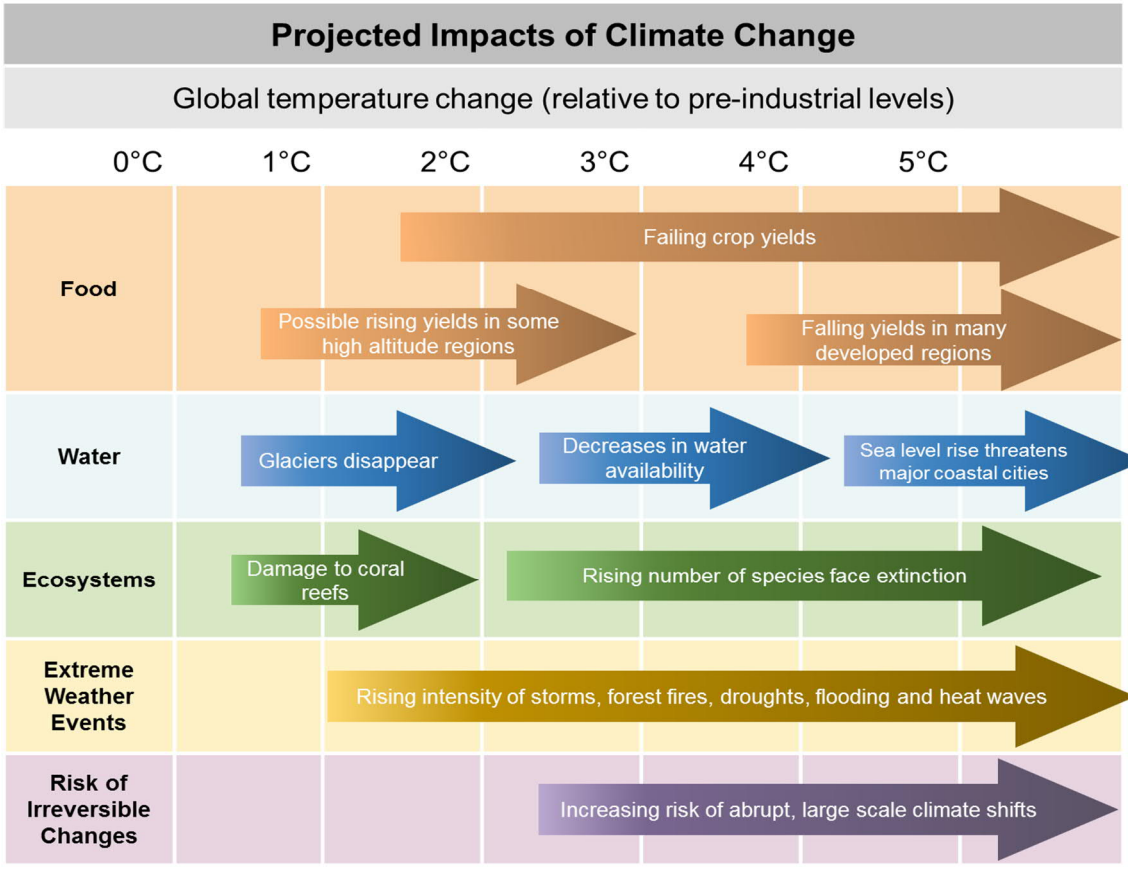


Figure 10 - Projected impacts of climate change[67].

[64] Intergovernmental Panel on Climate change (IPCC), *Global warming of 1.5ºC Special report; Summary for Policymakers*
[65] Intergovernmental Panel on Climate change (IPCC), *Global warming of 1.5ºC Special report; Chapter 3: Impacts of 1.5 ºC of Global Warming on Natural and Human Systems.*
[66] Intergovernmental Panel on Climate change (IPCC), *Global warming of 1.5ºC Special report; Chapter 3: Impacts of 1.5 ºC of Global Warming on Natural and Human Systems.*
[67] IPCC, AR4 Climate Change 2007: *Mitigation of Climate Change (2007)*

Costs related to the impacts of extreme weather events on public infrastructures include cost resulting from delays in construction and/or costs from extreme weather damage. There is a default assumption that infrastructure construction projects and/or actual assets are fully insured against extreme weather damage, and that damage liabilities are therefore limited to payment of an insurance excess. However if any infrastructure construction projects or assets have no insurance, or limits to insurance coverage, then the cost impact of physical damages to contract works, plant and equipment will have a far larger impact on overall costs.

With the recent announcement by Insurance Australia Group (IAG) that failing to reduce GHG emissions could create a world that is "pretty much uninsurable"[68] and with a greater number of areas in Queensland would be exposed to cyclones and flooding (if the temperature increases more than 3^{o}C degrees which is closer to RCP 8.5 scenario outlined in Section 4.2), with a rise of more than 4^{o}C could make the risks to insurers prohibitive. With efforts made by CoGD to build climate change resilience and adopting a leadership position in understanding and managing physical risks, there is scope to build collaboration between the Council and the relevant insurance companies (in respect to Council owned and managed infrastructure) and potentially reducing insurance premiums.

In the context of managing the risks associated with climate change impacts, it is the primary responsibility of the Australian states and local governments to prepare for and respond to projected climate change. It is therefore important to recognise the correlation between the climate change projections and the associated risks and impacts that this will have on not just the general operations (of government, businesses etc.), but also on the broader community. It will be essential to factor these impacts into state planning for long term infrastructure including utilities, urban planning and emergency management[69].For example, initial modelling from the Department of Treasury and Finance found that climate change impacts such as bushfire, flood and drought cost the Victorian Government over $4 billion from 2003 – 2013. The average annual cost of bushfires are projected to rise from $172 million in 2014 to $378 million in 2050[70].

Victoria's Climate Change Adaptation Plan (2017-2020) outlines a framework for climate action to manage climate risks and embrace opportunities associated with climate change. The plan identifies six areas of priority; (i) leadership, (ii) collaboration and shared responsibility, (iii) connected, resilient and safe communities (iv) a healthy environment, (v)priority support for vulnerable communities, and (vi) a flexible and prosperous economy. Successful implementation of climate change adaptation actions will see short, medium and long term benefits for the Victorian government in relation to lowered costs and creation of new opportunities in the economy such as industries and jobs[71].

With the introduction of the *Local Government Bill* (2018) into Victorian State Parliament that specifically calls on the consideration of economic, social and environmental sustainability, including mitigation and planning for climate change risks, within council governance structures; the CoGD will be required to embed climate change considerations within its operations to meet these new expectations[72]. Specifically, local government's role in local planning and land use changes must be considered. As rezoning decisions are effectively made for an indefinite period of time, and infrastructure requires high capital and operational costs to build and maintain infrastructure for general expected life span of 50 to 100 years; climate change considerations need to be incorporated now to ensure the Council does not fail in its responsibility to adequately prepare the community for climate change impacts.

Specifically, for CoGD, climate change risks and associated impacts were identified for the following selected variables (as per projections outlined in Section 4.2) based on an extensive literature review:

- Temperature (increased mean annual and seasonal temperatures, and extreme hot days)
- Precipitation
- Bushfires
- Extreme storms events, including rain, hail, wind and electrical.

[68] Australian Financial Review, *Climate change may make world 'uninsurable'*
[69] Moody's Investors Services, *Evaluation potential impacts from climate change on the Australian states*
[70] Department of Environment, Land, Water and Planning, *Victoria's Climate Change Adaptation Plan 2017-2020*
[71] Department of Environment, Land, Water and Planning, *Victoria's Climate Change Adaptation Plan 2017-2020*
[72] Local Government Victoria*, Local Government Bill*

Temperature

Projections for CoGD:

Refer to Figure 9

Key temperature related risks

An increase in mean annual and seasonal (summer and winter) temperatures and extreme temperatures (above 35ºC) could result in the following risks:

- **Increasing energy and water costs [Council and Community]:**
  Higher temperatures will result in an increase in peak demand for electricity and water consumption (for cooling purposes) for commercial, residential and Council-owned buildings. This increase in demand will strain energy and water systems, not only decreasing the efficiency and performance of the systems, but also increasing associated costs. For vulnerable members of the CoGD community, the increase in costs may be disproportionate to their ability to pay, thus have negative implications on their livelihood.
- **Public health and wellness [Community]:**
  Over the past 100 years, heatwaves have been the cause of more deaths than any other natural hazard in Australia[73].
  Increased temperatures could result in more cases of heat stress, reduced public health and wellness, and increased morbidity rates. Changes to the distribution and increased occurrence of food-borne, vector-borne (including from mosquitos and ticks) and water-borne diseases resulting from increased temperatures will reduce public wellness/wellbeing and put pressure on health services.
  Increased temperatures and extreme temperatures can lead to a decline in workforce productivity due to the reduced ability to work outdoors during periods of extreme heat. This will not only affect the Council's own workforce, but also contractors and businesses that operate locally.
- **Disruption to utilities and transport infrastructure [Community]:**
  Extreme temperatures reached on hot days (above 35ºC), coupled with the increase in the duration and frequency of heat waves could result in damage to and failure of transport infrastructure (e.g. damage to rail lines being affected by heat, traffic light breakdown and cancellation of services), resulting in delays and congestion within the CoGD and impact the ability of CoGD to provide vital services. Similarly, such circumstances can also cause damage to power lines causing widespread power outages.

[73] Climate Council, *Heatwaves: Hotter, longer, more often*

Temperature

Projections for CoGD:

Refer to Figure 9

Key temperature related risks continued.

- **Biodiversity loss [Community]:**
  Increased temperature may result in changes to the distribution and occurrence of flora and fauna, resulting in terrestrial biodiversity loss and species variations. This increase in atmospheric temperatures can in turn warm surface water which will impact aquatic ecosystems (including through algal blooms) leading to associated biodiversity loss, for example in the Dandenong Creek and Tirhatuan Wetlands.

- **Infrastructure degradation [Council and Community]:**
  Prolonged periods of extreme temperatures can lead to the accelerated degradation and weathering of construction materials such as concrete and asphalt. This degradation can in turn lead to safety concerns for users, more frequent repairs and higher maintenance costs for Council and privately owned buildings. For vulnerable residents, this may disproportionately impact on their livelihood compared to other residents through increased costs.

- **Green infrastructure [Council]:**
  Vegetation and green infrastructure within the CoGD will require increased irrigation, pest treatment and replanting to address heightened water, pest and/or heat stress resulting from increases in temperature.

- **Reduced appeal and public amenity [Council and Community]:**
  A combination of the temperature related risks outlined above such as limited green infrastructure, lack of shaded areas, aquatic and terrestrial biodiversity loss and variations (e.g. increased algae blooms in creeks) can lead to reduced public appeal of Council- owned and managed public open spaces, such as Dandenong Park, Fotheringham Reserve and Tirhatuan Park. This could lead to fewer residents and tourists visiting and considering the Council's public open space for social and recreational use, and impacting the health and wellbeing of the users. The risk of heat stress and dehydration to members of the public attending events held at public open spaces may result in the postponement or cancellation of public and private events and could have a detrimental economic impact on the tourism industry.

Precipitation

Projections for CoGD:

Refer to Figure 9

Key precipitation related risks

Projected decline in mean annual rainfall and increase in drier conditions will result in water scarcity associated with the following risks:

- **Increasing water costs [Council and Community]:**
  Prolonged drier conditions will lead to water supply constraints and consequently result in water shortages and put upward pressure on water prices. As water consumption is expected to rise with predicted population increases in the CoGD, this is expected to lead to an increase in water supply charges and costs for potable and irrigation water to the Council as well as to local commercial and residential tenants. With the likely increased water demand in the future, this will place further pressure on water supply requiring greater focus on integrated water management across both Council's operations and the municipality.

  The CoGD's vulnerable members of the community may be disproportionately impacted by any increase in water prices. Communication with the culturally and linguistically diverse community on these restrictions will require additional consideration to ensure that clear messages are being conveyed to the wider community in an understandable manner.

- **Public health [Community]:**
  The impacts of a decrease in precipitation will be amplified by an increase in temperature (both mean annual and seasonal temperatures; as well as extreme temperatures), and a combination of the two climate variables will result in a higher likelihood of sporting grounds and associated surfaces drying. This leads to both increased maintenance (including irrigation) costs as well as increased public health risk as individuals playing on these dry surfaces are at risk of injuring themselves as a result of falls, with injuries ranging in severity from sprains, to broken bones and concussions.

- **Increased irrigation [Council and Community]:**
  A decrease in precipitation and overall drier conditions will lead to increased heat and water stress in plants and vegetation that require increased irrigation requirements and re-establishment of replantings in Council-operated facilities as well as residential and commercial properties. As the CoGD residents place high value on public amenity of parks and open spaces, the community will expect the Council to maintain its open spaces at an appropriate standard for the benefit of residents. This will be particularly relevant for open spaces containing water bodies such as fountains, ponds and lakes.

Bushfires

Projections for CoGD:

Refer to Figure 9

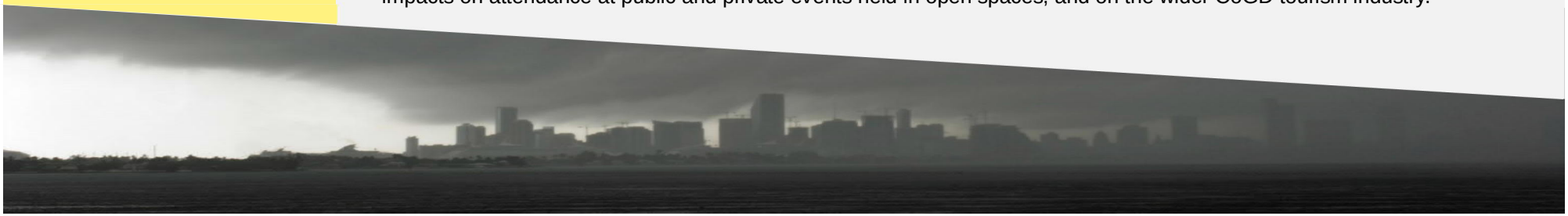
Key bushfire related risks

An increase in the frequency and intensity of bushfires could result in the following risks:

- **Public health and wellness [Community]:**
  While CoGD is not at (high) risk of bushfires due to its location, there are still potential health-related impacts relating to bushfires for Council workers, residents and workers that need to be considered. For example, periods of prolonged heat associated with fire weather conditions, can cause heat stress or loss of lives. Smoke from bushfires (including smoke blown into the CoGD locality from other bushfires) exacerbates conditions for smog and air particulates, causing breathing and respiratory issues affecting public health and wellness. This can affect Council employees and contractors, especially outdoor workers and the general public, with the most at-risk being vulnerable and isolated populations. This can have knock-on impacts on community sociability with Council and community run events being cancelled for safety concerns.

- **Infrastructure damage [Council and Community]:**
  Harsher fire weather coupled with potential for more severe bushfires can cause damage to and loss of commercial and residential properties as well as Council-owned infrastructure. While projections suggest that CoGD will experience an increase in the number of high fire weather danger days (FFDI), these pose a lower risk to the urban areas due to CoGD's location. There are three areas of remnant bushland in the urban areas of Greater Dandenong that pose a lower risk to the spread of bushfires with the extensive grasslands in the Green Wedge posing a higher risk. Bushfires can still cause significant damage to essential power utilities resulting in widespread power outages and blackouts. These can place additional strain on transport infrastructure through power failures affecting the operation of traffic signals as well as electrified train networks, in turn causing increased disruptions to transport systems through the cancellation and delay of services.

- **Biodiversity loss and reduced public appeal and amenity [Council and Community]:**
  The projected increase in frequency and intensity of bushfires will place species under stress and can cause irreversible changes to ecosystems resulting in the loss of flora and fauna and their associated habitat. Bushfires can injure and kill wildlife, including posing a threat to endangered species within the CoGD boundary. This could lead to reduced public appeal of Council-owned and managed spaces, resulting in fewer visitation from residents and tourists. This could have detrimental impacts on attendance at public and private events held in open spaces, and on the wider CoGD tourism industry.



Extreme storm events

Projections for CoGD:

Refer to Figure 9

Key extreme storm events related risks

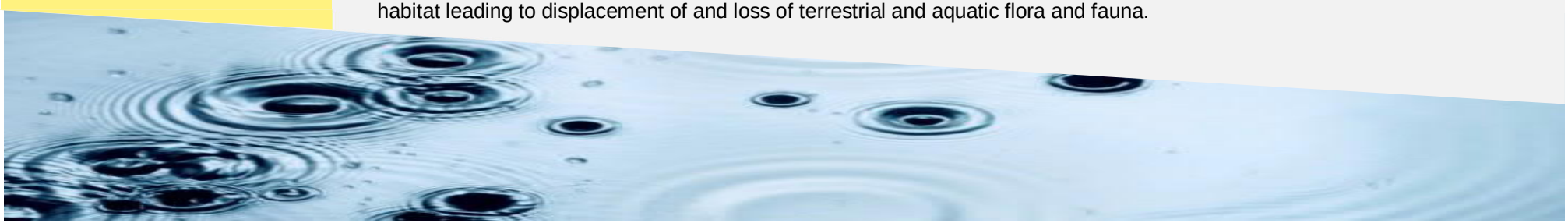
The projected increase in the intensity of extreme storm events (including rainfall, hail and wind), could result in the following risks:

- **Infrastructure damage [Council and Community]:**
  An increase in the intensity of extreme storm events, can result in damage to infrastructure including buildings, fences, stormwater drains, bridges and street lights, which can have safety implications and increase associated repair and maintenance costs. Flash flooding may occur if storm water runoff exceeds drainage capacity causing damage to low-lying buildings and transport infrastructure. Key transport nodes such as the Eastlink, Frankston-Dandenong Road, the Municipality's five train stations and the Dandenong bus interchange can be severely impacted during such events causing widespread disruption to services. Excess drainage issues as a result of stormwater runoff could have further implications for potential breaches of sewage plants in the area.

  Heavy rainfall associated with these extreme storm events can also cause erosion, mud slides and/or subsidence. These can reduce the number of people visiting the CoGD due to reduced access (including for public and private events) which could then have economic implications for businesses in the locality through loss of revenue, reduced patronage and business continuity.

- **Community health and safety [Community]:**
  Heavy rainfall, hail, wind, flash floods and mudslides can endanger human safety and result in mass displacement. This can have a particularly large impact on vulnerable members of the community such as the homeless, elderly among others; as experienced in 2011 with the evacuation of the Palm Lakes Willow Lodge retirement village. The need for emergency shelter smay arise, increasing pressures on social and health services. Increased contaminants and sediment runoff into surface water may spread disease and result in concerns for public health and wellbeing.

- **Biodiversity loss [Community]:**
  Extreme storm events result in reduced water quality due to increased contaminants, nutrient and sediment runoff into surface water, causing damage to and loss of biodiversity and natural habitat. Heavy rainfall, hail and winds can also damage natural habitat leading to displacement of and loss of terrestrial and aquatic flora and fauna.



5. Climate change risk analysis

5. Climate change risk analysis

5.1 Risk management framework

Enterprise risk management can assist decision makers to make informed evaluations, prioritise actions and differentiate between alternative courses of action dependent on the unique circumstances of each organisational environment/ context. The *International Standard AS/NZ ISO 31000:2009 – Risk Management ("ISO 31000")* offers a set of guiding principles and a framework to address risk in a coherent, systematic and transparent manner. This standard highlights the need for an organisation to not only develop and implement a risk management framework, but to continuously revisit and revise the framework as required[74].

In addition to the risk management principles and guidelines provided by *ISO 31000*, the impacts of climate change on the CoGD and its wider community were considered through *AS 5334 – 2013 Climate change adaptation for settlements and infrastructure*, which provides guidance on the management of climate change risk and the implementation of adaptation plans for cities like CoGD and follows *ISO31000:2009*. EY also utilised the framework set out by the Australian Greenhouse Office in the *Climate Change Impacts & Risk Management: A Guide for Business and Government* ("Commonwealth Government Guidance")[75]. This document provides guidance on integrating climate change impacts into risk management and strategic planning activities for the Australian public and private sector establishments. Furthermore, it aims to assist organisations to:

- Compute risks related to climate change impacts.
- Prioritise risks that require further attention.
- Establish a process for ensuring that any higher priority risks that have been identified through the process, are managed effectively.

This Guide continues to be a useful source for local governments assessing their climate risk and coupled with the risk management guidelines and principles outlined under ISO 31000 and C40's Climate change risk assessment guidance, have been applied to develop a risk management framework for CoGD. The key tasks that were undertaken to build the CoGD risk management framework are outlined in Figure 11. The approach undertaken included an alignment to CoGD's existing risk management framework and associated processes, including the Council's internal risk register, amongst others.

As part of this undertaking, EY completed a comprehensive a literature review, stakeholder interviews and facilitated a stakeholder workshop to establish the context and identify, analyse and evaluate the risks posed by climate change to the CoGD's operations and the broader community. The final phase included the treatment of these risks which was informed by an extensive literature review and conduct of an adaptation stakeholder workshop. This phase utilised elements of the C40 Adaptation framework to guide the prioritisation of adaptation actions. All key stages of this engagement were centred on significant stakeholder consultation, collaborating with the Council and engaging closely with key stakeholders with CoGD throughout the period of the project.

The development of a risk management framework is determined by an organisation's own mandate and commitment towards managing its risks. As part of this process, discussions were held with CoGD team leader and personnel from the Risk Management department to understand the Council's risk management policy, framework and procedures[76]. These discussions also extended to gauging the Council's risk appetite as well as an initial assessment of its enterprise risk register. On the latter, it was noted that climate change and its associated impacts were not appropriately integrated into the Council's risk register and that there was significant room for improvement in this space. Nevertheless, it was noted that the Council is currently undergoing a review of its internal risk management framework in relation to business continuity and that the outcomes of this project will be incorporated into its risk register.

[74] International Standards Organisation (ISO), *ISO 31000:2009 Risk management -- Principles and guidelines*
[75] Australian Greenhouse Office, *Climate Change Impacts & Risk Management: A Guide for Business and Government*
[76] CoGD Risk Management Policy (2015); CoGD Risk Management Procedure (2015); CoGD Risk Management Strategy 2014-18

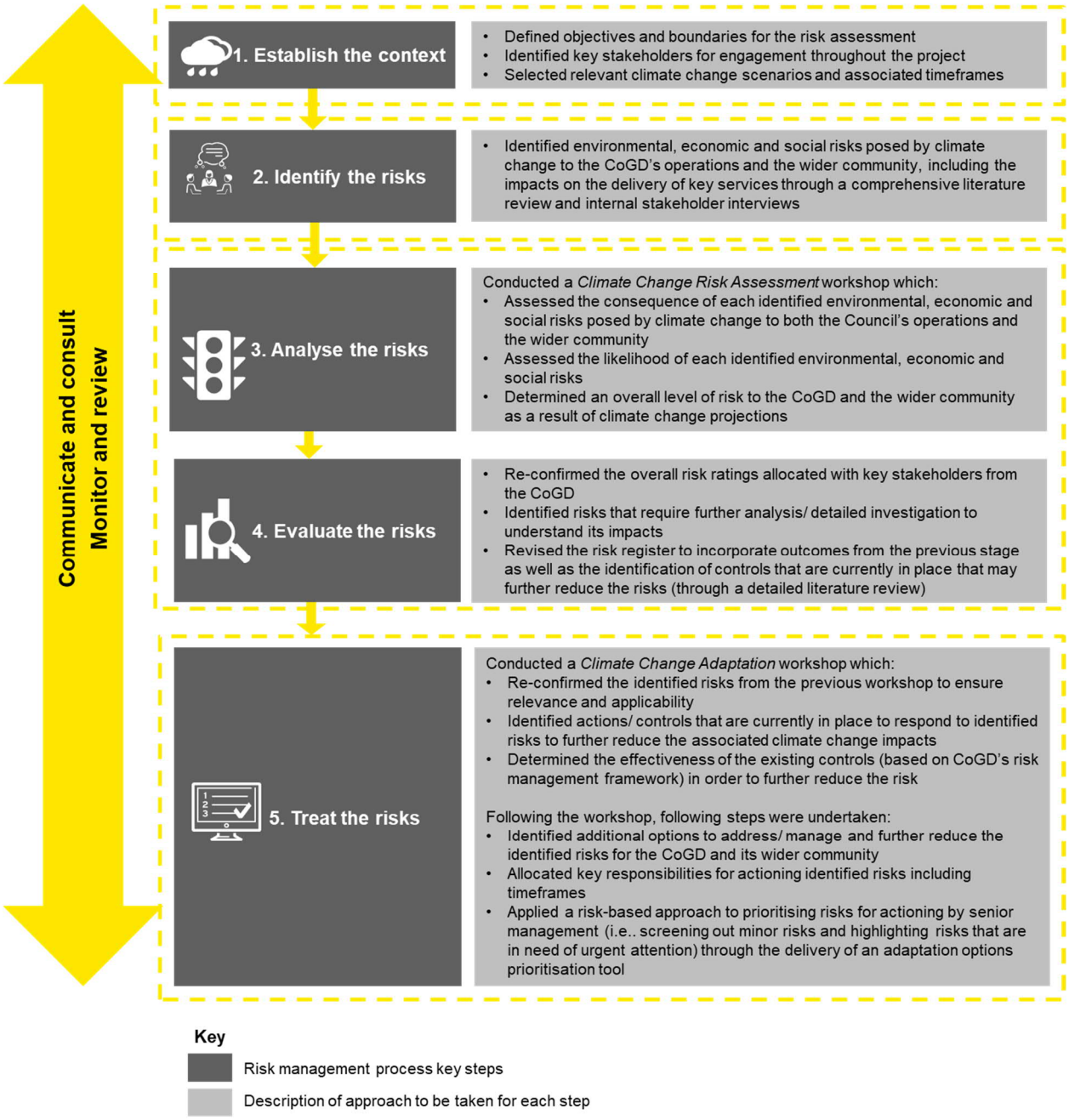


Figure 11 - Approach undertaken to develop a climate change risk management and adaptation framework for the CoGD

5.2 Literature review

A comprehensive literature review was undertaken to assess the climatic and legislative contexts for climate change action as part of the development of the CoGD's Climate Change Strategy and Action Plan. This literature review aimed to identify the legislative framework and existing initiatives that should be considered by the Council when planning climate action, as well as the environmental, economic and social risks posed by climate change to the Council's operations as well as on the broader community.

This review also extended to the selection of climate change projections that were applicable for the CoGD guided by IPCC's Fifth Assessment Report and the associated selection of the relevant RCPs and time horizons as outlined in Section 4.2.

The outcomes this literature review, specifically the selection of relevant climate variables and the associated environmental, economic and social risks that were identified are outlined in Section 4.3.

5.3 Stakeholder interviews

EY conducted a series of interviews with 15 internal stakeholders identified by the CoGD sustainability team to obtain a comprehensive understanding of the Council's operations, function, potential risks, and existing controls on a business and community level. In the context of climate change risk assessment, the purpose of these interviews were to identify environmental, economic and social risks posed by climate change to be further evaluated in the Climate Change Risk Assessment workshop. The objective of the interviews were to:

- Raise awareness of the project and climate-related risks (environmental, social and economic) amongst internal stakeholders.
- Gain a deeper understanding of the Council's departmental functions.
- Understand how risks will vary depending on existing projects as well as potential future projects.
- Identify assets and activities that are potentially sensitive to climate change and its impacts from a social, environmental and economic perspective.
- Understand the existing controls and adaptation strategies in place.

Table 2 below presents a list of the roles/positions of Council's internal stakeholders that participated in the interviews.

Table 2 - Roles of interviewees

Role
Coordinator - Asset Management
Coordinator - Building Projects
Senior Coordinator - Media and Communications
Manager - Planning and Design
Manager - Infrastructure Services and Planning
Planning Engineer - Strategic Infrastructure
Team Leader – Transport
Manager - Transport and Civil Development
Team Leader - Bushland & Garden Services
Coordinator - Community Development
Service Unit Leader - Parks and Waste
Manager - Business Networking
Team Leader Risk - Management and OHS
Coordinator - Emergency Management
Team Leader - Community Advocacy

Table 3 on the next page summarises the discussions held during interviews, including highlighting general themes. For anonymity purposes, all information has been de-identified and has not been formally documented except in the form of the above table.

Table 3 - Summary of interview discussions

	General themes identified during interviews
Key themes	► Public health risks were most commonly identified as the most significant climate change related risk, specifically extreme storm events and intense hot days and/or heatwaves. Interviewees referred to the 2011 extreme storm event and required evacuation of low lying communities (such as the Willow Lodge caravan park) as a recent example a community wide public health and safety risk. ► Vulnerable residents (such as culturally and linguistically diverse communities and the elderly) stand to be disproportionately impacted by climate change risks. Council has an important role in managing and minimising the risks on behalf of the community. Language barriers and communication with culturally and linguistically diverse communities further increases the complexity of managing climate risks for the community. ► The CoGD community place strong value on public amenity of parks and open spaces, which makes the Council obligated to maintain these spaces and amenity even during extreme heat and drought. ► Capacity constraints within Council already exist in BAU operations, and climate change will further exacerbate this constraint. Human resources were noted as a specific issue during emergencies such as extreme storms, as Council employees were required to assist with emergency response and management.
	Climate risk 1: Increased mean, maximum and minimum temperatures
	► Council employees and contractors becoming more susceptible to heat related stress and illness, particularly those working outside. ► Increase in pests and diseases impacting biodiversity, such as pine scale and Cyprus canker. ► Increased costs associated with increased use of electricity (for cooling) and water. ► Use of staff resources to warn residents (through increased media communications and door-knocking) about the risks associated with temperature rise. ► Increased irrigation requirements for new and/or established Council plantings in parks, gardens and open spaces. ► Public health related implications associated with food spoilage from food not being stored at the correct temperatures.

	Climate risk 2: Increased frequency and or intensity of heat waves and extreme hot weather
	► Vulnerable people within the CoGD (including culturally and linguistically diverse communities, the elderly and people with disabilities) could be severely impacted by heat stress, which could lead to loss of life in the worst circumstances. ► Heat stress damaging or killing local flora and fauna, including thermal stress impacts on the wetlands such as Tirhatuan Wetlands; and the associated cost of maintaining or replacing damaged flora. Heat stress on residents' pets also identified as a climate risk. ► Resourcing impacts with Council employees being diverted from BAU activities to assist with community engagement on extreme heat. ► Increase in costs for Council, residents and businesses in relation to cooling costs for electricity and water, and potential brownouts associated with overuse of electricity for cooling. ► Council employees and contractors becoming more susceptible to heat related stress and illness. ► Reputation risk for Council associated with expectations from community on use of Council facilities (e.g. libraries) and potential liability risk associated with this expectation and associated usage. ► Risk of isolation for Council employees and contractors and wider community with road and rail transport interruptions.
	Climate risk 3: Decrease in precipitation
	► Increased irrigation requirements for Council, residential and commercial plantings and associated costs with meeting higher irrigation demand in line with community expectations around public amenity of parks, open spaces and sporting grounds. While desalination is now an option for the CoGD, unlike in the Millennium Drought, this would represent a significant cost to Council. ► Impacts on biodiversity (flora and fauna) due to reduction in water supply and associated heat impacts, including drying out of wetlands. ► Increased instance of dust associated with drier conditions, and reputational risk associated with dust clean up in line with expectations. ► Increased damage to infrastructure such as properties, roads, pathways and stormwater pipelines due to the drying out of the ground. ► Potential health impacts from increased dust (asthma) and people playing on dried out surfaces in Council managed sporting grounds.

	Climate risk 4: Increased frequency and or intensity of bushfires
	► Impacts on biodiversity (flora and fauna) after a bushfire event, and reduced public amenity associated with burnt flora and death of fauna. ► Resourcing impacts associated with emergency management and response from bushfire. ► Economic productivity implications from forced shutdown of local businesses and industry. ► Cost of repair, maintenance or rebuilding for buildings either damaged or lost to bushfires. While the risk of bushfire in the municipality was identified as low by a number of employees, it was noted that a number of residential properties back on to reserves and could be at risk during a bushfire. ► Significant safety concerns associated with facilities in highly combustible industries in the CoGD during a bushfire, including waste and chemicals. ► Public health issues associated with increased heat, smoke inhalation and asthma, which could occur from fires either inside or just outside the Council's boundaries.
	Climate risk 5: Increased frequency and or intensity of extreme rainfall events (including hail, wind and lightning)
	► Increase in infill development in the CoGD will see increases in run-off from extreme storm events, leading to capacity of stormwater drains being exceeded and localised flooding occurring. ► Impact to biodiversity due to flora damage and/or loss, and impacts on future growth of grass and vegetation. ► Cost of repair, maintenance of rebuilding for properties damaged during and after extreme storm events, including increased demand of Council for hard rubbish waste collection. The CoGD's housing stock varies in quality, and vulnerable members of the community are more likely to inhabit lower quality of stock, and therefore may be disproportionately impacted. ► As the CoGD sits downstream for its catchment, it stands to also be impacted by storm events occurring upstream. ► Cost of recovery and response during emergency management, such as evacuations like those required in the 2011 extreme storm. ► Transport disruptions to rail and road impacting economic productivity of businesses and residents, as well as hindering response effort. These could also impact the delivery of critical Council BAU services to the community, such as Meals on Wheels. ► Public health and safety risks, including tree falls, flooding and wellbeing implications of emergency situations on culturally and linguistically diverse communities.

5.4 Climate change risk assessment workshop

EY facilitated a Climate Change Risk Assessment workshop on the 15th of November 2018 to analyse and evaluate the inherent environmental, social and economic risks posed by climate change to the CoGD's business operations and the wider community without taking into account existing CoGD controls. The objectives of this workshop were to:

- Understand and agree on potential economic, environmental and social risks to the CoGD posed by future climate change impacts.
- Assess the consequences of each identified risk to the CoGD's business and community.
- Establish the likelihood of each of these risks to CoGD's business and community.
- Establish an overall preliminary risk rating for each identified risk.

Table 4 below presents a list of the Council's internal stakeholders who participated in the climate change risk assessment workshop.

Table 4 - List of the climate change risk assessment workshop attendees' roles

Role
Coordinator - Asset Management
Coordinator - Building Projects
Manager - Planning & Design
Coordinator - Sport & Leisure
Planning Engineer - Strategic Infrastructure
Manager - City Projects & Asset Improvement
Corporate Planning Officer
Environmental Planner
Team Leader - Sustainability Planning
Place Making Officer
Sustainability Officer
Coordinator - Strategic, Design & Sustainability Planning
Team Leader - Festivals & Events
Manager - Transport & Civil Development
Service Unit Leader - Works, Fleet & Cleansing
Risk Management Consultant
Coordinator - Community Development
Service Unit Leader - Parks & Waste
Team Leader - Asset Management
Team Leader Risk - Management & OHS
Former Emergency Management Coordinator
Team Leader - Community Advocacy
Coordinator - Statutory Planning

The workshop commenced with an introduction to the project, an overview of the projected change in climate variables and the associated impacts before summarising the risks identified from the stakeholder interviews. EY facilitated a discussion on these risks to assign a consequence and likelihood to each of the risks in line with the Council's Risk Management Procedure. The raw results from the Resolver Ballot system can be found in Appendix A.

EY used the Resolver Ballot system to vote on the consequence and likelihood ratings of each of the identified inherent risks. This is an anonymous voting system which utilises voting pads to record votes in real time for a given set of metrics. At the workshop, stakeholders were presented with a voting pad to vote on the consequence and likelihood of each identified risk and the results were indicated on a screen once all stakeholders had submitted their votes. Anonymous voting helps to reduce the influence of bias on votes, if people feel pressured or judged in relation to how they are voting on a particular issue. The use of the Resolver Ballot system also helps to provide structure and purpose to discussions, and can help to effectively manage the voting process.

The Council's Risk Management Procedure has predetermined criteria for levels of consequence and likelihood to ensure consistency of application across the Council's operations. As per the Council's Risk Management Procedure, a consequence is an outcome or impact on an event considered in relation to the achievement of objectives[77]. There can be multiple consequences as a result of an event that range from positive to negative or quantitative to qualitative. Consequence is rated based on severity ranging from "Insignificant" to "Catastrophic" as shown in the CoGD's consequence rating scale in Table 5. Similarly, the likelihood is used as a general description of probability or frequency and is rated from "Rare" to "Almost Certain as shown in Table 6.

The product of the risk's consequence and likelihood results in the final risk priority rating (Figure 12).

Development of a risk register

Prior to the Workshop a risk register was developed to guide the conduct of the Climate Change Risk Assessment. The draft risk register that was generated for CoGD was in alignment with the risk assessment template that was outlined in its risk management procedure.

A total of 44 risks were identified in a collaborative effort between EY and the CoGD prior to the workshop. These risks sat across the five different climate variables outlined earlier in this report, being:

- Increase in average annual and seasonal temperatures.
- Increase in intensity and frequency of extreme hot days and heat waves.
- Reduction in precipitation.
- Increase in intensity and frequency of bushfires.
- Increase in intensity and frequency of extreme storm events (including hail, wind and lightning).

In addition to these five climate variables, a sixth category was added to the risk register that encompassed impacts from all the above climate variables. This category was used to identify the following whole-of-Council risks and stand to be impacted by all climate variables. These include:

- The CoGD's ability to deliver services through its statutory and asset planning functions.
- The CoGD's ability to deliver key emergency management services to the community.
- Reputational damage to the Council as a result of a failure to respond to climate change issues.
- The CoGD's ability to delivery key services to the community.

[77] Australian Greenhouse Office, *Climate Change Impacts & Risk Management*

Table 5 - Consequence rating scale as outlined in the CoGD's *Risk Management Procedure (updated 2017 version)*

Severity	Insignificant	Minor	Moderate	Major	Catastrophic
Reputation	Letters to suppliers, clients or local/state press	Series of articles in local/state press	Extended negative local / state media coverage	Short term negative nation-wide media coverage	Extended negative nation -wide media coverage
Regulatory Compliance	Minor breaches by individual staff members	No fine – no disruption to service delivery. Formal discussion & correspondence requiring formal response	Minor or single regulatory breach. Fine but no disruption to service delivery	Regulatory breach. Fine and short term disruption to service delivery	Significant or several regulatory breaches resulting in legal action or ministerial inquiry. Significant disruption to service delivery over an extended period
Financial Impact	Less than $5,000	Between $5,001 - $19,999	Between A$20,000 – A$249,999	Between $250K - $500,000	Between $501K - $20 Million
Assets, Security & Infrastructure	Infrastructure or asset is subject fails causing minor delays and is subject to routine maintenance	Failure of infrastructure and asset creates slight inconvenience to users	Part of infrastructure creates a danger to employees or public in immediate vicinity.	Partial destruction/collapse and denial of access to asset or infrastructure	Complete destruction/collapse and denial of access to asset or infrastructure
People, Safety (incl. public safety) & Environment	Injuries or ailment not requiring medical treatment i.e. FAI Minor environmental impact. Contamination – on-site release contained within short time frame.	Medical treatment Injury. (MTI) Transient environmental impact with minimal cost To restore.	Injury causing hospitalisation and or Lost time Injury (LTI). Transient environmental impact requiring clean-up work. Contamination – on-site release contained with outside assistance	Serious or life threatening injury or multiple serious injuries causing hospitalisation. Significant harm requiring restorative work. Contamination – off-site release with no detrimental effects.	Single or multiple deaths. Long term harm with major irreversible damage. Toxic release off-site with detrimental effect or loss of ecosystem functions across species and landscapes.
Business Continuity	Brief loss of service. Minor errors in systems or processes requiring corrective action, or minor delay without impact.	Localised loss of service for up to one day. Inconvenient, but does not impact service delivery.	Critical service loss for more than one week. Key accountability requirements not met. Services do not fully meet needs.	Critical service loss for up to one month.	Critical system failure. Business severely affected with interruption exceeding 1 month in duration.

Table 6 - Likelihood rating scale as outlined in the CoGD's *Risk Management Procedure (updated 2017 version)*

Rating	Likelihood
Almost Certain	Has a 90% chance of occurring in a given year
Likely	Has a 50% chance of occurring in a given year
Possible	Has a 25% chance of occurring in a given year
Unlikely	Has a 10% chance of occurring in a given year
Rare	May occur in exceptional circumstances

		CONSEQUENCE				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
LIKELIHOOD	Almost Certain 5	M	H	E	E	E
	Likely 4	M	H	H	E	E
	Possible 3	L	M	M	H	E
	Unlikely 2	L	L	M	M	H
	Rare 1	L	L	L	M	H

Extreme	Critical risk Immediate action required. Requires timely reporting and oversight by Executive Management Team and Senior Management
High	Significant risk Senior management attention needed. Managed within existing Directorate.
Moderate	Medium risk Management responsibility must be specified. Managed within Department.
Low	Low risk Manage by routine procedures.

Figure 12 - CoGD's risk priority matrix – sourced from the *Risk Management Procedure (updated 2017 version)*

During the risk assessment workshop, there was high levels of engagement across all participants on the subject matter. Some small areas for clarification in specific risks were raised for EY, but they were minor in nature and required additional clarity in the existing risks, rather than adding or deleting existing risks. These included:

- Specifically outlining impacts on commercial animals and pets via the risk related to impacts to flora and fauna across the different climate variables.
- Incorporation of / making reference to electric storms within the extreme storms climate variable, and the incidence of thunderstorm asthma associated with increased intensity of wind conditions that could further exacerbate the associated impacts.
- Additional reference to bushfire smoke (inhalation and disruption to activities) and associated health implications. This not only extended to bushfires within the CoGD, but also from bushfires that could occur in neighbouring regions that could have knock-on implications for CoGD.
- One internal stakeholder noted that the bushfire risks were being rated higher than expected given the CoGD's lower risk of bushfire, with only three gazetted bushfire zones. However, this individual did note that the results were not necessarily wrong, but more reflective of general levels of concern within Council for bushfire risks. It is noted that the limited areas of remnant bushland in the urban areas of Greater Dandenong may have caused the participants to perceive a lower risk of bushfires despite the southern areas of extensive grassland in the Green Wedge. While the projections indicate that CoGD will see an increase in the number of high fire weather danger days (FFDI) which will increase the likelihood of extreme bushfires occurring, it is noted that these will pose a lower risk to those three areas of remnant bushland in the urban areas with a slightly higher risk of spreading posed by the extensive grasslands in the Green Wedge.

Overall, stakeholders were engaged and offered valuable insights during the Climate Change Risk Assessment workshop which received positive feedback from a number of program participants. Key achievements included:

- **Cross-departmental representation** – majority of the CoGD internal stakeholders that were interviewed also attended the climate change risk assessment workshop, which allowed for valuable multi-stakeholder / cross- departmental discussions during the workshop with representation across Council operations.

- **Anonymous voting** – the use of the Resolver Ballot system allowed for anonymous voting on the consequence and likelihood for each identified risk which was well received by the participants. Anonymous voting allows for full participation within the group and reduced the risk of particular individuals within the group exerting undue influence on the voting for a particular risk, which can most often occur when that climate risk relates to that individual's area of operations.

- **Progressing through all 44 risks** – due to strict time management and extensive preparation before the workshop, EY was able facilitate an appropriate level of discussion and complete the voting for all 44 identified risks facing the Council and the wider community. This is commendable given the large number of participants, complexity of several risks and limited timeframe that was available for this workshop.

While the Climate Change Risk Assessment workshop was well received, there were a number of limitations to the process. Key challenges faced included:

- **Timing** – the Climate Change Risk Assessment workshop was allocated 3 hours where adequate discussions needed to be held on top of the allocation of risk priority ratings for all 44 identified risks. At the commencement of this voting process, there was significant variations in scores for the first vote cast. A discussion was held that reiterated that participants needed to have the same frame of mind when voting (to avoid any bias in voting), so a re-vote was conducted. While this discussion provided clearer context and guidance for participants to vote, it limited time available to be spent in detailed discussions. Due to these time constraints, stakeholders were unable to provide comprehensive input into the controls in place currently to adapt to climate change, with information on controls for the climate change adaptation workshop relied upon from the literature review and stakeholder interviews.

- **Prior engagement with risk register** – while a draft set of economic, environmental and social risks was distributed to the participants prior to the workshop, it was noted that majority of the participants were not familiar with this material during the workshop. Print outs of the registers were available for each participant during the workshop which allowed for real time engagement with the material, however it would have been beneficial if all participants had conducted an initial 'pre-reading' of this material prior to the workshop.

- **Assigning risk criteria** – during the anonymous voting process some participants raised concerns over the accuracy of the voting process and relative risk consequence/likelihood across the different risks. An option to address this in the future would be to include the ability to vote on the 'confidence rating'. This would allow people to outline whether they feel the right people were in the room to respond confidently to this risk. This would also help identify any risks to be revisited with other stakeholders with specific expertise.

- **Revision to CoGD's 'consequence' rating scale** – during the workshop, it was noted that the consequence risk rating scale currently being used by CoGD from its risk management procedure was not very comprehensive, and did not incorporate consequence scales for social impacts thoroughly. For example, the catastrophic rating had economic impact of over $500,000. While this impact would be significant (either to Council or wider community) and would be a high priority, it would not necessarily be as high priority as something that caused loss of life or significant public health issues. Given that nearly half of the risks identified were in relation to CoGD's wider community, it was recognised at the workshop that further work needs to be undertaken to refine CoGD's consequence rating scale.

- **Current risk register completeness** – in preparation for the workshop, CoGD's current risk register was reviewed to understand whether climate change was incorporated as a risk to the Council and what the associated risk management procedures were. It was noted that the current Council risk register only had three climate-related risks, in relation to flood modelling and planning not adequately taking into account climate scenarios; decline viability of regional tourism linked to changed climate; and reputational risk associated with not responding to climate change. Given the risk that climate change poses to Council operations, the current level of identification and disclosure indicated that the Council is not accurately identifying and managing its climate-related risks. This represents a significant gap in the current register and risk for the Council in relation to current management of climate change related risks.

- **Relevant expertise** – some differences in opinion regarding the potential risks and impact of bushfires in CoGD were noted throughout the workshop process, indicating a limited understanding of the risks in relation to bushfires. A citizen's jury style approach could help to overcome this issue in future engagements, where a significant amount of time is spent to ensure that expert advice on relevant issues is shared with workshop participants prior to the allocation of likelihood and consequence ratings.

5.5 Risk assessment results

The consequence and likelihood ratings that were voted on through the Resolver Ballot system at the Climate Change Risk Assessment workshop (as outlined in Section 5.4) was collated to determine the overall risk priority levels for the 44 identified risks. These results were then standardised to eliminate any voting bias and superimposed on the Council's own risk matrix as indicated in Figure 13. Figure 13 also indicates the overall spread of all the risks identified based on the RCP 8.5 high emissions scenario to a time horizon of 2030. Appendix A contains the raw voting outputs captured via the Resolver Ballot system from the stakeholder workshop. The breakdown of the 44 risks into corporate and community risks is also depicted in Figure 13 along with the breakdown of the associated climate variable.

On a climate variable (e.g. temperature, precipitation etc) basis, it is noted that majority of the climate risks identified were in relation to increased extreme temperature and extreme storm events. This aligns with historical climate-related events that CoGD has been impacted by, in particular the 2009 Victorian heat wave, which increased heat related hospital visits, caused transport delays and placed severe strain on local emergency services[78]. Furthermore, researchers at Monash University identified the CoGD region as being one of Melbourne's most at-risk suburbs from heatwaves due to its demographics79. Similarly, in alignment with the risks identified in Figure 13 another historical event that the CoGD was subjected to was the 2011 floods which severely affected the region with cancellations and disruption to utility and transport networks and restricted Council's ability to respond to this emergency. The outputs of the risk assessment (Figure 13 and Table 7) is in alignment with expectations, with the majority of the bushfire related risks receiving a 'low' risk priority rating due to the reduced likelihood of bushfires spreading across the region due to its built environment.

In total there were 12 economic risks, nine social risks, three environmental stand-alone risks with the remaining 32 being a combination of one of the three areas. The vast majority of risks had economic and/or social consequences which indicated where most of the Council's risks were in relation to its role as a key governing body.

[78] Victoria State Government, *January 2009 Heatwave in Victoria: an Assessment of Health Impacts*
[79] Monash, *Heatwave map reveals Melbourne's most vulnerable postcodes*

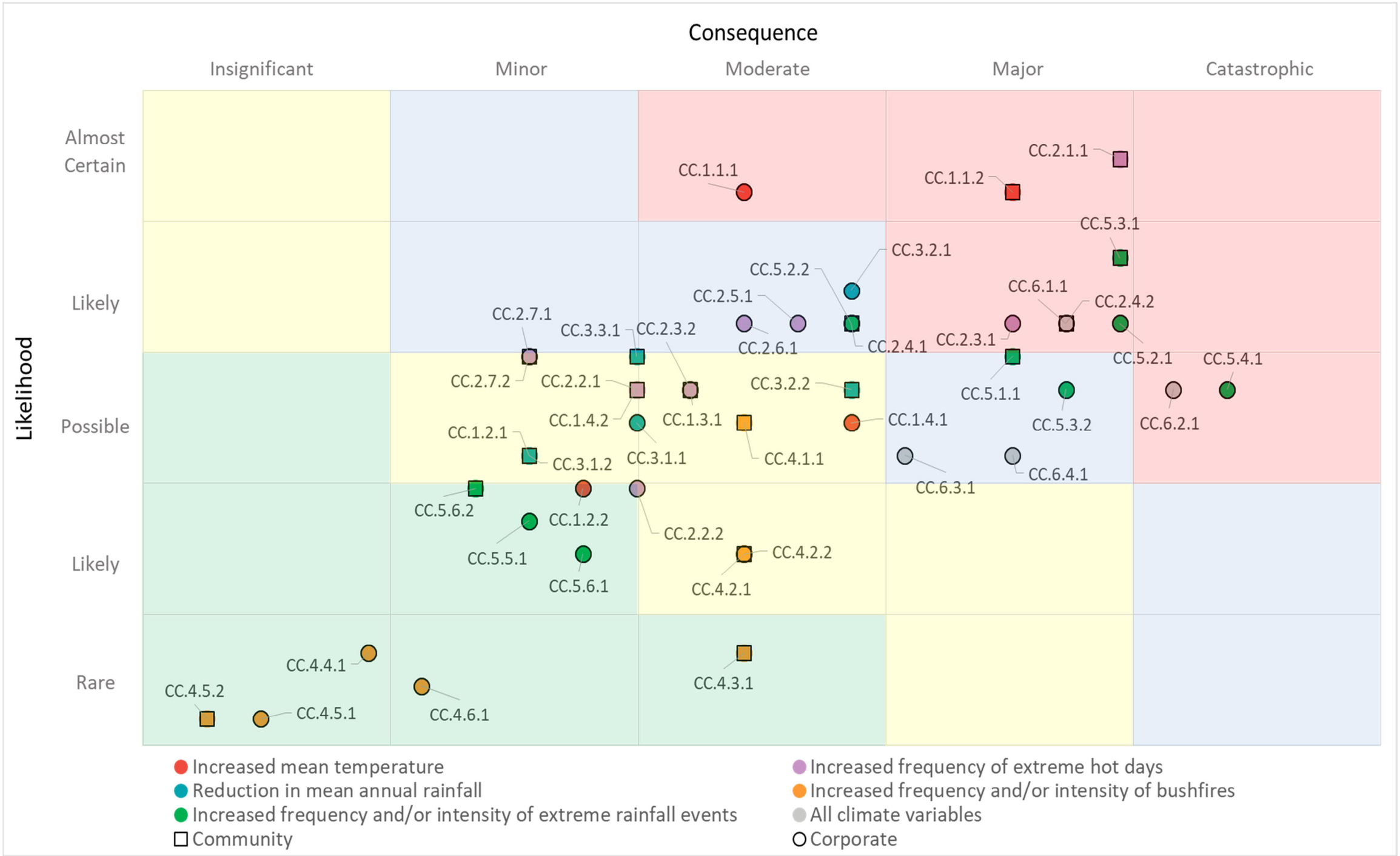


Figure 13 - Final output from the risk assessment workshop (risk matrix outlines inherent risks posed by climate change excluding CoGD's current controls)

Refer to Table 7 for an outline of the risks on the above matrix.

Table 7 - Table of risks identified in the risk assessment workshop

Risk ID	Corporate/ Community	Risk Description	Type
CC.1.1.1	Corporate	Increase in mean annual temperatures leading to an increase in demand and use of electricity and water for cooling Council-owned properties and facilities.	Economic
CC.1.2.2		Increase in mean annual temperatures leading to changing conditions that allow new pests and diseases to be introduced and proliferate in the environment and impacting land and aquatic flora and fauna on Council owned public spaces.	Economic
CC.1.3.1		Increase in mean annual temperatures, leading to a loss of aquatic and terrestrial biodiversity resulting in reduced appeal, public amenity and usability of Council managed green infrastructure (e.g.: parks, open spaces, etc.).	Environmental
CC.1.4.1		Increase in mean annual temperatures, leading to increased degradation and weathering of buildings and infrastructure owned and or operated by the Council, resulting in increased maintenance and repair costs to the Council.	Economic
CC.2.2.2		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, can result in an amendment, postponement or cancellation of Council-run public activities & events.	Economic/ Social
CC.2.3.1		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, and in turn causing damage to, and loss of utilities and transport infrastructure leading to disruptions to the Council managed operations and services.	Economic
CC.2.4.1		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, leading to an increase in demand and use of electricity and water for cooling Council-owned properties and facilities.	Economic
CC.2.5.1		Increased frequency of extreme hot days (above 35°C) and intensity of heatwave that restricts the ability of Council employees and/or contractor employees to undertake work activities.	Social
CC.2.6.1		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, causing changes to the distribution and occurrence of fauna and flora and in turn terrestrial biodiversity loss.	Social
CC.2.7.1		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, leading to reduced use and visitation by residents and tourists of Council managed green infrastructure (e.g. parks, open spaces, etc.).	Economic/ Social
CC.3.1.1		Reduction in mean annual rainfall resulting in increased heat and water stress in plants/vegetation that require increased irrigation requirements and re-establishment or replantings in Council operated facilities.	Economic/ Social
CC.3.2.1		Reduction in mean annual rainfall resulting in water supply constraints/ water shortages, that in turn increase water supply requirements, charges and costs for potable and irrigation water to the Council to service built infrastructure and public facilities.	Economic/ Social
CC.4.2.1		An increase in the frequency and/or intensity of bushfires, resulting in damage to and loss of Council-owned buildings, properties and infrastructure.	Economic
CC.4.4.1		An increase in the frequency and/or intensity of bushfires, resulting in damages to open spaces in turn reduces the appeal and public amenity such spaces and impacts the use and visitation of the spaces from residents and tourists.	Economic
CC.4.5.1		An increase in the frequency and/or intensity of bushfires, resulting in the cancellation of Council-run public activities & events.	Economic/ Social
CC.4.6.1		An increase in the frequency and/or intensity of bushfires, resulting in damage to and loss of biodiversity and natural habitat.	Environmental / Economic
CC.5.2.1		Increased frequency and/or intensity of extreme rainfall events resulting in damage to and loss of Council-owned buildings, properties and infrastructure.	Economic/ Social
CC.5.3.2		Increased frequency and/or intensity of extreme rainfall events causing damage to, and loss of, utilities and transport infrastructure	Social
CC.5.4.1		Increased frequency and/or intensity of extreme rainfall events, leading to stormwater runoff exceeding stormwater drainage/ retention capacity and in turn damage to and loss of Council owned and/or operated utilities and transport infrastructure as well as residential and commercial properties within CoGD.	Social/ Environmental
CC.5.5.1		Increased frequency and/or intensity of extreme rainfall events causing damage to and loss of biodiversity and natural habitat, including in the marine environment	Social/ Environmental
CC.5.6.1		Increased frequency and/or intensity of extreme rainfall events, can result in the postponement/ cancellation of Council-run public events.	Economic
CC.6.1.1		The CoGD's ability to deliver services through its statutory and asset planning functions	Economic
CC.6.2.1		The CoGD's ability to deliver key emergency management services to the community	Social
CC.6.3.1		Reputational damage to the Council as a result of a failure to respond to climate change issues	Social
CC.6.4.1		The CoGD's ability to deliver key services to the community	Economic/ Social
CC.1.1.2	Community	Increase in mean annual temperatures leading to an increase in demand and use of electricity and water for cooling residential and commercial properties.	Economic
CC.1.2.1		Increase in mean annual temperatures leading to changing conditions that allow new pests and diseases to be introduced and proliferate in the environment and impact land and aquatic flora and fauna.	Economic/ Social
CC.1.4.2		Increase in mean annual temperatures, leading to increased degradation and weathering of commercial and residential properties in the CoGD, resulting in increased maintenance and repair costs to commercial and residential building owners.	Economic/ Social
CC.2.1.1		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, leading to extreme hot weather conditions, impacting public health and wellbeing through heat related stress and illness.	Economic/ Social
CC.2.2.1		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, can result in the postponement or cancellation of community events.	Social
CC.2.3.2		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, and in turn causing damage to, and loss of utilities and transport infrastructure leading to commuter delays and community disruptions.	Environmental
CC.2.4.2		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, leading to an increase in demand and use of electricity and water for cooling residential and commercial properties.	Social
CC.2.7.2		Increased frequency of extreme hot days (above 35°C) and intensity of heatwaves, leading to reduced use and visitation by residents and tourists of Council managed green infrastructure (e.g. parks, open spaces, etc.).	Economic
CC.3.1.2		Reduction in mean annual rainfall resulting in increased heat and water stress in plants/vegetation that reduces stream flows and requires increased irrigation requirements and re-establishment or replantings in residential and commercial properties.	Economic/ Social
CC.3.2.2		Reduction in mean annual rainfall resulting in water supply constraints/ water shortages, that in turn increase water supply requirements, charges and costs for potable and irrigation water to commercial and residential tenants.	Economic/ Social
CC.3.3.1		Reduction in mean annual rainfall resulting in water supply constraints/ water shortages, that in turn creates public health and safety risks in relation to recreation activities.	Economic/ Social
CC.4.1.1		An increase in the frequency and/or intensity of bushfires, resulting in a reduction of public health and wellness, or causing loss of life.	Economic/ Social
CC.4.2.2		An increase in the frequency and/or intensity of bushfires, resulting in damage to and loss of residential and commercial properties, including community housing.	Environmental
CC.4.3.1		An increase in the frequency and/or intensity of bushfires, resulting in damage to, and loss of, utilities and transport infrastructure	Economic/ Social
CC.4.5.2		An increase in the frequency and/or intensity of bushfires, resulting in the cancellation of community activities & events.	Social
CC.5.1.1		Increased frequency and/or intensity of extreme rainfall events, in turn reducing public health and wellness, or causing loss of life.	Economic
CC.5.2.2		Increased frequency and/or intensity of extreme rainfall events resulting in damage to and loss to residential and commercial properties, including community housing.	Social/ Economic
CC.5.3.1		Increased frequency and/or intensity of extreme rainfall events causing damage to, and loss of, utilities and transport infrastructure	Social
CC.5.6.2		Increased frequency and/or intensity of extreme rainfall events, can result in the postponement/ cancellation of community events.	Social/ Economic

Based on the overall results outlined in Figure 13, there were a total of 10 inherent risks rated by workshop participants as 'extreme' with the highest priority for treatment and a total of nine risks rated as 'high' with the next highest priority for actioning; with the remaining inherent risks rated as either 'medium' or 'low'. Further analysis of these risks indicated that:

- The majority of the '**extreme**' priority rated inherent risks were in relation to the projected increase in the frequency and/or intensity of extreme hot days (above 35ºC) and heatwaves, and the increased frequency and/or intensity of extreme rainfall events (Figure 14) in CoGD.
  - All identified '**extreme'** priority rated inherent risks are classified as critical risks that require immediate action as per the Council's risk management procedure.
  - All 'extreme' rated inherent risks outlined in Figure 14 had 'moderate' to 'catastrophic' consequence ratings and with the likelihood rating ranging from 'almost certain' to 'possible', as per the Council's Risk Management Procedure.
  - There is an equal split of community and Council- related risks that received an overall 'extreme' rating which indicates the importance of Council's role in managing risks that pose a threat to its operations and services, but also to the wider community it serves.
  - The key areas of impact of extreme risks were related to the following (Figure 14):
    - An increase in demand and use of electricity and water for cooling Council-owned properties and facilities, and residential or commercial properties.
    - Reduced public health and wellbeing.
    - Increased damage to, and loss of utilities and transport infrastructure leading to disruptions to the Council managed operations and service.
    - Damage to and loss of Council-owned buildings, properties and infrastructure.
    - Council's ability to deliver services through its statutory and asset planning functions and key emergency management services to the community.

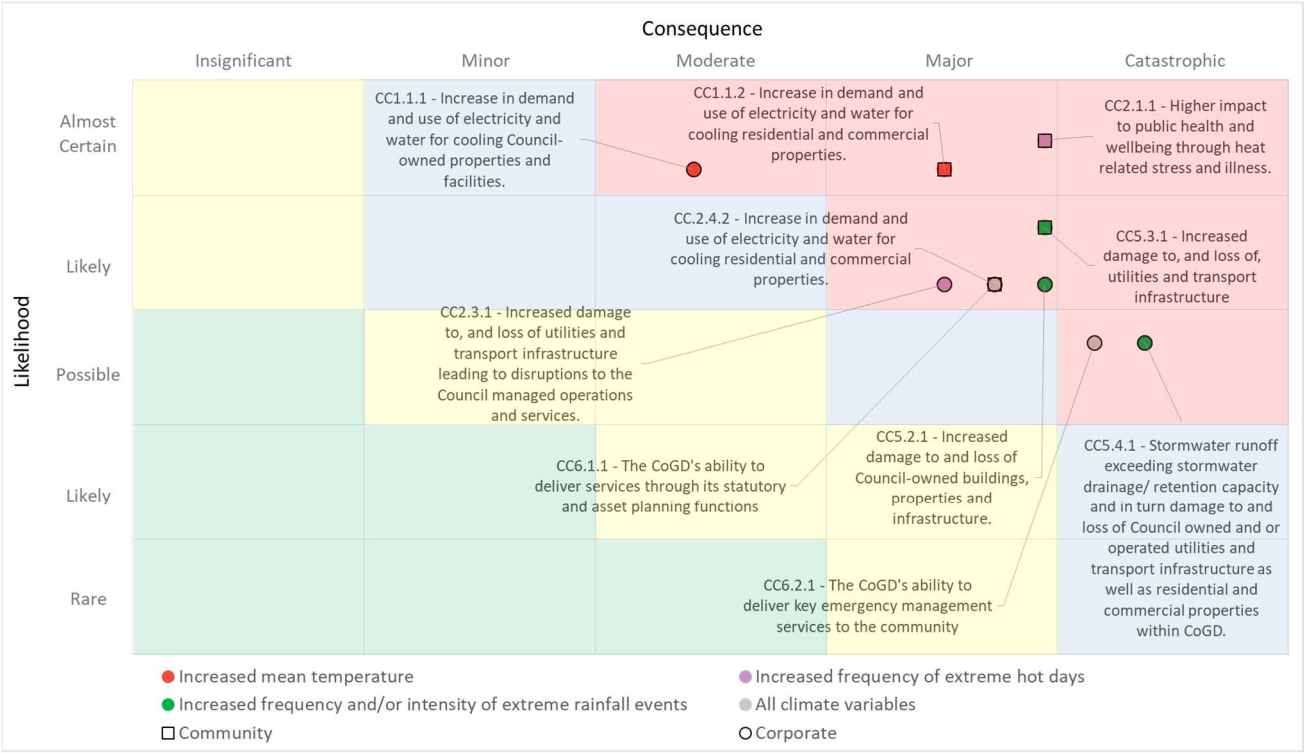


Figure 14 - Snapshot of 'extreme' priority rated inherent risks identified from the risk assessment workshop before CoGD's controls.

- The three highest ranked inherent risks (overall risk rating) were specifically in relation to:
  - Increased frequency of extreme hot days (above 35ºC) and increased frequency, intensity and duration of heatwaves, leading to extreme hot weather conditions, impacting public health and wellbeing through heat related stress and illness.
  - Increased frequency and/or intensity of extreme rainfall events causing damage to, and loss of, utilities and transport infrastructure.
  - Increase in mean annual and seasonal (summer and winter) temperatures leading to an increase in demand and use of electricity and water for cooling residential and commercial properties.
- Of the top three 'extreme' priority rated risks, the one assessed by the workshop with the highest likelihood of occurring was in relation to impacts on public health and wellbeing through heat related stress and illness. In the context of CoGD's current community profile, this will have associated implications for CoGD's large population of vulnerable people including a large culturally and linguistically diverse community base as well as the elderly who are more susceptible to heat-related illnesses.
- The risks related to the damage of infrastructure through extreme weather also pose further complications for CoGD's major industrial hub, especially the five 'major hazard facilities' listed below due to power outages that could result in hazardous material incidents that can further disrupt business operations. These five industrial facilities have been identified by the CoGD as "major hazard facilities" and emergency services organisations have developed plans for each these sites based on their associated risks. These facilities include[80]:
  - BOC Limited – 351 Hammond Road, Dandenong South.
  - Elgas Ltd – 120 Greens Road, Dandenong South.
  - Gas Net Australia Pty Ltd – 180 Greens Road, Dandenong South.
  - Melbourne Water – Thompson Road, Bangholme.
  - Supagas Pty Ltd – 23 Commercial Drive, Dandenong South.
- Out of the four Council-specific 'all climate variable' encompassing risks identified, two were allocated an overall 'extreme' priority risk rating.

- A total of nine '**high**' priority rated risks were identified in relation to projected increase in the frequency and/or intensity of extreme hot days (above 35ºC) and heatwaves in the CoGD, and the increased frequency and/or intensity of extreme rainfall events (Figure 15); similar to those identified with an 'extreme risk rating (Figure 15).
  - All identified 'high' priority rated risks are classified as significant risks that require management attention as per the Council's risk management procedure.
  - All associated risks in Figure 15 had 'moderate' to 'major' consequence ratings and with the likelihood rating ranging from 'almost certain' to 'possible', as per the Council's Risk Management Procedure.
  - These 'high' priority risks result in the potential for a variety of impacts for the council and the community as follows (Figure 15):
    - Increased demand and use of electricity and water for cooling Council-owned properties and facilities.

[80] City of Greater Dandenong, *Municipal Fire Management Plan 2015-2017*

- Decreased ability of Council employees and/or contractor employees to undertake work activities.
- Disruption and occurrence of fauna and flora leading to biodiversity loss.
- Reduced public health and wellness, or loss of life.
- Damage to and loss to residential and commercial properties, including community housing.
- Damage to, and loss of, utilities and transport infrastructure.
- Water supply constraints/ water shortages leading to increased costs for potable and irrigation water to the Council to service-built infrastructure and public facilities.

- One of the key impacts identified under these 'high' risks was the impact on biodiversity loss. Taking into consideration CoGD's existing lack of/limited open space available in the locality, this will pose further challenges in the management of these type of risks.

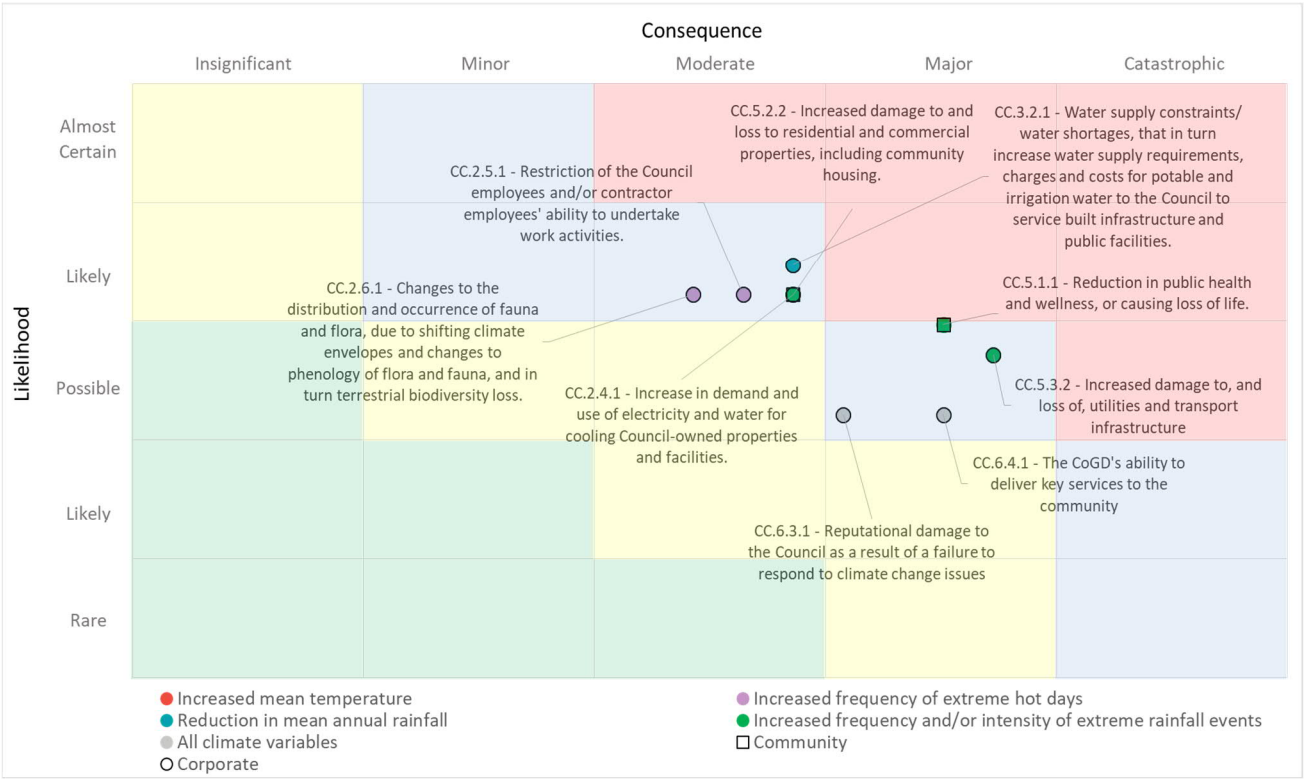


Figure 15 - Snapshot of 'high' priority rated inherent risks identified from the risk assessment workshop

- Sixteen of the 44 inherent risks identified through the risk assessment process were classified as '**medium**' priority. Nine of these were risks that related to projected increases in mean temperature, extreme hot days (above 35ºC), decrease in precipitation and increase in bushfires. According to CoGD's risk management procedure, these risks require management responsibility to be specified and assigned.

- Nine of the 44 inherent risks identified through the risk assessment process were classified as '**low**' priority. Five of these risks are in relation to the occurrence of bushfires within CoGD's built and natural environment layout and landscape with a low likelihood that bushfires will spread in this region. These risks can be managed through routine practices as outlined in Council's risk management procedures.

6. Climate change adaptation

6. Climate change adaptation

6.1 Concept of climate change adaptation

Climate change adaptation "consists of actions undertaken to reduce the adverse consequences of climate change, as well as to harness any beneficial opportunities."[81] It is seen as a mechanism to manage the (actual and projected) risks posed by climate change. Adaptation measures are necessary to respond to those impacts of climate change which cannot be avoided. In general, the objective of any adaptation response is to reduce the vulnerability of communities, societies, businesses, environment, biodiversity and the economy as a whole to climate risks and to build resilience to both present and future climate change. Adaptation measures should be tailored to meet the specific requirements of a particular region, focusing where possible on vulnerable communities and sectors.

Adaptation actions can be implemented at the local council or community level and help to minimise the environmental, economic and social impacts of climate change on council operations and/or the broader municipality community. These actions could range in complexity and scale, from running behavioural campaigns for residents and businesses on the importance of adequate cooling during heatwaves; to upgrading stormwater infrastructure to increase capacity and reduce the risk of overflow and associated flooding.

Climate change mitigation and adaptation actions should be implemented in tandem as part of a climate change strategy. Adaptation is focused on responding to; and preparing for, the projected risks of climate change impacts; while mitigation is focused on reducing GHG that is linked to the causes of climate change.

Figure 16 below outlines the relationship between GHG, climate change and mitigation and adaptation. It is important to note that there are mutual synergies between adaptation and mitigation actions that present win-win outcomes. For example, building efficiency projects can help to reduce energy demand and associated emissions, while also increasing the resilience of the building stock to climate change impacts. Water conservation methods can also reduce emissions from reduced demand for pumping and/or recycling of water and also help manage climate change impacts of reduced precipitation. Even under the current ambition to keep global average temperature rise associated with climate change below 2^{o}C (in the Paris Agreement), there will still be climate-related risks that require adaptation actions to help the economy and community respond to the physical impacts.

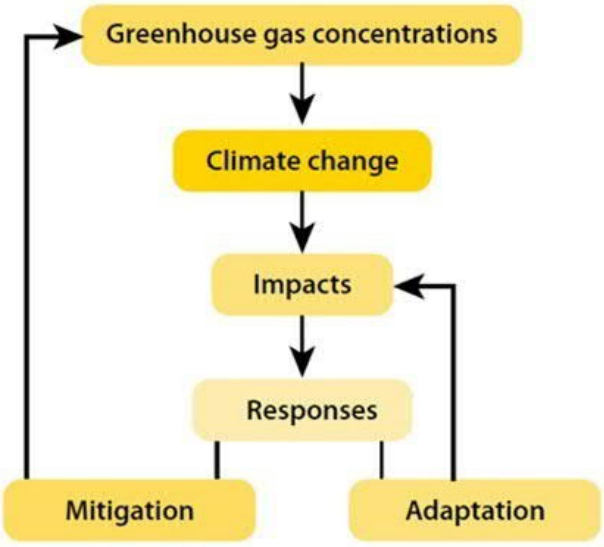


Figure 16 - GHG mitigation and adaptation.

[81] National Climate Change Adaptation Research Facility, *What does climate change mean for Australia?*

Given the complexity and uncertainty associated with climate change projections and its associated risks and impacts, it can be difficult to identify appropriate adaptation actions to manage future risk. To assist in the development of climate change adaptation actions, the Australian Greenhouse Office outlines six principles for adaptation for consideration[82] (see Figure 17):

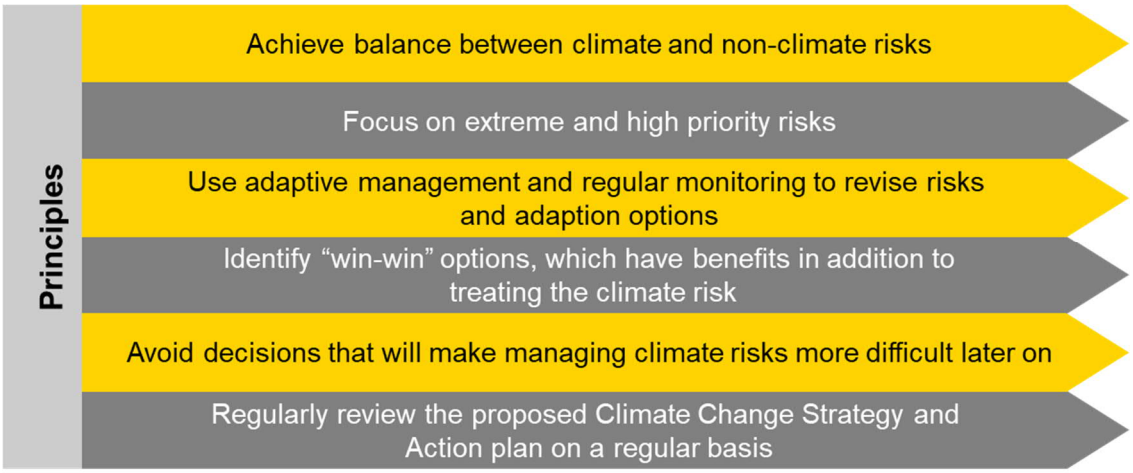


Figure 17 - Adaptation principles[83]

In more detail, Figure 17 can be interpreted as relates to:

- Achieve balance between climate and non-climate risks – recognition that climate change risks are not the only risks that the Council is subject to, as there are other non-climate risks that need to be taken into consideration therefore a balanced approach is required to integrate climate change risk management with the broader risk -management processes within CoGD.

- Manage priority climate change risks – as outlined in Section 5.5, focus must be on placed on 'extreme' and 'high' priority risks where priorities must be set to raise management attention for these risks as well as allocation of resources to action these.

- Use adaptive management – concept designed to deal with the degree of uncertainty surrounding climate change while putting in place flexible, incremental changes based on regular monitoring of information to continually update and challenge existing policies and plans as new knowledge becomes available.

- Identify 'win-win' or 'no-regrets' treatment options – 'No regrets' and 'win-win' measures are adaptation measures deemed to have associated co-benefits other than the direct benefits of climate change adaptation and are, moreover, measures that would generate net environmental, social and/or economic benefits irrespective of whether or not anthropogenic climate change occurs.

- Avoid decisions that will make managing climate risks more difficult in the longer term. For example, not approving a residential development in a well-known flood-prone area.

- Regular review and monitoring of the climate change risks and adaptation actions to make the necessary revisions as climate change projections are updated over time.

The above principles help to ensure adaptation actions are robust, achievable and do not lead to either maladaptation or over-adaptation.

[82] Australian Greenhouse Office, *Climate Change Impacts and Risk Management: A Guide for Business and Government*
[83] Ibid

6.2 Adaptations actions workshop

As part of the final step in the risk management framework, EY facilitated a climate change adaptation workshop on the 6th of December 2018 to identify potential adaptation options to treat the economic, environmental and social risks that were identified at the previous workshop. The objectives of this workshop were to:

- Review the climate change risks previously identified.
- Identify existing controls/ actions in place at the CoGD that address the identified climate change risks (including the effectiveness of existing controls).
- Determine the effectiveness of the existing controls/ actions in place at CoGD in addressing and further reducing the residual risk.
- Identify additional adaptation actions to manage climate change risks.
- Perform an overarching prioritisation of potential adaptation actions (allocation of responsibilities and timeframes).

Table 8 below presents a list of the role/position of Council's internal stakeholders that participated in the climate change adaptation workshop.

Table 8 - List of the climate change adaptation workshop attendees' roles

Role
Coordinator - Asset Management
Manager - People & Procurement Services
Officer - Community Advocacy
Manager - Planning & Design
Coordinator - Sport & Leisure
Officer - Corporate Planning
Team Leader - Transport
Environmental Planner - Sustainability Planning
Team Leader - Sustainability Planning
Officer - Place Making
Coordinator - Strategic, Design & Sust.Planning
Coordinator - Public Health
Service Unit Leader - Works, Fleet & Cleansing
Consultant - Risk Management
Service Unit Leader - Parks & Waste

The workshop commenced with a progress update on the work that was undertaken to date on the Climate Change Risk and Adaptation Analysis component of this project. This included the presentation of the finalised risk ratings that were standardised following the Climate Change Risk Assessment workshop where Figure 14 and Figure 15 were discussed with the workshop attendees.

Existing controls were considered to be measures currently put in place by the Council to reduce the risk of a particular climate variable occurring (such as a bushfire) or reduce the impact of the associated risk (e.g. raising future flood levels to avoid flooding of residential properties). For the purposes of this workshop, additional adaptation actions are measures that are not currently being implemented but if in addition to the current controls (in place) could help to manage climate-related risks in the future.

A comprehensive literature review was undertaken prior to the adaptation workshop to identify existing controls that were in place at CoGD that may further reduce the identified risks based on its existing strategies, plans and procedures. This literature review was also informed by the best practice adaptation options that were undertaken by other local councils. Additional information on best practice climate change adaptation can be found in Appendix B. These were then verified internally by CoGD officers, who revised the list as required. The risks, associated existing controls and future adaptation actions were then provided to the workshop participants on the day of the workshop and were asked to verify these actions as part of the workshop activity.

The adaptation actions discussed at the workshop were identified collaboratively between EY and the CoGD. Using the Australian Government's adaptation principles, the 'extreme' and 'high' priority rated risks and the associated existing controls and adaptation actions were the focus of the workshop. Given that internal stakeholders only were invited to the workshop, only corporate risks (rather than community risks) were considered in the workshop. The main objective of the workshop was to discuss the existing controls in place at the CoGD and to identify any gaps in exiting controls from the stakeholders in attendance at the workshop based on their areas of operations.

Based on the existing controls discussed at the workshop, a number of specific policies, plans and strategies were identified as playing a critical role in addressing multiple risks that were identified. These included the Asset Management Plan and Strategy (for infrastructure related risks), the Emergency Management Plan (for extreme storms, bushfires and extreme hot days), the Flood Management Plan 2018, the Municipal Fire Management Plan 2015 and the Urban Street Tree Strategy 2018 among others.

Risks were categorised into themes due to timing issues in the workshop and were initially categorised based on similarities in the impacts across different climate variables (Table 9). After the initial groupings, additional categorisations (infrastructure, biodiversity, community etc) were included based on the type of impact to align with key stakeholder groups within CoGD to ensure efficient delivery of the adaptation workshop.

Table 9 - Risks and themes discussed at the Climate Change Adaptation workshop

Theme	Risk description	Climate variable
Events and activities	► An amendment, postponement or cancellation of Council-run public activities & events as a result of projected climate changes.	► Hot days ► Bushfires ► Extreme storms
Infrastructure	► Increase in demand and use of electricity and water for cooling Council-owned properties and facilities.	► Temperature (mean)
	► Reduced use and visitation by residents and tourists of Council managed green infrastructure (e.g. parks, open spaces, etc.).	► Temperature (mean) ► Bushfires
	► Increased degradation and weathering of buildings and infrastructure owned and or operated by the Council	► Temperature (mean)
	► Increased heat and water stress in plants/vegetation that require increased irrigation requirements and re-establishment or replanting in Council operated facilities.	► Precipitation
	► Increased water supply requirements, charges and costs for potable and irrigation water to the Council to service built infrastructure and public facilities.	► Precipitation
	► Loss of utilities and transport infrastructure leading to disruptions to the Council managed operations and services.	► Hot days ► Precipitation ► Extreme storms
	► Damage to and loss of Council-owned buildings, properties and infrastructure.	► Bushfires ► Extreme storms
Others	► Restrictions on the ability of Council employees and/or contractor employees to undertake work activities under extreme conditions (i.e. Hot days above 35^{o}C)	► Bushfires
Community	► Increased public health and welling risks due changes in the climate	► Hot days ► Precipitation ► Bushfires ► Extreme storms
	► Increase in demand and use of electricity and water for cooling residential and commercial properties.	► Temperature (mean) ► Hot days

Theme	Risk description	Climate variable
Biodiversity	► Changes to the distribution and occurrence of fauna and flora, due to shifting climate envelopes and changes to phenology of flora and fauna, resulting in damage to and loss of biodiversity and natural habitat.	► Temperature (mean) ► Bushfire ► Extreme storm
	► Changing conditions that allow new pests and diseases to be introduced and proliferate in the environment and impacting land and aquatic flora and fauna on Council owned public spaces.	► Temperature (mean)
Council specific	► The CoGD's ability to deliver services through its statutory and asset planning functions.	► All climate variables
	► The CoGD's ability to deliver key emergency management services to the community.	► All climate variables
	► Reputational damage to the Council as a result of a failure to respond to climate change issues	► All climate variables
	► The CoGD's ability to deliver key services to the community.	► All climate variables

The controls for each risk were discussed and assessed for its 'effectiveness' on managing the risk. The evaluation of controls is important, as any controls assessed to not be adequate or effective in managing the risk needs to be strengthened with additional actions in order for the organisation to be adequately prepared to manage the risks. Table 10 below indicates the control effectiveness rating scale from the CoGD's risk management procedure[84] which was used in the workshop to assess the effectiveness of existing internal controls.

Table 10 - CoGD's Control effectiveness rating scales – as outlined in the Risk Management Procedures (updated 2017 version)

Control effectiveness rating		
Effective:	Nothing more to do done except review and monitor existing controls. Controls are well designed for the risk, address the root causes and Management believes that they are effective and reliable at all times.	100%
Adequate:	Most controls are designed correctly and are in place and effective. Additional work is required to improve the operating effectiveness or Management has doubts about operational effectiveness and reliability	75%
Improvement Required:	While the design of the controls may be largely correct in that they treat most of the root causes of the risk, they are not currently operational or reliable. And/or Some of the controls have design flaws in that they do not treat the root cause of the risk and therefore they are ineffective in and unreliable	50%
Weak:	Virtually no credible controls. Management has no confidence that any degree of control is being achieved due to poor control design and/or very limited operational effectiveness	25%

Overall, Council stakeholders were engaged and offered valuable insights during the adaptation workshop. Key achievements included:

- **Large number of controls discussed** – despite timing restrictions, all the existing controls across all of the corporate risks were discussed during the workshop including the allocation of the associated control effectiveness.

- **Stakeholder engagement** – all participants at the workshop contributed to the discussion and were engaged in the process. The majority of attendees who attended the Climate Change Risk Assessment workshop were also able to attend the adaptation workshop, which allowed for consistency in the risk ratings (and biases) and discussions across both workshops. Additionally, a number of new internal stakeholders who did not previously attend the Climate Change Risk Assessment workshop joined the adaptation workshop, which provided additional insights into different areas of CoGD's business operations.

[84] City of Greater Dandenong, *Risk Management Procedures 2017*

There were also a number of challenges associated with the adaptation workshop, being:

- **Timing** – as already outlined, timing for the adaptation workshop was shorter than the Climate Change Risk Assessment workshop (which was already on a tight timeframe). This resulted in only the existing controls being discussed, with limited time left to discuss future adaptation actions. Ideally, both existing controls and future adaptation actions would have been discussed at the workshop to not only ensure that all relevant measures are being captured, but future actions/plans/strategies and levels of ambition are also being captured for future adaptation actions.

- **Stakeholder availability** - a number of key internal stakeholders from the Climate Change Risk Assessment workshop were not able to attend the adaptation workshop, which resulted in some areas (such as events and activities, biodiversity and community) being underrepresented in the workshop. While participants did attempt to discuss and engage with risks on those that were not in their area of expertise, the session would have benefitted from having the relevant stakeholders in the room to provide insights into all of the existing controls (and future adaptation actions) which are currently in place within the Council. This aligns with the 'relevant expertise' limitation observed in the Climate Change Risk Assessment workshop, outlined in Section 5.5 of this report. It is noted however that the outcomes of the adaptation workshop and the selected existing controls are currently being validated by internal CoGD stakeholders who were unable to attend the workshop.

6.3 Climate change adaptation framework

A climate change adaptation framework assists decision makers within local government to understand and incorporate climate change risks and associated impacts into policies, plan, strategies and operational decisions across all key areas within which it functions. This also assists decision makers to identify, assess and evaluate climate change risks to its business operations and the wider community in which it serves and treat these risks through the implementation of associated adaptation actions to control, thus further reduce these risks. It is important that this framework is developed and implemented in conjunction with key stakeholders within local government and the community to develop practical strategies to manage the risks posed by climate change.

The C40 Cities initiative is a network of 90+ cities globally who have committed to addressing climate change. The mayors of the cities, representing over 700 million people and over one quarter of the global economy, have committed to a 1.5 degree future aligned with the Paris Agreement[85]. C40 has developed a Climate Action Planning Framework for cities to use to deliver on the Paris Agreement, for which the City of Melbourne joined seven other global cities to help develop the framework and pilot the climate action plans. Within the framework, resilience to climate hazards is one of the key components of the Action Plan, where cities must demonstrate an ability to adapt and improve resilience against climate risks[86].

The C40 Climate Action Planning Framework is the basis for conducting EY's Gap Analysis and Evaluation Report (see Figure 1), comparing CoGD's current policies and procedures against the requirements outlined in the C40 Framework. The Gap Analysis work identified that CoGD does not currently have a specific Climate Change Strategy/Risk Register which resulted in the CoGD not meeting most of the 'essential' criteria in the framework. Nevertheless, it is noted that the Climate Change Strategy and Action Plan to be developed by EY will result in a strategy and approach for Council that is expected to meet most of the remaining criteria in the C40 Framework. The risk management process outlined in Section 5.1 forms the basis of a framework to be used by CoGD to adapt to climate change; which is in alignment with the Council's existing internal risk management framework. A climate change risk register was developed as part of this process to document the outcomes from each key stage of the risk assessment process (Figure 11).

It was noted that CoGD's current risk register only has three climate-related risks and therefore does not adequately consider risks related to climate change or have sufficient linkages drawn to climate change. As part of this work, a climate change risk register was developed to address this gap, where consideration of existing controls and adaptation actions were incorporated.

[85] C40, *Climate Action Planning Framework*
[86] C40, *Climate Action Planning Framework*

Following the selection of adaptation options, a prioritisation process must be applied to determine which actions need to be addressed immediately as opposed to which actions can be re-visited later. Within the prioritisation process, many factors, including the technical feasibility and resource requirements of the proposed adaptation action need to be taken into account. One of the key reasons for this is the cost-effectiveness, as well as the level of care that needs to be taken to avoid maladaptation that cause negative impacts on the local community, economy and environment.

A considered approach will be used to prioritise actions to assist with the successful implementation of determined adaptation actions for the CoGD. EY notes that CoGD already have strategies and policies in place that have multiple action items within them, and will not be looking to replicate any actions. However, although actions may already exist within existing council strategies and plans, they may not be the most appropriate items to address the associated risk, and may not yet be implemented by CoGD.

EY will utilise an internally developed Prioritisation Tool which is used to aid organisations in prioritising climate change adaptation actions following the undertaking of a comprehensive climate change risk assessment. This tool takes into account the relative importance of each climate variable through an adjustable weighting scheme for CoGD's stakeholders and the inputs outlined in Table 11 to give a prioritised list of climate actions. These actions will then inform the themes and objectives of the Climate Change Strategy and Action Planthat will not only address adaptation components, but other mitigation and social co-benefits achieved through synergies across objectives.

Table 11 - Considerations for prioritisation of adaptation actions

Key task	Description
Screening of adaptation actions	To identify which adaptation actions should be prioritised, all actions need to go through two main phases, as follows: ► A feasibility screening which assesses the action's robustness, flexibility, and financial and practical viability. ► A climate risk reduction assessment which assesses the level of climate risk reduction for CoGD's chosen climate variables.
Accounting for uncertainty	Where the feasibility or level of climate risk reduction is not certain, this can be factored into the prioritisation process which determines a 'worst case' and 'best case' scenarios based on the level of uncertainty to rank these actions depending on CoGD's risk appetite.
Assign key responsibilities	Determination of key accountabilities through the allocation of key action owners for each identified adaptation action will assist with the implementation of these actions. This can be extended to Council as well as external organisations depending on the nature of each action. These action owners are then responsible for implementing the respective actions, monitoring progress and reporting outcomes.
Allocation of timeframes	All identified adaptation actions need to be allocated timeframes for actioning based on the risk priorities allocated for each risk. Time scales can range from short to long term based on the appetite of the Council. Time scales can be categorised into short, medium and long term in alignment with the existing risk ratings. For example, all risk priorities rated as 'extreme' need to be addressed immediately and depending on the proposed actions, on a shorter timeframe.
Accounting for interaction	Certain climate change actions will often have other actions which it is dependent on, has synergetic complimentary benefits with, or is mutual exclusive with. The user can identify these projects in this section of the tool so they are listed in the final prioritised list to help inform the decision making process.

In Council's role as a governing body it is important that the CoGD continues to work collaboratively with all stakeholders, including all spheres of government, the private sector and civil society, to facilitate climate-resilient development and promote sustainable development. Adaptation at the local government scale is unlikely to be effective if it is undertaken in isolation and not in alignment with regional, state or national actions, since climate change impacts will be experienced at broader geographic scales. An important component of this approach is to harness and co-ordinate the efforts of existing stakeholders within the wider Melbourne region, to enable a collaborative approach to build climate resilience in the wider community.

In addition, as nearly half of the risks identified during the risk assessment stage were in relation to the CoGD's wider community, it is important that the Council build capacity within its community to effectively respond to the challenges posed by climate change through awareness raising and education. These efforts will focus on improving the understanding of the impacts of climate change on the region; through science-based education and communication programs catered to its unique culturally and linguistically diverse community and will involve collaboration between scientific partner institutions, representatives of all spheres of government, the private sector, media and civil society groups.

Finally, it is essential that a process is in place for the ongoing review and monitoring across the development, application and implementation of the adaptation framework. If this step in the process is given insufficient attention, the framework will become ineffective and irrelevant over time. The Prioritisation Tool that was referred to previously will provide CoGD a mechanism to review and monitor the progress made on prioritised adaptation actions. Continuous monitoring and review over the following focus areas will ensure the relevancy of the climate change adaptation framework:

- Updating the climate change scenarios that underpin the identification of risks as new information is made available (e.g. new reports and data released by IPCC, CSIRO and BOM and updated Australian Rainfall & Runoff Standards).
- Identifying any new risks as new climate science information is made available and as changes are made to the delivery of Council services.
- Checking that controls are effective over time and accounting for any changes.
- Reviewing progress against actions made throughout the process (implementing treatment actions).

7. Next steps

7. Next steps

As part of the development of CoGD's Climate Change Strategy and Action Plan, a thorough Climate Change Risk and Adaptation Analysis was conducted by EY. Throughout the course of this stage of work, there was significant internal stakeholder engagement with multiple departments at the Council to enable the selection of relevant economic, environmental and social risks that posed a risk to the CoGD under projected climate change scenarios. Internal stakeholder engagement with the CoGD identified that there is a base level of understanding of climate change and the risk it poses to the Council's services and to the wider community it serves.

Across the Council, there was a willingness to engage on the subject matter and provide specific expertise and insights as required. However, there is currently a lack of a climate change risk register or associated adaptation approach that ties the different internal stakeholders in Council together to take a collaborative and comprehensive approach to climate change risk management. The results of this Climate Change Risk and Adaptation Analysis will assist EY in the drafting of the Climate Change Strategy and Action Plan in the later stages of this project which will help to bridge this current gap within Council operations. Based on the work completed to date, there were a number of key findings in relation to climate change risk management and adaptation as follows:

- The most significant risks to the CoGD were assessed to be extreme storms and extreme hot days and heatwaves, associated with potential health implications associated with these events and the potential for significant property damage and interruption of utilities and transport routes which could impact not just Council operations, but also the wider community. This places higher reliance on the Council's ability to effectively respond to and recover from extreme events.

- Given the CoGD's large population of vulnerable people, including a large culturally and linguistically diverse community as Australia's most diverse municipality[87], Council has an important role to play in managing risks posed by climate change on behalf of these community members and assisting them to increase their resilience against projected climate change impacts. As the CoGD is also an industrial hub, the Council will need to manage the needs of residents and industry within its constrained resources.

- While the CoGD has a number of different policies, plans and strategies that in part can help to address climate risks, these tend to operate within siloed teams and in aggregate still do not provide an adequate level of control over most identified climate risks.

As the Council progresses towards the development of its Climate Change Strategy and Action Plan, next steps for the CoGD to consider include:

- The climate change register developed as part of this report need to be integrated into CoGD's enterprise risk register to incorporate climate risks into the Council's risk profile. The climate change risk register was developed in alignment with CoGD's internal risk framework to assist with this integration process which will allow for this process.

- An approach to the implementation of adaptation actions should be developed, with guidance on prioritisation of identified adaptation actions (and any new actions identified after this process) in order to ensure a considered, systematic approach is followed to implement the proposed actions.

- Regular monitoring and review of the risk register should be conducted, including the updating of the climate change scenarios that underpin the identification of risks as new information is made available (e.g. new reports and data released by the IPCC, CSIRO, BOM etc.). This review should include a consideration of new risks that may emerge as the new climate science information is made available.

[87] City of Greater Dandenong, *Greater Dandenong Officially Nations Most Culturally Diverse Community*

Appendices

Appendix A Raw results from the Climate Change Risk workshop

Raw results obtained via the Resolver Ballot system from the risk assessment workshop.

Community/ Corporate	No.	Risks	Consequence	Likelihood	Total Risk
Corporate	CC.1.1.1	Increase in mean annual and seasonal (summer and winter) temperatures leading to an increase in demand and use of electricity and water for cooling Council-owned properties and facilities.	3.5	4.2	14.7
	CC.1.2.2	Increase in mean annual and seasonal (summer and winter) temperatures leading to changing conditions that allow new pests and diseases to be introduced and proliferate in the environment and impacting land and aquatic flora and fauna on Council owned public spaces.	3.2	3.3	10.56
	CC.1.3.1	Increase in mean annual and seasonal (summer and winter) temperatures, leading to a loss of aquatic and terrestrial biodiversity resulting in reduced appeal, public amenity and usability of Council managed green infrastructure (e.g.: parks, open spaces, etc).	3.4	3.6	12.24
	CC.1.4.1	Increase in mean annual and seasonal (summer and winter) temperatures, leading to increased degradation and weathering of buildings and infrastructure owned and or operated by the Council, resulting in increased maintenance and repair costs to the Council.	3.7	3.5	12.95
	CC.2.2.2	Increased frequency of extreme hot days (above 35ºC) and increased frequency, intensity and duration of heatwaves, can result in an amendment, postponement or cancellation of Council-run public activities & events.	3.3	3.3	10.89
	CC.2.3.1	Increased frequency of extreme hot days (above 35ºC) and increased frequency, intensity and duration of heatwaves, and in turn causing damage to, and loss of utilities and transport infrastructure leading to disruptions to the Council managed operations and services.	4	3.8	15.2
	CC.2.4.1	Increased frequency of extreme hot days (above 35ºC) and increased frequency, intensity and duration of heatwaves, leading to an increase in demand and use of electricity and water for cooling Council-owned properties and facilities.	3.7	3.8	14.06
	CC.2.5.1	Increased frequency of extreme hot days (above 35ºC) and increased frequency, intensity and duration of heatwaves, that restricts the ability of Council employees and/or contractor employees to undertake work activities.	3.6	3.8	13.68
	CC.2.6.1	Increased frequency of extreme hot days (above 35ºC) and increased frequency, intensity and duration of heatwaves, causing changes to the distribution and occurrence of fauna and flora, due to shifting climate envelopes and changes to phenology of flora and fauna, and in turn terrestrial biodiversity loss.	3.5	3.8	13.3
	CC.2.7.1	Increased frequency of extreme hot days (above 35ºC) and increased frequency, intensity and duration of heatwaves, leading to reduced use and visitation by residents and tourists of Council managed green infrastructure (e.g. parks, open spaces, etc).	3.1	3.7	11.47
	CC.3.1.1	Reduction in mean annual rainfall leading to drier conditions resulting in increased heat and water stress in plants/vegetation that require increased irrigation requirements and re-establishment or replantings in Council operated facilities.	3.3	3.5	11.55
	CC.3.2.1	Reduction in mean annual rainfall leading to drier conditions resulting in water supply constraints/ water shortages, that in turn increase water supply requirements, charges and costs for potable and irrigation water to the Council to service built infrastructure and public facilities.	3.7	3.9	14.43
	CC.4.2.1	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in damage to and loss of Council-owned buildings, properties and infrastructure.	3.5	3.1	10.85
	CC.4.4.1	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in damages to open spaces in turn reduces the appeal and public amenity such spaces and impacts the use and visitation of the spaces from residents and tourists.	2.8	2.8	7.84
	CC.4.5.1	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in the cancellation of Council-run public activities & events.	2.6	2.6	6.76
	CC.4.6.1	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in damage to and loss of biodiversity and natural habitat.	2.9	2.7	7.83
	CC.5.2.1	Increased frequency and/or intensity of extreme rainfall events resulting in damage to and loss of Council-owned buildings, properties and infrastructure.	4.2	3.8	15.96
	CC.5.3.2	Increased frequency and/or intensity of extreme rainfall events causing damage to, and loss of, utilities and transport infrastructure	4.1	3.6	14.76
	CC.5.4.1	Increased frequency and/or intensity of extreme rainfall events, leading to stormwater runoff exceeding stormwater drainage/ retention capacity and in turn damage to and loss of Council owned and or operated utilities and transport infrastructure as well as residential and commercial properties within CoGD.	4.4	3.6	15.84
	CC.5.5.1	Increased frequency and/or intensity of extreme rainfall events causing damage to and loss of biodiversity and natural habitat, including in the marine environment	3.1	3.2	9.92
	CC.5.6.1	Increased frequency and/or intensity of extreme rainfall events, can result in the postponement or cancellation of Council-run public activities & events.	3.2	3.1	9.92
	CC.6.1.1	The CoGD's ability to deliver services through its statutory and asset planning functions	4.1	3.8	15.58
	CC.6.2.1	The CoGD's ability to deliver key emergency management services to the community	4.3	3.6	15.48
	CC.6.3.1	Reputational damage to the Council as a result of a failure to respond to climate change issues	3.8	3.4	12.92
	CC.6.4.1	The CoGD's ability to deliver key services to the community	4	3.4	13.6

Community/ Corporate	No.	Risks	Consequence	Likelihood	Total Risk
Community	CC.1.1.2	Increase in mean annual and seasonal (summer and winter) temperatures leading to an increase in demand and use of electricity and water for cooling residential and commercial properties.	4	4.2	16.8
	CC.1.2.1	Increase in mean annual and seasonal (summer and winter) temperatures leading to changing conditions that allow new pests and diseases to be introduced and proliferate in the environment and impact land and aquatic flora and fauna.	3.1	3.4	10.54
	CC.1.4.2	Increase in mean annual and seasonal (summer and winter) temperatures, leading to increased degradation and weathering of commercial and residential properties in the CoGD, resulting in increased maintenance and repair costs to commercial and residential building owners.	3.3	3.6	11.88
	CC.2.1.1	Increased frequency of extreme hot days (above 35^{o}C) and increased frequency, intensity and duration of heatwaves, leading to extreme hot weather conditions, impacting public health and wellbeing through heat related stress and illness.	4.2	4.3	18.06
	CC.2.2.1	Increased frequency of extreme hot days (above 35^{o}C) and increased frequency, intensity and duration of heatwaves, can result in the postponement or cancellation of community events.	3.3	3.6	11.88
	CC.2.3.2	Increased frequency of extreme hot days (above 35^{o}C) and increased frequency, intensity and duration of heatwaves, and in turn causing damage to, and loss of utilities and transport infrastructure leading to commuter delays and community disruptions.	3.4	3.6	12.24
	CC.2.4.2	Increased frequency of extreme hot days (above 35^{o}C) and increased frequency, intensity and duration of heatwaves, leading to an increase in demand and use of electricity and water for cooling residential and commercial properties.	4.1	3.8	15.58
	CC.2.7.2	Increased frequency of extreme hot days (above 35oC) and increased frequency, intensity and duration of heatwaves, leading to reduced use and visitation by residents and tourists of Council managed green infrastructure (e.g. parks, open spaces, etc).	3.1	3.7	11.47
	CC.3.1.2	Reduction in mean annual rainfall leading to drier conditions resulting in increased heat and water stress in plants/vegetation that reduces stream flows and requires increased irrigation requirements and re-establishment or replantings in residential and commercial properties.	3.1	3.4	10.54
	CC.3.2.2	Reduction in mean annual rainfall leading to drier conditions resulting in water supply constraints/ water shortages, that in turn increase water supply requirements, charges and costs for potable and irrigation water to commercial and residential tenants.	3.7	3.6	13.32
	CC.3.3.1	Reduction in mean annual rainfall leading to drier conditions resulting in water supply constraints/ water shortages, that in turn creates public health and safety risks in relation to recreation activities.	3.3	3.7	12.21
	CC.4.1.1	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in a reduction of public health and wellness, or causing loss of life.	3.5	3.5	12.25
	CC.4.2.2	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in damage to and loss of residential and commercial properties, including community housing.	3.5	3.1	10.85
	CC.4.3.1	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in damage to, and loss of, utilities and transport infrastructure	3.5	2.8	9.8
	CC.4.5.2	Harsher fireweather conditions leading to an increase in the frequency and/or intensity of bushfires, resulting in the cancellation of community activities & events.	2.5	2.6	6.5
	CC.5.1.1	Increased frequency and/or intensity of extreme rainfall events, in turn reducing public health and wellness, or causing loss of life.	4	3.7	14.8
	CC.5.2.2	Increased frequency and/or intensity of extreme rainfall events resulting in damage to and loss to residential and commercial properties, including community housing.	3.7	3.8	14.06
	CC.5.3.1	Increased frequency and/or intensity of extreme rainfall events causing damage to, and loss of, utilities and transport infrastructure	4.2	4	16.8
	CC.5.6.2	Increased frequency and/or intensity of extreme rainfall events, can result in the postponement or cancellation of community activities & events.	3	3.3	9.9

Appendix B Best practice climate change adaptation strategies and implementation

Best practice adaptation approaches

City of Darebin Climate Emergency Plan

The City of Darebin released a Climate Emergency Plan in 2017 that outlines the Council's commitment to take action against climate change, with adaptation and resilience as one of the nine key pillars of the Plan. As part of this work, Darebin conducted a climate change risk assessment in 2009 to identify key risk areas and prioritise adaptation actions to increase resilience for the municipality. These actions are detailed in the Climate Emergency Plan, alongside actions for engagement with external stakeholders (Darebin community, State Government and Federal Government) to help meet the Council's adaptation and resilience objectives.

City of Sydney

The 2017 City of Sydney Climate Adaptation Strategy includes climate actions to address climate change risks and impacts, such as developing a Heatwave response Plan, flood management plans and a Sea Level Adaptation Action plan. Actions outlined in the strategy are based on the worst case emissions scenario projection, and utilises City-specific modelling for projections as the basis of the adaptation actions. The City of Sydney used a Citizens Panel to engage with residents on climate change risks and priorities for action.

City of London

As part of the City of London's environment strategy, submitted through its partnership with C40, climate change adaptation is highlighted as a key component of the strategy. The City of London takes an integrated approach to adaptation, considering the interconnectedness of risks and responses. Detailed modelling, has been undertaken across all risks, including on projections of intensity/frequency of the risk (such as expected average monthly temperatures in London over the 21st century), but also on impacts, such as the number of properties at risk of surface water flooding in London in a one in 30 year or one in 100 year flood event.

Best practice implementation of adaptation actions

City of Melbourne Adaptation Strategy

Within the City of Melbourne Adaptation Strategy Refresh (2017), key achievements in climate change adaptation are reported on against the Adaptation Strategy (2009). Against the strategy's climate risk of insufficient water supply, the City of Melbourne has installed a stormwater harvesting system in Fitzroy Gardens, providing 70 million litres of water annually to water the heritage garden. The City of Melbourne has also installed increased permeable surfaces and greenery into the new La Trobe Street Green bicycle lane, which will help increase bike transportation (providing alternate transportation routes during disruption during extreme heat related events, and also help reduce run-off from these areas (reducing risk of stormwater systems overflowing leading to flooding) during extreme storms.

Cloudburst Master Plan, Copenhagen

After a major rainfall event resulting in damage to critical infrastructure in 2011, the city of Copenhagen developed the Cloudburst Master Plan, a subsidiary climate change adaptation plan under the Copenhagen Climate Adaptation Plan, focused on extreme rainfall. The actions in this plan saw 300 dual function projects implemented in Copenhagen that used blue and green infrastructure, and recreational, mobility and biodiversity areas for flood mitigation and water detention. The actions reduces risk of flooding for residents, seeing insurance premiums decreasing for some residents, and in some cases, insurance is now available for previously uninsurable properties.

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