

# City of Cockburn **Climate Change Risk Assessment**



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### **Acknowledgement of Country**

The Mayor, Councillors and staff of the City of Cockburn acknowledge the Whadjuk Nyungar people of Beeliar boodja as the traditional custodians of this land. We pay our respect to the Elders, past, present and emerging.

## Introduction

In 2020 the City of Cockburn engaged Ernst and Young<sup>1</sup> to undertake a risk assessment and update the climate change risk register.

This report presents information on the impacts of climate change and outcomes of the risk assessment which have been used to develop the City of Cockburn Climate Change Strategy 2020 -2030.

## Summary of the latest climate science

### Climate change science

Anthropogenic climate change is happening now, and its occurrence is supported by extensive scientific research undertaken collectively around the world. Through numerous longitudinal studies, scientific communities have reached a consensus that our climate has changed, with this change attributed to the additional greenhouse gases in the atmosphere resulting from human activities such as the burning of fossil fuels, land clearing and agriculture.

The primary forum for the consolidation of current climate science are the Assessment Reports of the Intergovernmental Panel on Climate Change (IPCC), with the fifth and most recent Assessment Report published in 2014, and the sixth report due for release in 2022. The fifth assessment report highlighted that:

*'we have the means to limit climate change and its risks, with many solutions that allow for continued economic and human development. However, stabilizing temperature increase to below 2°C relative to pre-industrial levels will require an urgent and fundamental departure from business as usual'.*

The IPCC has concluded that temperature increases by the end of the 21st century are likely to exceed 1.5°C relative to 1850–1900 levels for most future scenarios, with the reality being that based on the world's current emission trajectory these increases are likely to exceed 2°C, bringing with it significant and foreseeable physical and socio-economic risks.

In 2019, atmospheric carbon dioxide was recorded as 415ppm<sup>2</sup>, representing an increase from the previous year and moving closer to the 450ppm, which is the expected threshold that will risk triggering extreme weather events and temperature rises of 2°C, and at which point climate change is considered to be detrimental to our future.

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<sup>1</sup> M.Carlton, L.Hughes, A.Carrel, Ernst and Young, 2020

<sup>2</sup> National Oceanic and Atmospheric Administration - The average for May peaked at 414.7 parts per million (ppm) at NOAA's Mauna Loa Atmospheric Baseline Observatory.



## Impacts of climate change

Observed changes over the 20th century include increases in global average air and ocean temperatures, rising global sea levels, long-term sustained widespread reduction of snow and ice cover, and changes in atmospheric and ocean circulation and regional weather patterns, which influence seasonal rainfall conditions.

The impacts of climate change threaten both human and natural systems, in the form of more frequent and severe heat waves, coastal inundation due to sea level rise, disruptions to rainfall patterns and other effects.

CSIRO's *State of the Climate 2018* report details the effects of climate change in Australia, where our climate has already warmed by just over 1°C since 1910, which has led to an increase in the frequency of extreme heat events. Australia is the driest inhabited continent on earth, and even in the absence of climate change is characterised by variability and extremes. The report details how, around the country, sea levels are rising, increasing the risk of inundation of coastal infrastructure. There have been observed declines in rainfall amounts in the southwest and southeast, whereas the north of Australia has experienced increased rainfall in some areas since the 1970s. Critically for a country already prone to the devastating impacts of bushfire, it is important to note that these changes in climate will also result in increased extreme fire weather and longer bushfire seasons.

The City of Cockburn is expected to experience higher temperatures, less rainfall, more extreme weather events and conditions conducive to bushfires, and the impacts of sea level rise. The impact of these changes may pose potentially critical risks to the safety and wellbeing of the community, the sustainability of infrastructure, the liveability of the area, and the delivery of the City's responsibilities and services.

## Predicting climate change

The scientific community produce climate models, using advanced computer simulations, to predict changes to our climate into the future, for a range of different scenarios that may unfold.

These scenarios represent a possible view of a point in the future and a potential pathway to reaching that point, by making assumptions relating to an array of socio-economic and climate change response factors that may occur. These scenarios are used by policy and decision makers to plan for the future.

*CoastAdapt* provides information to help every coastal council in Australia prepare for the impacts of climate change. *CoastAdapt* utilises CSIRO datasets plus scenarios from the IPCC fifth assessment report, to model climate change and impacts.

In its most recent assessment report, the IPCC proposed a set of four possible future emissions pathways which Ernst and Young have used to develop The City's scenarios:

- Very low emissions scenario - based on the IPCC's RCP2.6, and assuming significant collaborative efforts will be made to drive decarbonisation and curb emissions which will result in a temperature increase of 1.0°C, a lower rise in sea levels and a lower increase in extreme weather events
- Low emissions scenario - based on the IPCC's RCP4.5, and assuming collaborative efforts will be made to drive decarbonisation and curb emissions

resulting in a 1.8°C rise in global average temperatures, a moderate rise in sea levels and a moderate increase in extreme weather events

- High emissions scenario - based on the IPCC's RCP6.0, and assuming minimal efforts are made to curb emissions resulting in a 2.2°C rise in global average temperatures, a moderate rise in sea levels and a moderate increase in extreme weather events
- Very high emissions scenario - based on the IPCC's RCP8.5, and assuming very low levels of effort will be made to curb emissions resulting in a 3.7°C rise in global average temperatures, a high rise in sea levels and a large increase in extreme weather events

RCP stands for Representation Concentration Pathway, with the values (e.g. RCP '2.6') relate to the radiation force caused by greenhouse gases or, put simply, are a measure of how much the earth's climate will change.

The higher radiating force results from higher greenhouse gas concentration levels in the earth's atmosphere and causes a more extreme change in our climate, hence the RCP2.6 scenario estimates a 1.0°C increase in average temperature, the RCP4.5 results in a 1.8°C increase in average temperature, and the RCP8.5 scenario results in a 3.7°C increase in average temperature (by 2081-2100, relative to 1986-2005).

The current level of global emissions puts us on a trajectory that tracks closely to RCP8.5, which would see the largest increase in temperatures, sea level rise, and extreme weather events, with a significant level of adaptation required to accommodate these future climatic conditions.

## ***Impact of climate change - scenarios for Cockburn***

The risk assessment focused on the future change of three key climatic factors for the City; these are temperature, rainfall and sea-level rise. In addition Ernst and Young also considered the impact of the increased frequency of extreme weather events, which may occur as a result of climatic changes.

Within the City of Cockburn the impacts of climate change are likely to have significant impacts on the future of the natural and built environments, the community and the liveability of our City.

To get an understanding of the potential variability of these climatic factors on the future of Cockburn, Ernst and Young used both a ***low greenhouse gas scenario (RCP4.5)*** and a ***very high greenhouse gas scenario (RCP8.5)***.

## Temperature

The number of hot days and the number of heat waves experienced in the City of Cockburn is projected to increase under both low and very high scenarios.

By 2090, under the very high greenhouse gas scenario it is predicted that there will be 52 more days with maximum temperatures greater than 30°C and heat waves of around 18 days in length, which will have major consequences for the City, its community and its environment.

An increase in the number of hot days and heat waves within the City may result in:

- Public health impacts
- Reduced public safety and or wellbeing
- Damage to, or loss of properties, buildings and other infrastructure
- Biodiversity loss
- Increased electricity and water demand
- Increased heat, pest and water stress on vegetation and urban forest
- Reduced liveability.

| Scenario | Mean annual number of days with maximum temperature greater than 30°C |         |          |
|----------|---|---------|----------|
|          | Historic average (1981-2010)  | 2050    | 2090     |
| RCP4.5   | 50 days   | 67 days | 74 days  |
| RCP8.5   |   | 73 days | 102 days |

Table 1: Hot days in the City of Cockburn (Source: CoastAdapt, 2018)

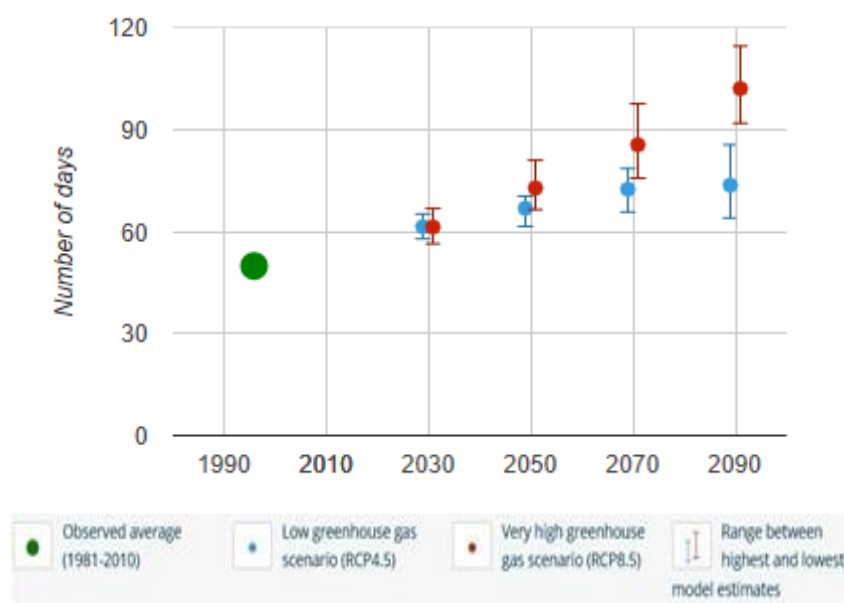


Figure 1: Mean annual number of days with maximum temperature greater than 30°C in the City of Cockburn (Source: CoastAdapt, 2018)

| Scenario | Average of longest run of days in each year with maximum temperature greater than 30°C |           |           |
|----------|--|-----------|-----------|
|          | Historic average (1981-2010)   | 2050      | 2090      |
| RCP4.5   | 8.7 days   | 11.8 days | 12.6 days |
| RCP8.5   |  | 12.8 days | 18.4 days |

Table 2: Heat waves in the City of Cockburn (Source: CoastAdapt, 2018)

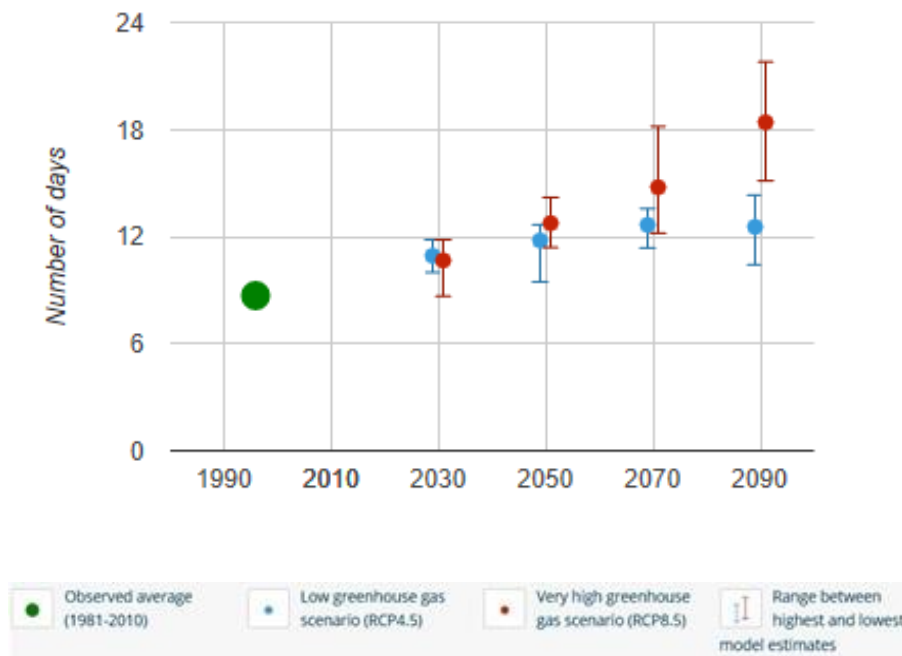


Figure 2: Heatwaves, average of longest run of days in each year with maximum temperature greater than 30°C in the City of Cockburn (Source: CoastAdapt, 2018)

## Sea-level rise

Under all future climate scenarios the City of Cockburn will be subject to significant sea level rise as a result of climate change.

The *City of Cockburn Coastal Adaptation Plan* was developed using information from the Coastal Vulnerability Study<sup>3</sup>. The analysis was carried out using a high level sea rise scenario of 0.9 to 1.5 meters by 2110.

CSIRO forecasts that under a very high scenario by 2050 sea level will rise by approximately 0.24m and by 0.61m by 2090, and under a very low scenario by 2050 sea level will rise by approximately 0.20m and by 0.46m by 2090. These forecasts have been obtained from 2016 modelling conducted by CSIRO on Sea-Level Rise and Allowances for Coastal Councils around Australia. These forecasts differ from those the within the City’s Coastal Adaptation Plan due to the CSIRO data being more recent than the 2010 Department of Transport sea level rise guidance on which the figures in the Coastal Adaptation Plan were based.

Coastal inundation may have major consequences on some areas of the City, particularly near the coastline and lake areas. For a very high scenario by 2050 the regional inundation level is predicted to be 0.91 m above mean sea level. Under the same scenario this level increases to 1.38 m by 2100. Under a low scenario by 2100 the regional inundation level is predicted to be 1.18 m above mean sea level.

Sea-level rise within the City may result in:

- Damage to or loss of natural environment and habitat
- Damage to, loss of or permanent closure of low-lying buildings, infrastructure and land.

| Scenario      | Sea level rise relative to an average calculated between 1986 and 2005 |        |
|---------------|--|--------|
|               | 2050   | 2090   |
| <b>RCP4.5</b> | 0.22 m   | 0.46 m |
| <b>RCP8.5</b> | 0.24 m   | 0.61 m |

Table 3: Sea level rise in the City of Cockburn (Source: CoastAdapt, 2018)

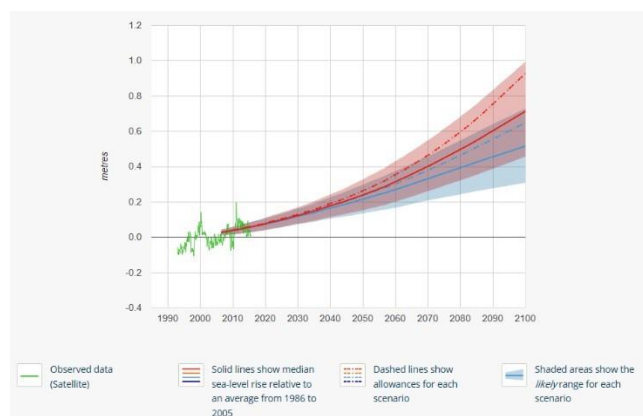


Figure 3: Sea-level rise: in the City of Cockburn (relative to an average calculated between 1986 and 2005) (Source: CoastAdapt, 2018)

Cockburn Sound Coastal Alliance, <sup>3</sup> Coastal Vulnerability Study, Erosion and inundation hazard report, March 2013, [www.cockburn.wa.gov.au](http://www.cockburn.wa.gov.au)



## Rainfall

Under both low and high greenhouse gas scenarios the number of very wet days in the City is predicted to remain at a fairly similar level to the observed historical average (1981-2010).

Conversely, the number of months with dry conditions is expected to increase significantly under both climate scenarios, with the highest range under the very high scenario forecasting that dry conditions may be experienced for an additional 2 to 3 months by 2090.

Reduced rainfall within the City may result in:

- Public health impacts
- Reduced public safety and or wellbeing
- Damage to, or loss of properties, buildings and other infrastructure
- Biodiversity loss
- Increased electricity and water demand
- Increased heat, pest and water stress on vegetation and urban forest.

*Table 4: Dry conditions in the City of Cockburn (Source: CoastAdapt, 2018)*

| Scenario | Mean annual (May to Apr) number of months when total rainfall is less than the historic 10th percentile |            |            |
|----------|---|------------|------------|
|          | Historic average (1981-2010)  | 2050       | 2090       |
| RCP4.5   | 1.2 months  | 1.9 months | 2.1 months |
| RCP8.5   |   | 2.6 months | 3.5 months |

## Extreme weather events

Changes to Australia's climate system are resulting in more frequent and intense extreme weather events such as bushfires, floods, drought, cyclones and storms.

CSIRO predicts that during the coming decades Australia will experience an increase in the number of high fire weather danger days and a longer fire season for southern and eastern Australia, fewer tropical cyclones but a greater proportion of high-intensity storms, and more time spent in drought across many regions of southern Australia.

An increase in the frequency and intensity of extreme weather events within the City may result in:

- Public health impacts
- Reduced public safety and or wellbeing
- Damage to, or loss of properties, buildings and other infrastructure
- Biodiversity loss
- Reduced liveability
- Increased insurance premiums
- Higher number of displaced persons.



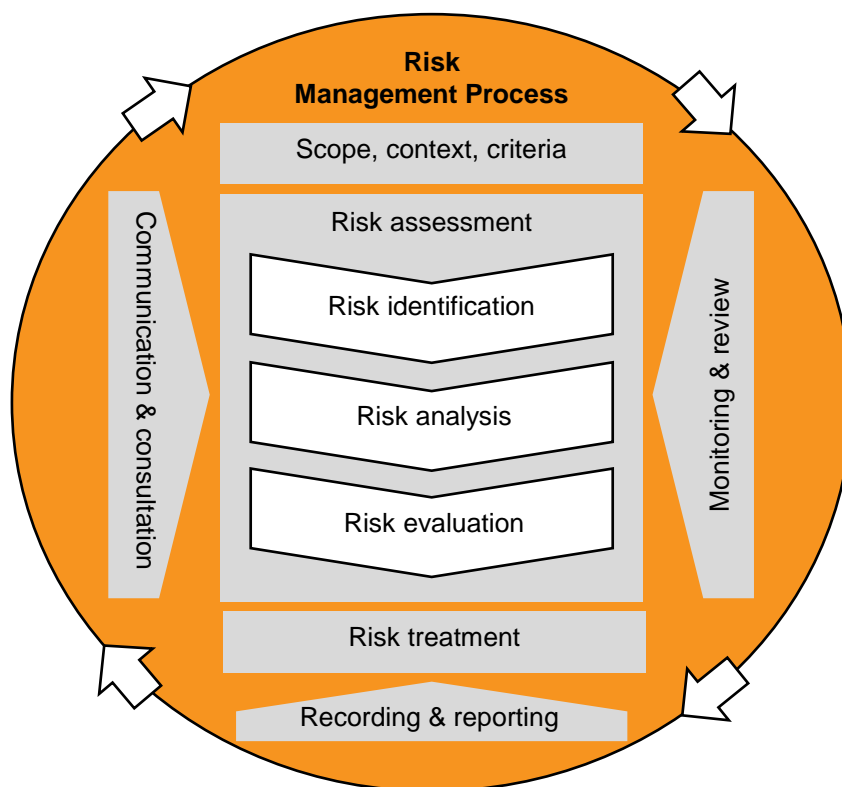
# Risk Assessment Methodology

## City of Cockburn's existing risk framework

The City of Cockburn has a strong vision for tackling climate change through mitigation and adaptation strategies and are focused on reducing our greenhouse gas emissions through investments in renewable energy and energy efficiency projects, establishing partnerships, and supporting new technology and research.

In 2009, the City, in conjunction with the South-Metropolitan Regional Council (SMRC), produced the 2009 Regional Adaptation Plan, which identified regional climate change risks and adaptation actions. Subsequently, in 2010, the City prepared its own Climate Change Adaptation Plan, which identified the specific climate change risks faced by the City of Cockburn and developed a specific set of actions to mitigate these risks. In 2012, following a review of both the Regional Adaptation Plan and the Climate Change Adaptation Plan, the City developed the Adaptation Risk (and action) Register, which was then updated in 2013.

In 2020, as part of the development of the City's Climate Change Strategy, the City have revised the Climate Change Risk and Action Register in consultation with key stakeholders to better reflect the range of climate change related risks the City is affected by, or may be affected by, in the future. The frameworks for this process followed that of AS ISO 31000:2018 Risk management Guidelines.



## Risk assessment methodology

Ernst and Young firstly established the scope, context and criteria by conducting a literature review of the legislative context of the City and the climate change science and trends. The findings from this review enabled them to identify the climate risks that the City is, or may be, affected by. Using the findings from the review, they updated the Climate Change Risk and Action Register to include a wider range of climate related risks, including the economic, environmental and social risks to the City as a result of climate change impacts.

Ernst and Young then conducted a workshop with the Senior Management Team and key internal stakeholders to analyse and evaluate the identified risks and to identify mitigation and adaptation actions. Participants represented various business units including Parks and Environment, Sustainability, Development, Recreation and Community Safety, Infrastructure Services, Risk and Governance, Buildings Services and Engineering.

During the workshop, the participants voted on the consequence and likelihood of 18 risks using the City's ratings frameworks, which are consistent with AS ISO 31000:2018 Risk management Guidelines:

- Consequence - The level of consequence was assessed based on ***the risk occurring***, and therefore what level of consequence would be expected. (The consequence definitions can be found in Appendix 1).
- Likelihood - The level of likelihood is assessed on ***the level of likelihood of suffering the consequence given the controls in place for each identified risk***. (The likelihood definitions can be found in Appendix 1).

Following the workshop, a priority risk rating was assigned for each risk based on the likelihood and consequence ratings assigned during the workshop. The priority risk rating categorises risks into those that need to be considered immediately through to risks that are considered a lower priority. The process of assigning a priority risk rating is based on the City's existing Risk Evaluation Matrix and Risk Acceptance Criteria outlined in Appendix 1. Extreme risks that have an overall risk priority rating of 'extreme' and 'high' will be identified for immediate further attention, whereas lower risks that have been rated as 'low' and 'moderate' will be considered in the longer term.

The risk register was then updated to include the risk ratings, the priority risk ratings and the mitigation actions for each identified risk (refer to Appendix 2 and 3). Some actions were combined with existing actions from the 2013 Adaptation Risk, whilst others were reviewed and consolidated to reflect best-practice.

The City recognises that risk management is an ongoing process, and will continue to monitor and review climate change risks and actions, including through communication and consultation with stakeholders.

## ***Identified risks and residual risk ratings***

### **Extreme risks**

- Damage to or loss of properties, buildings and other infrastructure as a result of increased bushfires.
- Reduced public safety, health and/or wellness or as a result of increased bushfires.

### **High risks**

- Biodiversity loss as a result of increased temperatures and decreased rainfall.
- Damage to or loss of biodiversity and natural habitat as a result of increased bushfires.
- Damage to or loss of natural environment and habitat as a result of sea level rise.
- Damage to or loss of biodiversity and natural habitat as a result of increased extreme weather events.
- Inadequate development approval and planning schemes result in legal liability and reputational damage as a result of sea level rise.
- Increased demand for electricity as a result of increased temperatures.
- Increased demand for water as a result of increased temperatures.
- Increased heat, pest and water stress on vegetation and urban forest as a result of increased temperatures and decreased rainfall.
- Increased public health impacts as a result of increased temperatures, heatwaves and changes to rainfall.
- Reduced public safety and/or wellness as a result of extreme weather events.

### **Substantial risks**

- Damage to or loss of buildings, properties and infrastructure as a result of increased extreme weather events.
- Insufficient resources to accommodate higher number of displaced persons due to climate change impacts.

### **Moderate risks**

- Damage to or failure of utilities and transport infrastructure as a result of increased temperatures.
- Damage to, loss of or permanent closure of low-lying buildings, infrastructure and land as a result of sea level rise.
- Increased degradation and weather of buildings and infrastructure as a result of increased temperatures.
- Reduced liveability of the City caused by loss of green infrastructure as a result of increased temperatures and reduced rainfall.



## Priority risks

Based on the outcome of the risk assessment, two extreme climate change risks were identified that require immediate attention. The two risks are as follows:

1. Reduced public safety, health and/or wellness as a result of increased bushfires - *Harsher fire-weather results in an increase in the frequency and or intensity of bushfires, and in turn reduced public safety, health and/or wellness and or loss of life.*
2. Damage to or loss of properties, building and other infrastructure as a result of increased bushfires - *Harsher fire-weather results in an increase in the frequency and or intensity of bushfires, and in turn damage to or loss of properties, buildings and other infrastructure.*

A number of controls have already been put in place to mitigate these risks, however the City has identified additional actions to further reduce the likelihood of these risks occurring and the consequence of the risks on the City, should they occur. Each of these actions has been assigned a priority rating and an action 'owner' to ensure that the City remains accountable for its climate change response.

### **Extreme risk 1: Reduced public safety, health and/or wellness or as a result of increased bushfires.**

Based on the literature review and climate data findings, Ernst and Young identified that increased bushfire events may occur as a result of climate change. Bushfires pose a significant risk to all aspects of the community, which was confirmed during the risk assessment workshop. In the workshop City staff determined that increased bushfires pose a significant risk to public safety, health and/or wellness.

Several actions have been identified in the existing Adaptation Risk (and action) Register, which aim to mitigate the risk and impact that fire may have on the community. These actions include, for example, implementing a Bushfire Risk Management Plan, reviewing current Emergency Response Plans, and undertaking a community information program around the risks.

### **Extreme risk 2: Damage to or loss of properties, building and other infrastructure as a result of increased bushfires.**

In addition to public health and safety concerns, increased bushfire events pose a significant risk to properties, buildings and other infrastructure located within the City. Damage to or loss of essential buildings and infrastructure may have further social and economic implications. The existing actions identified to mitigate the risk of increased bushfire events include, in addition to the above, vegetation and fuel load management in bushland reserves and community education programs to improve public emergency preparedness. In addition, several existing actions reduce the vulnerability of buildings, property and infrastructure to fire damage, for example ensuring all City owned buildings and infrastructure have Bushfire Evacuation Plans and continuing to ensure that the new building design approval process incorporates bush fire management.

## ***Risk consolidation***

The City has grouped the 18 risks into their areas of impact (water, biodiversity, coastal, urban forest, community infrastructure and public health) and consolidated them into six overarching risks (see table 5).

The highest risk rating for each group of risks has been applied to the overarching risk.

To reduce the impact of these risks and increase adaptive capacity, the City has integrated the six overarching climate risks into its Risk Management System (RMS) and identified key solutions in the Climate Change Strategy 2020 - 2030.

The six overarching climate change risks are presented in Table 5 and summarised below:

1. Reduced water availability from decreased rainfall
2. Biodiversity loss from climate change impacts
3. Coastal impacts from sea level rise
4. Urban forest decline from climate change
5. Community infrastructure damage from climate change impacts
6. Public health decline from climate change



| Risk #                            | Risk description   | Risk rating | Responsibility                  | Overarching risk  |
|-----------------------------------|--|-------------|---------------------------------|---|
| Water security risks              |  |             |                                 |   |
| 18                                | Increased demand for water resources as a result of increased temperatures   | Substantial | Manager Parks and Environment   | Reduced water availability from decreased rainfall          |
| 14                                | Reduced liveability of the City caused by loss of green infrastructure as a result of increased temperatures and reduced rainfall. | Moderate    | Manager Parks and Environment   |   |
| Biodiversity risks                |  |             |                                 |   |
| 3                                 | Damage to, or loss of ,biodiversity and natural habitat as a result of increased bushfires   | High        | Manager Parks and Environment   | Biodiversity loss from climate change impacts               |
| 8                                 | Increased temperatures and decreased rainfall causes biodiversity loss   | Substantial | Manager Parks and Environment   |   |
| 16                                | Damage to, or loss of biodiversity and natural habitat as a result of increased extreme weather events                             | Substantial | Manager Parks and Environment   |   |
| Coastal risks                     |  |             |                                 |   |
| 9                                 | Damage to or loss of natural environment and habitat as a result of sea level rise   | Substantial | Manager Parks and Environment   | Coastal impacts from sea level rise                         |
| 10                                | Damage to, loss of or permanent closure of coastal buildings, infrastructure and public land as a result of sea level rise         | Moderate    | Manager Infrastructure Services |   |
| 11                                | Legal liability and reputational damage as a result of inadequate development approval, planning schemes and sea level rise        | Moderate    | Manager Planning                |   |
| Urban Forest risk                 |  |             |                                 |   |
| 7                                 | Increased heat, pest and water stress on the urban forest as a result of increased temperatures and decreased rainfall             | Substantial | Manager Parks and Environment   | Urban forest decline from climate change                    |
| Community infrastructure risks    |  |             |                                 |   |
| 2                                 | Damage to or loss of properties, buildings and other infrastructure as a result of increased bushfires                             | Extreme     | Manager Infrastructure Services | Community infrastructure damage from climate change impacts |
| 5                                 | Increased demand for electricity as a result of increased temperatures   | Substantial | Manager Infrastructure Services |   |
| 17                                | Damage to or loss of buildings, properties and infrastructure as a result of increased extreme weather events.                     | Substantial | Manager Infrastructure Services |   |
| 6                                 | Damage to or failure of utilities and transport infrastructure as a result of increased temperatures.                              | Moderate    | Manager Engineering             |   |
| 4                                 | Increased degradation and weather of buildings and infrastructure as a result of increased temperatures                            | Moderate    | Manager Infrastructure Services |   |
| Public Health and wellbeing risks |  |             |                                 |   |
| 1                                 | Reduced public safety, health and/or wellness or as a result of increased bushfires.   | Extreme     | Manager Environmental Health    | Public health decline from climate change                   |
| 15                                | Increased public health impacts as a result of increased temperatures, heatwaves and changes to rainfall.                          | High        | Manager Environmental Health    |   |
| 12                                | Reduced public safety and/or wellness as a result of extreme weather events  | High        | Manager Environmental Health    |   |
| 13                                | Insufficient resources to accommodate higher number of displaced persons due to climate change impacts.                            | Substantial | Manager Environmental Health    |   |

Table 5: Identified risks and residual risk ratings

# Appendix 1: Risk Assessment Matrices

## City of Cockburn Consequence Definitions

| Level                            | 1   | 2   | 3  | 4   | 5   |
|----------------------------------|---|---|--|---|---|
| Description                      | Insignificant   | Minor   | Major  | Critical  | Catastrophic  |
| OHS / Injury / Well-being        | <ul style="list-style-type: none"> <li>No injuries.</li> </ul>  | <ul style="list-style-type: none"> <li>First aid treatment.</li> </ul>  | <ul style="list-style-type: none"> <li>Medical treatment</li> <li>No lost time injury (LTI).</li> </ul>  | <ul style="list-style-type: none"> <li>Partial disablement or severe injury.</li> <li>LTI &lt; 10 days.</li> </ul>  | <ul style="list-style-type: none"> <li>Death or permanent disablement</li> <li>LTI ≥ 10 days.</li> </ul>  |
| Financial Impact                 | <ul style="list-style-type: none"> <li>&lt; \$50,000 or &lt;5% of OP.</li> <li>Little or no impact on asset.</li> </ul>                                 | <ul style="list-style-type: none"> <li>\$50K - \$250K or 5% - 10% of OP.</li> <li>Minor loss or damage.</li> </ul>  | <ul style="list-style-type: none"> <li>\$250K - \$1M or 10% - 25% of OP.</li> <li>Major damage to asset.</li> </ul>  | <ul style="list-style-type: none"> <li>\$1M - \$5M or 25% - 50% of OP.</li> <li>Significant loss of asset.</li> </ul>   | <ul style="list-style-type: none"> <li>&gt; \$5M or &gt;50% of OP.</li> <li>Complete loss of asset.</li> </ul>  |
| Brand Reputation                 | <ul style="list-style-type: none"> <li>Low impact.</li> <li>Low profile.</li> <li>No complaint.</li> </ul>  | <ul style="list-style-type: none"> <li>Low impact.</li> <li>Low profile.</li> <li>Low media attention.</li> <li>Possible complaint.</li> </ul>                        | <ul style="list-style-type: none"> <li>Moderate impact.</li> <li>Moderate media attention.</li> <li>Public complaint.</li> </ul>   | <ul style="list-style-type: none"> <li>Damage to reputation.</li> <li>Public embarrassment.</li> <li>High media attention.</li> <li>Several public complaints.</li> <li>Third party legal action.</li> </ul>                      | <ul style="list-style-type: none"> <li>Irreversible damage to reputation.</li> <li>Very high level of public embarrassment.</li> <li>Very high media attention.</li> <li>Many public complaints.</li> </ul>   |
| Operations / Delivery Disruption | <ul style="list-style-type: none"> <li>Little impact</li> <li>Business-as-usual.</li> <li>&lt; 5% variation against PI.</li> </ul>                      | <ul style="list-style-type: none"> <li>Minor impact.</li> <li>Easily dealt with.</li> <li>Still business-as-usual.</li> <li>5% - 10% variation against PI.</li> </ul> | <ul style="list-style-type: none"> <li>Some objectives affected.</li> <li>Can continue as business-as-usual, with minor controls executed.</li> <li>10% - 25% variation against PI.</li> </ul> | <ul style="list-style-type: none"> <li>Some of the major objectives cannot be achieved.</li> <li>Business can still deliver but not to expected level.</li> <li>25% - 50% variation against PI.</li> </ul>                        | <ul style="list-style-type: none"> <li>Most objectives cannot be achieved.</li> <li>Business cannot operate.</li> <li>&gt; 50% variation against PI.</li> </ul>   |
| Environmental Health             | <ul style="list-style-type: none"> <li>An insignificant environmental event that can be immediately corrected under the control of the City.</li> </ul> | <ul style="list-style-type: none"> <li>A minor environmental event that can be corrected through system improvements within the City.</li> </ul>                      | <ul style="list-style-type: none"> <li>A moderate environmental event that can be remediated but requires multiple stakeholder input.</li> </ul>   | <ul style="list-style-type: none"> <li>A significant environmental event where rehabilitation involves multiple stakeholders and various levels of the community and government.</li> </ul>                                       | <ul style="list-style-type: none"> <li>A severe environmental event requiring multiple stakeholders, all levels of the community and government to remediate.</li> </ul>  |
| Compliance                       | <ul style="list-style-type: none"> <li>Minor breach of policy / process requiring some response with little impact on other criteria.</li> </ul>        | <ul style="list-style-type: none"> <li>Compliance breach of policy / process requiring additional work or minimal damage control.</li> </ul>                          | <ul style="list-style-type: none"> <li>Compliance breach requiring investigation, mediation or restitution and breach of legislation or regulations.</li> </ul>                                | <ul style="list-style-type: none"> <li>Compliance breach involving external investigation or third party actions resulting in tangible loss or reputation damage to the City and breach of legislation or regulations.</li> </ul> | <ul style="list-style-type: none"> <li>Compliance breach involving regulatory investigation and / or third party actions resulting in tangible loss or significant reputation damage to the organisation and breach of legislation or regulations.</li> </ul> |



## City of Cockburn Likelihood Definitions

| Level | Likelihood     | Description   |
|-------|----------------|---|
| 1     | Rare           | Theoretically such an event is possible but not expected to occur during an operation / asset life / project. |
| 2     | Unlikely       | Possible that such an event may occur once during operation / asset life / project.                           |
| 3     | Possible       | Such an event may occur more than twice during an operation / asset life / project.                           |
| 4     | Likely         | Such events may occur frequently during an operation / asset life / project.                                  |
| 5     | Almost Certain | Such events are expected to occur routinely during an operation / asset life / project.                       |

## City of Cockburn Risk Evaluation Matrix

|                        |                    | Likelihood / Probability |                   |                   |                   |                     |
|------------------------|--------------------|--------------------------|-------------------|-------------------|-------------------|---------------------|
|                        |                    | Rare<br>1                | Unlikely<br>2     | Possible<br>3     | Likely<br>4       | Almost certain<br>5 |
| Consequence / Severity | Insignificant<br>1 | 1<br>Low                 | 2<br>Low          | 3<br>Low          | 4<br>Low          | 5<br>Moderate       |
|                        | Minor<br>2         | 2<br>Low                 | 4<br>Low          | 6<br>Moderate     | 8<br>Moderate     | 10<br>Substantial   |
|                        | Major<br>3         | 3<br>Low                 | 6<br>Moderate     | 9<br>Moderate     | 12<br>Substantial | 15<br>High          |
|                        | Critical<br>4      | 4<br>Low                 | 8<br>Moderate     | 12<br>Substantial | 16<br>High        | 20<br>Extreme       |
|                        | Catastrophic<br>5  | 5<br>Moderate            | 10<br>Substantial | 15<br>High        | 20<br>Extreme     | 25<br>Extreme       |

## City of Cockburn Risk Acceptance Criteria

| Risk Level  | Criteria  | Treatment   | Responsibility                                   |
|-------------|---|---|--|
| Low         | Risk acceptable with adequate controls, managed by routine procedures. Subject to annual monitoring or continuous review throughout project lifecycle.  | Management through routine operations/project, Risk Registers to be updated.  | Service Unit Manager/ Project Manager            |
| Moderate    | Risk acceptable with adequate controls, managed by specific procedures. Subject to semi-annual monitoring or continuous review throughout project lifecycle.                                    | Communication and awareness of increasing risk provided to SM, Risk Registers to be updated.  | Senior Manager / Project Manager                 |
| Substantial | Accepted with detailed review and assessment. Action Plan prepared and continuous review.   | Assess impact of competing Service Unit/Business Unit Projects. Potential redirect of Service Unit/Business Unit resources. Risk registers to be updated. | Director / Steering Committee                    |
| High        | Risk acceptable with effective controls, managed by senior management/executive. Subject to quarterly monitoring or continuous review throughout project lifecycle.                             | Escalate to CEO, report prepared for Audit & Strategic Finance Committee. Quarterly monitoring and review required. Risk Registers to be updated.         | Executive / Steering Committee / Project Sponsor |
| Extreme     | Risk only acceptable with effective controls and all treatment plans to be explored and implemented where possible, managed by highest level of authority and subject to continuous monitoring. | Escalate to CEO, report prepared for Audit & Strategic Finance Committee. Monthly monitoring and review required. Risk Registers to be updated.           | CEO / Council / Project Sponsor                  |



## Appendix 2: Risk Register

| Risk ID | Climate Variable                | Change to Climate Variable   | Impact   | Risk Title   | Risk Description   | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls   | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|---------------------------------|--|--|--|--|----------------------|---------------------|----------------------|---|----------------------|---------------------|----------------------|
| 1       | Temperature<br>Rainfall<br>Wind | Increased mean, maximum and minimum temperatures<br>Decreased rainfall and humidity<br>Higher wind speed | <ul style="list-style-type: none"> <li>Increased pressure on emergency and social services.</li> <li>Reduced public safety, health and/or wellness, including from reduced air quality from smoke and smog and psycho-social impacts following bushfire events.</li> <li>Legal, financial and reputational damage to the City.</li> <li>Increased insurance premiums.</li> <li>Reduced liveability of the City, and financial loss to the City.</li> </ul> | Reduced public safety, health and/or wellness or as a result of increased bushfires.                   | Harsher fire-weather results in an increase in the frequency and or intensity of bushfires, and in turn reduced public safety, health and/or wellness and or loss of life.   | Catastrophic         | Likely              | Extreme              | <ul style="list-style-type: none"> <li>Back up generators installed in Council buildings.</li> <li>Community education.</li> <li>Fire risk mitigation actions including weed control and controlled burns.</li> <li>Maintain required fire breaks.</li> <li>Bush Fire Emergency Management Plans.</li> <li>Ongoing support for Volunteer Bush Fire brigades.</li> <li>Provide access to water for firefighting purposes.</li> <li>Ongoing inspection and enforcement of public fire mitigation measures.</li> </ul>       | Catastrophic         | Likely              | Extreme              |
| 2       | Temperature<br>Rainfall<br>Wind | Increased mean, maximum and minimum temperatures<br>Decreased rainfall and humidity<br>Higher wind speed | <ul style="list-style-type: none"> <li>Reduced liveability of the City</li> <li>Financial loss to the City.</li> <li>Increased insurance premiums</li> <li>Increased pressure on emergency and social services.</li> </ul>   | Damage to or loss of properties, building and other infrastructure as a result of increased bushfires. | Harsher fire-weather results in an increase in the frequency and or intensity of bushfires, and in turn damage to or loss of properties, buildings and other infrastructure. | Catastrophic         | Likely              | Extreme              | <ul style="list-style-type: none"> <li>Back up generators installed in Council buildings.</li> <li>Community education.</li> <li>Fire risk mitigation actions plans including weed control and controlled burns.</li> <li>Maintain required fire breaks.</li> <li>Bush Fire Emergency Management Plans.</li> <li>Ongoing support for Volunteer Bush Fire brigades.</li> <li>Provide access to water for firefighting purposes.</li> <li>Ongoing inspection and enforcement of public fire mitigation measures.</li> </ul> | Catastrophic         | Likely              | Extreme              |

| Risk ID | Climate Variable                | Change to Climate Variable  | Impact  | Risk Title  | Risk Description   | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls  | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|---------------------------------|---|---|---|--|----------------------|---------------------|----------------------|--|----------------------|---------------------|----------------------|
| 3       | Temperature<br>Rainfall<br>Wind | Increased mean, maximum and minimum temperatures<br>Decreased rainfall and humidity<br>Higher wind speed  | <ul style="list-style-type: none"> <li>Loss of biodiversity, reduced ecosystem health, function, and resilience, decreased ability of ecosystems to provide ecosystem services (carbon sequestration, provision of clean air, water filtration, public amenity, etc.).</li> </ul> | Damage to or loss of biodiversity and natural habitat as a result of increased bushfires.             | Harsher fire-weather results in an increase in the frequency and or intensity of bushfires, and in turn damage to or loss of biodiversity and natural habitat.                       | Critical             | Likely              | High                 | <ul style="list-style-type: none"> <li>Landscape guidelines provided to developers (e.g. species selection).</li> <li>Catchment and stormwater management.</li> <li>Vegetation condition mapping.</li> <li>Occasional treatment for pest species.</li> <li>Fire risk mitigation actions including weed control and controlled burns.</li> <li>Ongoing inspection and enforcement of public fire mitigation measures.</li> <li>Bush Fire and Emergency Management plans.</li> <li>Ongoing support for Volunteer Bush Fire brigades.</li> <li>Community education.</li> <li>Provide access to water for firefighting purposes.</li> <li>Grass and weed control.</li> <li>Controlled fuel reduction burns.</li> <li>Ongoing Inspection and enforcement of public fire mitigation measures.</li> </ul> | Critical             | Likely              | High                 |
| 4       | Temperature                     | Increase in the temperature reached on hot days, the frequency of hot days and the duration of heat waves | <ul style="list-style-type: none"> <li>Increased maintenance and repair costs.</li> <li>Power outage impacts on transport infrastructure such as traffic lights causing traffic congestion and delays.</li> </ul>   | Damage to or failure of utilities and transport infrastructure as a result of increased temperatures. | Increase in the temperature reached on hot days, the frequency of hot days and the duration of heat waves results in damage to or failure of utilities and transport infrastructure. | Major                | Possible            | Moderate             | <ul style="list-style-type: none"> <li>Continue to meet building and engineering construction codes.</li> <li>Development of best practice stormwater management systems.</li> <li>Continue to support the role out of underground power.</li> <li>Regular and ongoing maintenance.</li> </ul>   | Major                | Possible            | Moderate             |

| Risk ID | Climate Variable | Change to Climate Variable                       | Impact  | Risk Title   | Risk Description  | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls   | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|------------------|--|---|--|---|----------------------|---------------------|----------------------|---|----------------------|---------------------|----------------------|
| 5       | Temperature      | Increased mean, maximum and minimum temperatures | <ul style="list-style-type: none"> <li>Increased operational costs and peak energy demand for utilities.</li> </ul> | Increased demand for electricity as a result of increased temperatures.                                  | Increase in temperatures results in an increased demand on and use of electricity supply.   | Major                | Almost Certain      | High                 | <ul style="list-style-type: none"> <li>Implement best practise Environmentally Sustainable Design (ESD) in construction of all new facilities to improve water and energy efficiency.</li> </ul>  | Minor                | Almost Certain      | Substantial          |
| 6       | Temperature      | Increased mean, maximum and minimum temperatures | <ul style="list-style-type: none"> <li>Increase maintenance and repair costs.</li> </ul>                            | Increased degradation and weather of buildings and infrastructure as a result of increased temperatures. | Increase in temperatures results in increased degradation and weathering of buildings and infrastructure, and in turn increased maintenance and repair costs. | Minor                | Possible            | Moderate             | <ul style="list-style-type: none"> <li>Continue ongoing and regular maintenance of Council facilities.</li> <li>Implement best practise ESD in construction of all new facilities to incorporate climate resilience into building and infrastructure design.</li> </ul> | Minor                | Possible            | Moderate             |

| Risk ID | Climate Variable        | Change to Climate Variable   | Impact   | Risk Title   | Risk Description  | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls   | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|-------------------------|--|--|--|---|----------------------|---------------------|----------------------|---|----------------------|---------------------|----------------------|
| 7       | Rainfall<br>Temperature | Decreased rainfall<br>Increased mean, maximum and minimum temperatures | <ul style="list-style-type: none"> <li>Unable to irrigate all streetscapes and parklands due to water license restrictions and loss of water availability.</li> <li>Increased costs to meet irrigation requirements, pest treatment and/or re-planting vegetation and urban forest.</li> <li>Reduced liveability and decreased public amenity of the City.</li> <li>Amplification of the urban heat island effect due to the inability of the City to irrigate trees and plants as a result of water supply constraints/ water shortages.</li> </ul> | Increased heat, pest and water stress on vegetation and urban forest as a result of increased temperatures and decreased rainfall. | Increase in temperatures and decrease in rainfall results in increased stress on vegetation and urban forest, and in turn increased irrigation requirements, pest treatment and/or re-planting, and reduced public amenity in parklands with limited water availability and/or exhausted water license allocations. | Major                | Almost Certain      | High                 | <ul style="list-style-type: none"> <li>Ensure water use complies with water license allocations Continue to develop and implement best practise turf management programs.</li> <li>Continue to implement best practise water reduction initiatives.</li> <li>Development of best practice stormwater management systems.</li> <li>Maintain Waterwise Council accreditation.</li> <li>Implement water saving initiatives in reserves including rationalisation of irrigation through hydrozoning.</li> <li>Encourage stormwater recharge of wetland system through clever design.</li> <li>Modify planting regimes to more drought resilient species.</li> </ul> | Minor                | Almost Certain      | Substantial          |

| Risk ID | Climate Variable        | Change to Climate Variable   | Impact  | Risk Title  | Risk Description   | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls   | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|-------------------------|--|---|---|--|----------------------|---------------------|----------------------|---|----------------------|---------------------|----------------------|
| 8       | Rainfall<br>Temperature | Decreased rainfall<br>Increased mean, maximum and minimum temperatures | <ul style="list-style-type: none"> <li>Loss of biodiversity, reduced ecosystem health, function, and resilience, decreased ability of ecosystems to provide ecosystem services (carbon sequestration, provision of clean air, water filtration, public amenity, etc.).</li> </ul> | Biodiversity loss as a result of increased temperatures and decreased rainfall. | Increase in temperatures and decreased rainfall and water availability results in 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 biodiversity loss. | Critical             | Likely              | High                 | <ul style="list-style-type: none"> <li>Landscape guidelines provided to developers (e.g. species selection to encourage new fauna habitat.).</li> <li>Continue to implement best practise water reduction initiatives.</li> <li>Development of best practice stormwater management systems.</li> <li>Continue to undertake vegetation condition mapping.</li> <li>Continue to undertake regular fauna surveys.</li> <li>Select appropriate plant species for revegetation programs so as to adapt to changes in climate.</li> <li>Continue to offer Landowner Biodiversity Conservation Grants and habitat creation rebates for residents.</li> <li>Continue to offer Waterwise Verge Grants to encourage native species planting.</li> </ul> | Major                | Likely              | Substantial          |



| Risk ID | Climate Variable | Change to Climate Variable | Impact  | Risk Title  | Risk Description  | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls   | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|------------------|----------------------------|---|---|---|----------------------|---------------------|----------------------|---|----------------------|---------------------|----------------------|
| 9       | Sea level        | Increase in mean sea level | <ul style="list-style-type: none"> <li>Loss of biodiversity, reduced ecosystem health, function, and resilience, decreased ability of ecosystems to provide ecosystem services (dune stabilisation, coastal ecosystem services, public amenity, etc.).</li> </ul> | Damage to or loss of natural environment and habitat as a result of sea level rise. | Increase in mean sea level results in accelerated erosion and/or permanent inundation of low-lying areas, or coastal-plain/flood-plain inundation due to a rise of the groundwater table with sea level rise, as well as increased salinity and salt water intrusion, and in turn damage to or loss of natural environment and habitat. | Critical             | Likely              | High                 | <ul style="list-style-type: none"> <li>Continue to undertake vegetation condition mapping.</li> <li>Continue to undertake fauna surveys.</li> <li>Planning for managed retreat in selected areas.</li> <li>Continue to undertake wetland water quality monitoring in selected wetlands.</li> <li>Conform to state planning guidelines.</li> <li>Continue to undertake coastal monitoring and surveys.</li> <li>Continue to support and drive the Cockburn Coastal Alliance.</li> <li>Work with other landowners to mitigate issues associated with sea level rise.</li> </ul> | Major                | Likely              | Substantial          |

| Risk ID | Climate Variable | Change to Climate Variable | Impact   | Risk Title   | Risk Description   | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls  | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|------------------|----------------------------|--|--|--|----------------------|---------------------|----------------------|--|----------------------|---------------------|----------------------|
| 10      | Sea level        | Increase in mean sea level | <ul style="list-style-type: none"> <li>Increased maintenance and repair costs to buildings.</li> <li>Potential for reduced commercial tenancy in the City due to tenants moving to lower risk areas.</li> <li>Reduced liveability of the City.</li> <li>Increased insurance premiums.</li> <li>Increased pressure on emergency and social services.</li> </ul> | Damage to, loss of or permanent closure of low-lying buildings, infrastructure and land as a result of sea level rise. | Increase in mean sea level results in accelerated erosion and/or permanent inundation of low-lying areas, or coastal-plain/flood-plain inundation due to a rise of the groundwater table with sea level rise, as well as increased salinity and salt water intrusion, and in turn damage to, loss of or permanent closure of low-lying buildings, infrastructure and land. | Major                | Possible            | Moderate             | <ul style="list-style-type: none"> <li>Planning for managed retreat in selected areas.</li> <li>Conform to state planning regulation and guidelines for coastal planning and development.</li> <li>Continue to undertake coastal monitoring and surveys.</li> <li>Continue to support and drive the Cockburn Coastal Alliance.</li> <li>Work with other landowners to mitigate issues associated with sea level rise.</li> </ul> | Major                | Possible            | Moderate             |

| Risk ID | Climate Variable | Change to Climate Variable  | Impact  | Risk Title  | Risk Description  | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls   | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|------------------|---|---|---|---|----------------------|---------------------|----------------------|---|----------------------|---------------------|----------------------|
| 11      | Sea level        | Increase in mean sea level  | <ul style="list-style-type: none"> <li>Reduced liveability of the City.</li> <li>Financial loss and reputational damage to the City.</li> </ul>   | Inadequate development approval and planning schemes result in legal liability and reputational damage as a result of sea level rise. | Increase in mean sea level results in inappropriate development approval and planning schemes of low-lying areas and areas at high risk of permanent inundation, and in turn legal liability and reputational damage to the City. | Critical             | Likely              | High                 | <ul style="list-style-type: none"> <li>Planning for managed retreat in selected areas.</li> <li>Conform to state planning regulations and guidelines for coastal planning and development.</li> <li>Continue to undertake coastal monitoring and surveys.</li> <li>Continue to support and drive the Cockburn Sound Coastal Alliance.</li> <li>Work with other landowners to mitigate issues associated with sea level rise.</li> </ul> | Major                | Possible            | Moderate             |
| 12      | Extreme weather  | Increase in the intensity and frequency of extreme weather events | <ul style="list-style-type: none"> <li>Increased pressure on emergency and social services.</li> <li>Reduced public safety, wellness, and or loss of life.</li> <li>Legal, financial and reputational damage to the City.</li> <li>Increased insurance premiums.</li> <li>Reduced liveability of the City, and financial loss to the City.</li> </ul> | Reduced public safety and/or wellness as a result of increased extreme weather events.  | Increase in the intensity and frequency of extreme weather events such as flooding, hail and high wind speeds, results in reduced public safety, wellness and/or loss of life.  | Catastrophic         | Possible            | High                 | <ul style="list-style-type: none"> <li>Maintain emergency management plans.</li> <li>Continue to promote community health education information.</li> <li>Utilise social media for awareness raising and warnings.</li> </ul>   | Catastrophic         | Possible            | High                 |

| Risk ID | Climate Variable               | Change to Climate Variable  | Impact   | Risk Title   | Risk Description  | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls  | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|--------------------------------|---|--|--|---|----------------------|---------------------|----------------------|--|----------------------|---------------------|----------------------|
| 13      | Extreme weather                | Increase in the intensity and frequency of extreme weather events   | <ul style="list-style-type: none"> <li>Greater demand for resources to accommodate displaced persons.</li> <li>Legal, financial and reputational damage to the City.</li> </ul>              | Insufficient resources to accommodate higher number of displaced persons due to climate change impacts.                            | Insufficient resources available to accommodate higher numbers of displaced persons due to climate change impacts such as bushfires, storms, and climate change refugees.                   | Critical             | Unlikely            | Substantial          | <ul style="list-style-type: none"> <li>Maintain emergency management plans.</li> <li>Utilise social media for awareness raising and warnings.</li> </ul> | Critical             | Unlikely            | Substantial          |
| 14      | Temperature<br>Extreme weather | Increased mean, maximum and minimum temperatures<br><br>Increase in the intensity and frequency of extreme weather events | <ul style="list-style-type: none"> <li>Reduced liveability of the City.</li> <li>Financial loss to the City as a result of loss of trees and vegetation in parks and streetscapes</li> </ul> | Reduced liveability of the City caused by loss of green infrastructure as a result of increased temperatures and reduced rainfall. | Increase in temperatures, changes to rainfall and increased occurrence of extreme weather results in reduced use and visitation of natural environment and parks by residents and tourists, | Major                | Possible            | Moderate             | <ul style="list-style-type: none"> <li>Urban Forest Plan</li> <li>Waterwise Council program</li> </ul>   | Major                | Possible            | Moderate             |

| Risk ID | Climate Variable        | Change to Climate Variable   | Impact  | Risk Title   | Risk Description  | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls  | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|-------------------------|--|---|--|---|----------------------|---------------------|----------------------|--|----------------------|---------------------|----------------------|
| 15      | Temperature<br>Rainfall | Increased mean, maximum and minimum temperatures<br>Increase in the temperature reached on hot days, the frequency of hot days and the duration of heat waves<br>Decreased rainfall<br>Increase in the intensity and frequency of extreme weather events | <ul style="list-style-type: none"> <li>Reduced public health.</li> <li>Increased pressure on emergency, health and social services (including from negative changes in social behaviour, in particular violence and anti-social behaviour).</li> <li>Increased "downtime" and associated costs to operational and project activities, due to contractors and or employees being unable to work during hot weather.</li> </ul> | Increased public health impacts as a result of increased temperatures, increased extreme weather events and changes to rainfall. | Increase in temperatures, changes to rainfall and results in public health impacts including increase in food poisoning cases, mosquito borne disease, nuisance species, heat stress and reduced wellbeing. | Catastrophic         | Possible            | High                 | <ul style="list-style-type: none"> <li>Maintain emergency management plans.</li> <li>Undertake regular wetland water quality monitoring in selected wetlands.</li> <li>Continue to implement the Integrated Midge Control Program.</li> <li>Undertake treatment for insect control in selected wetlands as required.</li> <li>Continue to implement the Mosquito Control Program.</li> <li>Environmental Health inspectors continue to undertake regular inspections.</li> <li>Continue to promote community health education information.</li> </ul>  | Catastrophic         | Possible            | High                 |
| 16      | Extreme weather         | Increase in the intensity and frequency of extreme weather events  | <ul style="list-style-type: none"> <li>Loss of biodiversity, reduced ecosystem health, function, and resilience, decreased ability of ecosystems to provide ecosystem services (carbon sequestration, provision of clean air, water filtration, public amenity, etc.).</li> </ul>   | Damage to or loss of biodiversity and natural habitat as a result of increased extreme weather events.                           | Increase in the intensity of extreme weather events result in damage to or loss of biodiversity and natural habitat.  | Critical             | Likely              | High                 | <ul style="list-style-type: none"> <li>Landscape guidelines provided to developers (e.g. species selection to encourage new fauna habitat.).</li> <li>Continue to undertake vegetation condition mapping.</li> <li>Continue to undertake regular fauna Surveys.</li> <li>Select appropriate plant species for revegetation programs so as to adapt to changes in climate.</li> <li>Continue to offer Landowner Biodiversity Conservation Grants and habitat creation rebates for residents.</li> <li>Continue to offer Waterwise Verge Grants to encourage native species planting.</li> </ul> | Major                | Likely              | Substantial          |

| Risk ID | Climate Variable | Change to Climate Variable  | Impact  | Risk Title   | Risk Description  | Inherent Consequence | Inherent Likelihood | Inherent Risk Rating | City of Cockburn Current Controls  | Residual Consequence | Residual Likelihood | Residual Risk Rating |
|---------|------------------|---|---|--|---|----------------------|---------------------|----------------------|--|----------------------|---------------------|----------------------|
| 17      | Extreme weather  | Increase in the intensity and frequency of extreme weather events | <ul style="list-style-type: none"> <li>Increased pressure on emergency and social services.</li> <li>Reduced public safety, health and/or wellness.</li> <li>Increased repair costs and insurance premiums.</li> <li>Legal, financial and reputational damage to the City.</li> </ul> | Damage to or loss of buildings, properties and infrastructure as a result of increased extreme weather events. | Increase in the intensity of extreme weather events results in damage to or loss of buildings, properties and infrastructure. | Major                | Likely              | Substantial          | <ul style="list-style-type: none"> <li>Continue to meet Building and Engineering construction codes.</li> <li>Development of best practice stormwater management systems.</li> <li>Continue to support the role out of underground power.</li> <li>Regular and ongoing maintenance.</li> </ul>   | Major                | Likely              | Substantial          |
| 18      | Temperature      | Increased mean, maximum and minimum temperatures                  | <ul style="list-style-type: none"> <li>Increased operational costs and demand for utilities.</li> <li>Reduced water availability</li> </ul>   | Increased demand for water as a result of increased temperatures.  | Increase in temperatures results in an increased demand on water supply.  | Major                | Almost Certain      | High                 | <ul style="list-style-type: none"> <li>Ensure water use complies with water license allocations Continue to implement best practise water reduction initiatives.</li> <li>Development of best practice stormwater management systems.</li> <li>Maintain Waterwise Council accreditation.</li> <li>Implement water saving initiatives in reserves including rationalisation of irrigation through hydrozoning.</li> <li>Encourage stormwater recharge of wetland system through clever design.</li> <li>Implement best practise Environmentally Sustainable Design (ESD) in construction of all new facilities to improve water and energy efficiency.</li> </ul> | Minor                | Almost Certain      | Substantial          |



## Appendix 3. Action Register

| Relevant risks        | Action Description   | Is action currently being addressed? | Action Priority            | Action Status | Action Owner                            |
|-----------------------|--|--------------------------------------|----------------------------|---------------|---|
| <b>Water Security</b> |  |                                      |                            |               |   |
| 14, 18                | Maintain Gold waterwise Council Status. Aim for platinum endorsement.  | Yes                                  | Ongoing                    | In progress   | Manager Parks and Environment           |
| 14, 18                | Review, update and implement the Water Efficiency Action Plan to address climate change  | Yes                                  | Now (2020 to 2021)         | In progress   | Manager Parks and Environment           |
| 14, 18                | Establish a waterwise working group to advance the WEAP and water sensitive urban design   | Yes                                  | Now (2020 to 2021)         | In progress   | Manager Parks and Environment           |
| 14, 18                | Reduced water consumption in the community and within the City's infrastructure and streetscapes   | Yes                                  | Short Term (2021 to 2023)  | In progress   | Manager Parks and Environment           |
| 14, 18                | Increase water literacy and continue to offer incentives to encourage water efficiency in households   | Yes                                  | Ongoing                    | In progress   | Manager Parks and Environment           |
| 14, 18                | Continue to reduce Council groundwater abstraction and explore use of alternative water sources  | Yes                                  | Now (2020 to 2021)         | In progress   | Manager Parks and Environment           |
| 14, 18                | Maintain dialogue with the Water Corporation to enhance the outcomes of major stormwater drainage systems on Wetlands  | Yes                                  | Now (2020 to 2021)         | In progress   | Manager Parks and Environment           |
| 14, 18                | Explore the need for a Water Sensitive Urban Design Policy or guidelines to support groundwater replenishment  | Yes                                  | Now (2020 to 2021)         | In progress   | Manager Parks and Environment           |
| 14, 18                | Continue to monitor water use and sources for public open space and adjust regimes   | Yes                                  | Ongoing                    | In progress   | Manager Parks and Environment           |
| 14, 18                | Continue to investigate and implement opportunities to reduce irrigated surface area and improve irrigation design e.g. hydrozoning.   | Yes                                  | Ongoing                    | In progress   | Manager Parks and Environment           |
| 18                    | Continue to implement water saving measures at the ARC and water audits to identify savings.   | Yes                                  | Ongoing                    | In progress   | Manager Recreation and Community Safety |
| 18                    | Conduct water audits at the top 5 water consumption facilities   | No                                   | Short Term (2021 to 2023)  | Not Started   | Manager Parks and Environment           |
| 14, 18                | Require best practice water strategies for new urban development and existing storm water drainage management systems, to be capable of handling greater flows considering latest climate science. | No                                   | Medium Term (2024 to 2027) | Not Started   | Manager Engineering                     |

| Relevant risks      | Action Description   | Is action currently being addressed? | Action Priority                 | Action Status | Action Owner                            |
|---------------------|--|--------------------------------------|---------------------------------|---------------|---|
| <b>Biodiversity</b> |  |                                      |                                 |               |   |
| 3, 8, 16            | Implement the Natural Area Management Strategy.  | Yes                                  | Now (2020/2021)                 | In progress   | Manager Parks & Environment             |
| 3,16                | Update the City's Bushfire Risk Management Plan and Conservation specific Fire Response Plans to reduce adverse impacts upon biodiversity.   |                                      | Now (2020/2021)                 |               | Manager Recreation and Community Safety |
| 3, 8, 9, 16         | Continue to help to protect at risk species by increasing protected bushland areas, and relocating species that are under threat to suitable areas                                       | Yes                                  | Now (2020/2021)                 | In progress   | Manager Parks & Environment             |
| 8, 16               | Continue to investigate and implement alternative species of plants, and trees for new parks/ovals and old parks/ovals requiring upgrading/replacing                                     | Yes                                  | Now (2020/2021)                 | In progress   | Manager Parks & Environment             |
| 8, 16               | Continue to monitor wetlands and conservation areas and adapt management regimes to build resilience and maintain ecosystem function   | Yes                                  | Now (2020/2021)                 | In progress   | Manager Parks & Environment             |
| 3, 8, 16            | Provide education programs/campaigns to assist the public in understanding biodiversity loss and implementing biodiversity preservation strategies in their own gardens                  | No                                   | Short Term (2021/22 to 2023/24) | Not started   | Manager Parks & Environment             |
| <b>Coastal</b>      |  |                                      |                                 |               |   |
| 9, 10, 11           | Review and implement the Coastal Adaptation Plan with latest climate science, scenario mapping and WALGA recommendations.  | No                                   | Ongoing                         | Not started   | Manager Infrastructure Services         |
| 9, 10, 11           | Review and maintain ongoing coastal monitoring program to identify early changes to shoreline conditions and risks   | No                                   | Ongoing                         | Not started   | Manager Infrastructure Services         |
| 11                  | Receive legal advice to clarify the liability of the City in the event of coastal climate change risk scenarios  | No                                   | Short Term (2021 to 2023)       | Not started   | Manager Infrastructure Services         |
| 10, 11              | Engage with the community and stakeholders to raise awareness of coastal risks and increase collaboration  | No                                   | Short Term (2021 to 2023)       | Not started   | Manager Infrastructure Services         |
| 9, 10, 11           | Prepare site specific foreshore management plans to provide an implementation framework for coastal adaptation measures, including managed retreat or defence as appropriate to the site | No                                   | Short Term (2021 to 2023)       | Not started   | Manager Infrastructure Services         |
| 9, 10, 11           | Design and implement coastal adaptation measures as required and in alignment with the Coastal Adaptation Plan and foreshore management plans  | Yes                                  | Ongoing                         | Not started   | Manager Infrastructure Services         |

| Relevant risks                  | Action Description   | Is action currently being addressed? | Action Priority            | Action Status | Action Owner                            |
|---------------------------------|--|--------------------------------------|----------------------------|---------------|---|
| 9, 10, 11                       | Review and update planning schemes and controls according to latest coastal hazard information and legal advice and best-practice coastal engineering.   | No                                   | Medium Term (2024 to 2027) | Not started   | Manager Strategic planning              |
| 10, 11                          | Design for climate resilience and with consideration to the most appropriate sea level rise predictions for any expansion of Marina infrastructure or the development of other coastal structures.   | Yes                                  | Ongoing                    |               | Manager Infrastructure Services         |
| 9, 10, 11                       | Advocate for State and Commonwealth funding towards coastal adaptation measures  | Yes                                  | Ongoing                    |               | Manager Infrastructure Services         |
| <b>Urban Forest</b>             |  |                                      |                            |               |   |
| 7                               | Implement to Urban Forest Plan 2018- 2028 to increase canopy cover and enhance resilience of the City urban forest.  |                                      | Short Term (2021 to 2023)  |               | Manager Parks and Environment           |
| 7                               | Update the Local Planning Strategy to improve retention of mature trees in Cockburn  |                                      | Now (2020 to 2021)         |               | Manager Strategic Planning              |
| 7                               | Adopt the Local Planning Policy 1.2 Residential Design Guidelines to mandate deep soil zone for trees in new grouped dwellings.  |                                      | Now (2020 to 2021)         |               | Manager Strategic Planning              |
| 7                               | Create a plan for climate resilient green spaces to reduce irrigated grass and increase hydro zoning and tree canopy in identified streetscapes and public open space  |                                      | Medium Term (2024 to 2027) |               | Manager Parks and Environment           |
| <b>Community Infrastructure</b> |  |                                      |                            |               |   |
| 17, 6, 4                        | Review capacity of existing Council buildings to withstand more severe storms and retrofit as appropriate as and if required to meet updated building codes  |                                      | Now (2021 to 2022)         |               | Manager Infrastructure Services         |
| 4                               | Review the frequency of reactive and preventative maintenance performed on the City's infrastructure assets to identify potential gaps in service and develop an environmentally and financially sustainable methodology for maintenance, renewal and repair |                                      | Medium Term (2024 to 2027) |               | Manager Infrastructure Services         |
| 2, 17                           | Continue to ensure all proposed Structure Plans are accompanied and informed by a Bushfire Management Plan where required.   | Yes                                  | Ongoing                    |               | Manager Strategic Planning              |
| 2, 17                           | Ensure all City owned buildings (within Bushfire Prone Areas) have Bushfire Risk Assessment completed.   | Yes                                  | Ongoing                    |               | Manager Statutory Planning              |
| 2, 17                           | Continue to ensure that the new building design approval process (within Bushfire Prone Areas) incorporates bush fire management.  | Yes                                  | Ongoing                    |               | Manager Recreation and Community Safety |

| Relevant risks                     | Action Description   | Is action currently being addressed? | Action Priority           | Action Status | Action Owner                            |
|------------------------------------|--|--------------------------------------|---------------------------|---------------|---|
| 2, 5, 17, 6, 4                     | Design building for climate resilience and improve energy management, through implementation of ESD guidelines   |                                      | Now (2020 to 2021)        |               | Manager Infrastructure Services         |
| 6                                  | Continue to implement Drainage Management Strategy 2018 - 2028.  |                                      | Now (2020 to 2021)        |               | Manager Engineering                     |
| <b>Public Health and Wellbeing</b> |  |                                      |                           |               |   |
| 1, 15, 12, 13                      | Undertake a climate change health vulnerability assessment and map vulnerable residents and areas.   | Yes                                  | Short Term (2021 to 2023) |               | Manager Environmental Health            |
| 1, 15, 12, 13                      | Review, update and implement the Public Health Plan including actions that reduce climate change risk to public health including heat stress, increases in mosquito and vector borne disease, food poisoning, nuisance species, bushfires, pandemics extreme weather events, etc | Yes                                  | Short Term (2021 to 2023) |               | Manager Environmental Health            |
| 15                                 | Continue to update and implement shade strategy for community facilities, playgrounds, parks and beaches.  | Yes                                  | Ongoing                   |               | Manager Parks and Environment           |
| 1, 12                              | Review, update and implement the Bushfire Risk Management Plan and Local Emergency Risk Management Plan.   | Yes                                  | Short Term (2020 to 2021) |               | Manager Recreation and Community Safety |
| 1, 15, 12, 13                      | Provide education programs to assist the public prepare for emergency situations.  | Yes                                  | Ongoing                   |               | Manager Recreation and Community Safety |
| 1, 15, 12, 13                      | Review existing warning systems and identify potential gaps and opportunities for improvement.   | Yes                                  | Short Term (2021 to 2023) |               | Manager Recreation and Community Safety |
| 1, 15, 12, 13                      | Provide updated information to assist the public understand the impacts of climate changes and empower them to take action to build resilience   | Yes                                  | Short Term (2021 to 2023) |               | Manager Parks and Environment           |

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