Positive Change - Climate Change Risks and Opportunities for the Cairns Region

Climate Change Adaptation Action Plan

Cairns Regional Council

3 June 2009
**Quality Information**

Document: Positive Change - Climate Change Risks and Opportunities for the Cairns Region  
Ref: 60048375  
Date: 3 June 2009  
Prepared by: Andrew Zuch  
Reviewed by: Nicole Moffatt

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<td>0</td>
<td>03/06/2009</td>
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Executive Summary

Cairns Regional Council commissioned AECOM Australia Pty Ltd (AECOM) to assess the climate change risks and opportunities to their ‘urban management systems’.

The Intergovernmental Panel on Climate Change (2007) has assessed Far North Queensland as one of six key ‘hot spots’ in Australia where the impacts of climate change are likely to be significant. Climate change projections prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) in 2007 informed this climate change risk assessment. These suggest that the future climate of Eastern Australia will generally be characterised by:

- Lower average rainfall;
- More intense extreme rainfall events;
- Higher sea-level and storm surge events;
- Higher average temperatures;
- More frequent occurrence of extreme temperatures; and
- More frequent extreme fire danger days.

In responding to climate change there are two broad strategies. The first is climate change mitigation, which refers to actions designed either to reduce or to capture and store greenhouse gas emissions. The second is climate change adaptation, which refers to actions or adjustments made to cope with the physical impacts of changing climatic conditions. The identification of climate change risks and actions to adapt to climate change are the focus of this project.

In moving forward on climate change adaptation, and in an effort to prioritise future action, Cairns Regional Council elected to undertake a climate change risk assessment to better understand and capture the range of climate change risks and opportunities that the Council may encounter in the delivery of its services to the community. A qualitative risk assessment has been undertaken and possible climate change adaptation actions identified for risks that were assessed as being a high priority for climate change adaptation action (Appendix D). The risk assessment was undertaken in accordance with Cairns Regional Council’s risk management framework, which is consistent with the Australian and New Zealand Standard AS/NZS 4360 Risk Management. For both 2030 and 2070, the extreme risks are most commonly associated with:

- Sea-level rise;
- Increasing storm surges;
- More intense tropical cyclones; and
- More intense rainfall.

This adaptation action plan presents:

- A summary of potential climate changes for the Cairns region;
- An overview of the climate change risk assessment and adaptation action planning process;
- Identified and prioritised climate change risks to ‘urban management systems’ for Cairns Regional Council;
- Possible climate change adaptation actions for Cairns Regional Council; and
- Guidelines and recommendations for continued action to identify and adapt to potential climate changes and their associated risks.
The management of climate change risk and opportunity should be an integrated responsibility within all areas of Cairns Regional Council’s decision-making. Council’s governance arrangements will need to reflect its commitment to the treatment of climate change risks and its desire to take up relevant opportunities. This will require a coordinated and collaborative approach. An adaptive management framework providing support for of Cairns Regional Council’s departments to deliver climate change adaptation will be required.

The recommendations provided below are a ‘blueprint’ for Cairns Regional Council to move forward on climate change adaptation. Many of the actions entailed in these recommendations will be beyond the current financial capacity of Cairns Regional Council. Cairns Regional Council should prioritise the actions its wishes to implement directly, and seek funding support for them through its internal budgetary processes. Cairns Regional Council should also seek external funding support for priority climate change adaptation actions. Seeking external funding support can occur both proactively through representation and advocacy to the Queensland and Commonwealth Governments, and opportunistically by having the business case(s) developed ready for submission to funding programs as they arise.

**Corporate Governance**

1. Directly recognise the challenge that climate change presents to the Cairns region in the new Cairns Regional Council Corporate Plan.

2. Establish a dedicated climate change team within Cairns Regional Council to coordinate the Council’s ongoing climate change response.

3. Develop a climate change awareness raising program within Cairns Regional Council to build the capacity of officers to consider climate change impacts in their daily decisions.

4. Prepare climate change guidance materials to support Cairns Regional Council’s decision-making on climate change and ensure consistency in assessing climate change risks, and consistency in the assumed levels of climate change impacts across different areas in Council.

5. Require agenda items presented to Council to discuss the implications of climate change (both adaptation and greenhouse gas emissions) within either the ‘Sustainability’ or ‘Risk’ sections of the agenda item template.


7. Engage with the community on the possible impacts of climate change and the steps Cairns Regional Council has taken to better understand its exposure and prepare for it.

8. Require the outcomes of this assessment of climate change risks and opportunities to be considered in the annual review of the corporate risk register.

9. Develop an assessment and evaluation framework to evaluate the relative costs and benefits to the community of Cairns resulting from adaptation actions.

10. Require Cairns Regional Council’s departments to evaluate the possible climate change adaptation actions relevant to them against the assessment framework and identify the preferred climate change adaptation actions for their business.
11. Require relevant departments to undertake detailed project planning for their preferred adaptation actions, including the development of performance indicators and measures within the context of Cairns Regional Council’s strategic, budgetary and operational planning procedures.

12. Make it a formal requirement for climate change to be considered in business continuity, natural disaster, asset management and service delivery planning.

13. Adopt a ‘process based’ performance reporting approach for whole-of-council reporting on climate change adaptation action.

14. Plan for, and negotiate with staff and unions for more flexible working and contracting arrangements, including staff multi-tasking.

15. Monitor developments and legal precedents in climate change legislation and liability and, as required, reassess Cairns Regional Council’s insurance requirements and potential liabilities.


**Land Use Planning and Development**

17. Assess and map the areas within the jurisdiction of Cairns Regional Council that are vulnerable to climate change impacts.

18. Assess the changing levels of flood immunity resulting from climate change, especially from more intense rainfall events and higher storm surge heights.

19. Review the materials and information that guides Cairns Regional Council’s land use planning and development assessment activities to determine where amendments are necessary to incorporate the consideration of climate change impacts.

20. Monitor developments and amendments to technical standards, codes and guidelines to accommodate climate change considerations (especially with respect to flooding). As appropriate, based on an analysis of cost and benefits, apply them in land use planning, development assessment and infrastructure design processes.

21. Engage with the Department of Infrastructure and Planning to ensure Cairns Regional Council’s adaptation approach for land use planning and development is consistent with the direction provided on how climate change should be considered in regional infrastructure planning and delivery in the Far North Queensland Regional Plan 2009-2031.

**Assets and Operations**

22. Assess and map the assets and operations of Cairns Regional Council that are vulnerable to climate change impacts.

23. Require climate change risk assessments to be undertaken for major Council projects on a project-by-project basis.
24. Prioritise the assets and operations of Cairns Regional Council that require maintenance or upgrades to cater for changing climatic conditions.

25. Progressively upgrade Cairns Regional Council’s drainage and transport networks to provide a higher level of flood immunity.

26. Monitor technological developments in materials and construction techniques to make infrastructure more resilient to climate change impacts. As appropriate, based on an analysis of cost and benefits, apply them in land use planning, development assessment and infrastructure design processes.

27. Review Cairns Regional Council’s asset management plans to ensure climate change is considered in decisions about asset maintenance, upgrading and replacement.

28. Review Cairns Regional Council’s business continuity plans for essential operations that are not fixed spatially to ensure the possible impacts of climate change on service delivery are considered.

29. Engage with the Department of Infrastructure and Planning to ensure Cairns Regional Council’s adaptation approach for assets and infrastructure is consistent with the direction provided on how climate change should be considered in regional infrastructure planning and delivery in the Far North Queensland Regional Plan 2009-2031.

30. Engage with other infrastructure and service planners and providers in the Cains region, where disruption to their business from climate change could cause disruption to Cairns Regional Council’s business or influence its adaptation approach.

31. Advocate for, and participate in the development of a comprehensive assessment of climate change risks and an adaptation action plan for infrastructure in the region.

**Natural disaster planning and response**

32. Enhance Cairns Regional Council’s natural disaster coordination capacities, including establishing a new flood immune disaster coordination centre.

33. Enhance Cairns Regional Council’s natural disaster response capacity to cater for potentially more frequent and more extreme natural disasters.

34. Update storm surge maps for the Cairns region to take account of projected changes in storm surge heights resulting from higher sea levels and more intense tropical cyclones.

35. Ensure the potential impacts of climate change are considered in the development of business continuity plans for essential Cairns Regional Council services.

36. Identify flood immune community evacuation routes, taking into consideration the changing patterns of flood immunity arising from climate change.

37. Enhance community and business awareness of the risks associated with natural hazards and measures they can put in place to reduced their individual vulnerability and build their resilience.
38. Engage with agencies that have responsibilities for natural disaster planning and response including the Queensland Department of Community Safety, the Bureau of Meteorology and other emergency planning and response organisations to ensure a regional approach is taken in planning for potentially more frequent and more intense natural disasters.

Environment

39. As Cairns Regional Council’s natural resource management and environment strategies and management plans are reviewed and updated, incorporate consideration of the potential impacts of climate change.

40. Engage with natural resource management and environment agencies in the Cairns region to advocate for, and participate in the development of a comprehensive assessment of climate change risks and an adaptation action plan for the natural environment of the Cairns region.

41. Engage with the Department of Infrastructure and Planning to ensure that Cairns Regional Council’s proposed climate change adaptation actions for the environment are consistent with the direction provided in the Far North Queensland Regional Plan 2009-2031.

42. Review Cairns Regional Council’s erosion and sediment control management practices to determine if they are adequate to cater for projected increase in intense rainfall events.

Community health

43. Enhance community and business awareness of the public health risks arising from climate change and the practical steps they can put in place to reduce their risks.

44. Undertake scenario based planning to ensure appropriate strategies and sufficient resources are in place to response to potentially more frequent and more severe public health incidents.

45. Review public health management programs on a regular basis to ensure that are maintained at a level that is capable of meeting any additional demand arising from climate change.

46. Clarify Cairns Regional Council’s role in community health to determine where climate change, community health and ‘urban management systems’ intersect.

47. Engage with other regional health agencies including the Queensland Department of Health, Queensland Department of Community Safety, Queensland Department of Communities and health related professional associations to advocate for, and participate in, the development of a comprehensive assessment of climate change risks and the development of an adaptation action plan for community health in the region.

Barriers and Information Gaps

A range of barriers and information gaps in were identified that will affect the short to medium term implementation of a number of the possible climate change adaptation actions identified in this project. The identified barriers and information gaps include:

- Lack of local scale and uncertain climate change projections;
- Development cannot be prohibited under land use planning legislation;
- Changes to planning instruments to take into account the future impacts of climate change may trigger compensation processes or create legal liability exposure;
• Existing land use planning frameworks do not provide adequate and consistent benchmarks for key climate change variables to inform planning decisions;
• State and regional strategic planning frameworks do not provide adequate guidance for local government on how to address climate change impacts in local planning instruments;
• Technical guidelines, codes and standards do not consider climate change;
• Inability to evaluate the economic costs and benefits of climate change adaptation actions;
• Limited financial capability to implement climate change adaptation actions;
• The emerging legal framework for climate change; and
• The role and influence of other levels of government in climate change adaptation.

It will be necessary for Cairns Regional Council to identify how best to overcome these barriers and information gaps as part of the broader climate change adaptation response. This may necessitate action either directly by Cairns Regional Council, and/or were appropriate representation to the level of government which is in the best position to address the barrier(s).
1.0 Background

1.1 The Case for Responding to Climate Change

1.1.1 Intergovernmental Panel on Climate Change Assessments

Since 1990, the Intergovernmental Panel on Climate Change (IPCC) has provided regular scientific assessments of past, present and future climate. Four scientific assessments have been undertaken to date – in 1990, 1996, 2001 and 2007.

The IPCC Fourth Assessment Report (IPCC, 2007) concluded that:

- Warming of the climate system is unequivocal;
- Most of the warming in the past 50 years is ‘very likely’ (more than 90% in probability) due to the observed increase in greenhouse gas concentrations from human activities such as the burning of fossil fuels and land use change; and
- It is ‘very likely’ that changes in the global climate system will continue well into the future, and that they will be larger than those seen in the recent past.

The IPCC has also identified coastal areas of Australia as highly exposed to potential climate change impacts, including from sea level rise and due to increased frequency and velocity of extreme weather events (Christensen et al., 2007).

1.1.2 Responding to climate change

Through its Corporate Sustainability Policy, Cairns Regional Council has committed to applying the principles of sustainability to all of its decision-making and activities. One of the stated intents of the Council’s Corporate Sustainability Policy is to ‘respond to the challenge of climate change’.

In responding to climate change there are two broad strategies. The first is climate change mitigation, which refers to actions designed either to reduce or to capture and store greenhouse gas emissions. The second is climate change adaptation, which refers to actions or adjustments made to cope with the physical impacts of changing climatic conditions.

The Garnaut Climate Change Review (2008) concluded that as a result of past actions, the world is already committed to a level of warming that could lead to high-consequence climate change outcomes. The Garnaut Review further concluded that governments may yet fail to put in place substantial mitigation, in which case the challenge of adaptation to climate change will be more daunting.

Research indicates that there are significant economic benefits to responding early to climate change. The Stern Review on the Economics of Climate Change (2006) highlighted that adaptation will be crucial to reducing vulnerability to climate change, and is the only way to cope with its inevitable impacts over the next few decades (OCC, 2008). In simple terms, adapting to climate change earlier will mean less impact on economic growth and lifestyle (DIP, 2009).

1.2 Climate Change in Far North Queensland

1.2.1 The vulnerability of Cairns to climate change

Our climate is changing and climate change could pose new risks that go beyond natural climate variability. Projections prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) suggest that it could make Queensland’s climate more variable and extreme in the future.

Cairns is highly susceptible to the impacts of climate change due to its low topography, tropical location and coastal development pattern. The majority of the region’s population, settlements and
infrastructure are located on the coastal strip at sea-level and these are prone to severe weather events such as tropical cyclones, flooding and storm surges. The area is experiencing rapid growth, which is also projected into the future, potentially increasing the region’s vulnerability to the impacts of climate change and decreasing the resilience of natural systems to climate change.

People in the Cairns region will be affected, with climatic change causing more heat-related health problems, a higher incidence of mosquito borne diseases, and increased exposure to catastrophic events, such as cyclones, flooding and droughts. Climate change is also likely to compound the effects of existing threats, such as development-related habitat loss and fragmentation. It is therefore important to both reduce these existing threats and enhance natural ecosystems and their supporting ecological processes to build their resilience to the expected impacts of climate change (DIP, 2009).

The Intergovernmental Panel on Climate Change (2007) assessed that Far North Queensland was one of six key ‘hot spots’ in Australia where the impacts of climate change are likely to be high, if adaptation does not occur. In addition to concerns over the impact of climate change on the natural environment of the region, potential large losses to the built environment from flooding, sea-level rise and storm surges associated with tropical cyclones were also identified.

Their assessment was based on criteria including large impacts, low adaptive capacity, substantial population, economic importance, substantial exposed infrastructure and subject to other major stresses, which include continued rapid population growth, ongoing development, ongoing land degradation, ongoing habitat loss, and threats from rising sea-level.

1.2.2 Projected climate change

In October 2007, the CSIRO and the Australian Bureau of Meteorology (BoM) released *Climate Change in Australia — Technical Report 2007* which provides the most recent climate change projections for Australia. The report is based on international climate change research including the latest IPCC conclusions, and built on a large body of climate research for the Australian region.

The climate change projections were developed using many climate models and a range of scenarios of future global greenhouse gas emissions that have been produced by the IPCC. Emission scenarios are based on various assumptions about demographic, economic and technological driving forces likely to influence the level of emissions in the future. These emission scenarios are then used to ‘force’ the climate models and projections of possible future climatic conditions are derived.
The CSIRO and BoM (2007) climate change projections suggest that the future climate of Eastern Australia will generally be characterised by:

- Lower average rainfall;
- More intense extreme rainfall events;
- Higher sea-level and storm surge events;
- Higher average temperatures;
- More frequent occurrence of extreme temperatures, and
- More frequent extreme fire danger days.

Small changes in annual and seasonal temperature and rainfall conditions can be associated with large changes in extreme weather events, such as heatwaves, storms, stronger winds, increased lightning and higher intensity rainfall, which are potentially of greater significance than changes in average conditions. Changes in extreme weather events that are projected for eastern Australia include:

- An increase in the frequency of hot days and warm nights, and a decrease in the frequency of cold nights;
- An increase in both daily precipitation intensity (rain per rain-day) and the number of dry days, leading to longer dry spells interrupted by heavier rainfall events; and
- El Niño events becoming drier and La Niña events becoming wetter (CSIRO and BoM, 2007).

The science highlights that it can be expected that there will be changes in the flood, bushfire and storm risk associated with the above changes in average climate conditions and extreme weather events.

The work of the IPCC and CSIRO also suggests that future changes in Queensland’s climate could be abrupt, with a possibility of ‘surprises’ because climate systems are complex and changes are difficult to predict (OCC, 2008). Some commentators suggest that IPCC assessments underestimate the risks of adverse climate change impacts, especially as they relate to sea-level rise (Rahmstorf et al, 2007).

A more detailed description of the climate change scenario that were considered in the risk assessment workshop is provided in Appendix A of this action plan.

### 1.2.3 Adapting to climate change

The IPCC indicated that the implications of climate change can be reduced with adaptation measures (IPCC, 2007). The latest international and national science indicates that climate change is happening now and will continue into the future and that adaptation is necessary. The Garnaut Climate Change Review Interim Report noted that adaptation has already begun in response to observed climate change, and more will be necessary to address the impacts resulting from unavoidable climate change (Garnaut, 2008).

Climate change adaptation is not a one-off exercise – it requires an adaptive management framework or process. Adaptation is a continual process of gaining new information, incorporating information about the risks from climate change into planning and decision-making and reviewing and evaluating decisions and actions. These key elements are highlighted in Figure 1.
Adaptation to climate change will require an ongoing and evolving risk management approach. Wherever possible, climate change should be included in existing public and private decision-making processes, such as asset management procedures. If climate change is considered in isolation, it may be given too much significance relative to other challenges, or alternatively not sufficiently taken into account where the risks are assessed as being high. Greenhouse gas emissions reduction should also be considered in climate change adaptation responses to ensure the two responses do not work against each other, especially where the effects of a decision are long lasting. When identifying and assessing adaptation options the economic, social and environmental impacts of the options also need to be considered. Finally, adaptation responses will need to be regularly reviewed, not only for their success, but also for their relevance as climate change projections and knowledge about impacts improves.

1.3 Positive Change – Climate Change Risks and Opportunities

1.3.1 Need for the climate change risk assessment

While Cairns Regional Council has been implementing action for a number of years to mitigate greenhouse gas emissions, such as its participation in Cities for Climate Protection, adapting to climate change is a relatively new issue for local government. With a suite of new climate change adaptation policy responses being delivered at all levels of government, Cairns Regional Council has decided that it is timely to begin focussing on the development of strategies to manage the unavoidable impacts of climate change and capture any potential opportunities that may arise from climate change.

In moving forward on climate change adaptation, and in an effort to prioritise future action, Cairns Regional Council elected to undertake a climate change risk assessment to better understand and capture the range of climate change risks and opportunities that the Council may encounter in the delivery of its services to the community.
1.3.2 Commonwealth Government requirements

The Commonwealth Department of Climate Change has provided funding for the Cairns Regional Council Climate Change Risks and Opportunities Assessment through its Local Government Adaptation Pathways Program (LAPP). The project involved an assessment of climate change risks and the development of an adaptation action plan for high priority climate change risks.

Projects funded through a LAPP grant are required to conduct their climate change risk assessments in alignment with the methodology outlined in *Climate Change Impacts and Risk Management: A Guide for Businesses and Government* published by the Department of Climate Change (formerly the Australian Greenhouse Office) in 2006.

Under the terms of the grant, Cairns Regional Council was required to enlist the services of an approved service provider to assist it to undertake its climate change risk assessment and conduct adaptation action planning. AECOM is a member of the Commonwealth Department of Climate Change’s climate change risk management panel of service providers under the LAPP and was commissioned for this project.

This adaptation action plan presents:

- A summary of potential climate changes for the Cairns region;
- An overview of the climate change risk assessment and adaptation action planning process;
- Identified and prioritised climate change risks to ‘urban management systems’ for Cairns Regional Council;
- Possible climate change adaptation actions for Cairns Regional Council; and
- Guidelines and recommendations for continued action to identify and adapt to potential climate changes and their associated risks.
1.4 Project Objectives

The objective of the Cairns Regional Council Climate Change Risks and Opportunities Assessment is to:

- Assess the risk(s) of climate change against a range of climate variables;
- Identify the priority risks for further focus and investigation;
- Formulate an action plan to provide adaptation strategies to high risk climate change impacts; and
- Identify any gaps in knowledge and available research.

1.4.1 Project scope

The assessment of climate change risks and development of climate change adaptation actions has been constrained to ‘urban management systems’ that are within the direct control and responsibility of Cairns Regional Council. This project scope recognises that:

- Considerable work has been already been undertaken in Cairns and the surrounding region to assess climate change risks (and begin adaptation planning) to natural systems such as the Wet Tropics and Great Barrier Reef through the responsible management authorities in association with stakeholders and the local communities; and
- A wider project scope would impact on the level of assessment that could be undertaken.

1.4.2 Urban management systems

The focus of the assessment of climate change risks and opportunities for Cairns Regional Council was on ‘urban management systems’. Urban management systems have been defined in this project as the local land use planning and development frameworks, and decision processes that define the form, and ongoing function of an urban community. This definition incorporates the planning, delivery and management of essential social and economic infrastructure and services, including:

- Land use planning;
- Environmental planning;
- Social and economic planning and resilience;
- Regionally significant recreational and cultural assets (planning, provision and management);
- Development assessment and building approvals (commercial and residential);
- Water supply and demand management;
- Infrastructure planning, construction and maintenance (roads, drainage and stormwater, water treatment and distribution, waste water and waste);
- Flood planning and drainage;
- Foreshore and waterways engineering and management;
- Water and vector borne diseases; and
- Disaster planning and response.

1.4.3 Risk assessment methodology

The risk assessment was qualitative and consistent with the:

- Department of Climate Change’s (formerly the Australian Greenhouse Office) Climate Change Impacts and Risk Management: A Guide for Businesses and Government;
- Cairns Regional Council’s risk management policy and procedures; and
- Australian and New Zealand Standard AS/NZS 4360 Risk Management.
The project did not involve the development of detailed information for inclusion in Cairns Regional Council’s corporate risk register, or the preparation of detailed risk treatment plans in the format prescribed in the Cairns Regional Council risk management policy and procedures.

Further detail on the project methodology is provided in section 2.0 of this report.

1.4.4 Project exclusions

Risks to ‘urban management systems’ that Cairns Regional Council does not control are not with the scope of this project. Risks arising from strategies to reduce greenhouse gas emissions and the introduction of new greenhouse gas emissions policy and legislative requirements such as the proposed Carbon Pollution Reduction Scheme and National Greenhouse Gas and Energy Reporting System were also not within the scope of this project.
2.0 Methodology

A risk management approach was adopted to identify climate change risks to Cairns Regional Council’s ‘urban management systems’. A climate change risk is derived from the likelihood of a climatic change occurring, combined with the consequences that would be experienced if that climatic change occurred. Adaptation actions were then developed for high priority risks, as evaluated using Cairns Regional Council’s risk management framework. This work was undertaken through an iterative project methodology, the major stages of which included:

- Project inception and confirmation of project objectives and scope;
- Project research and preparation of a background briefing paper;
- A climate change risk assessment workshop;
- A climate change adaptation workshop; and
- Preparation of a climate change adaptation action plan.

Additional work is required to identify the preferred adaptation actions from the list of possible actions generated from this project. This work is beyond the scope of this project, but is briefly discussed in section 2.5 of this action plan.

The major project stages are illustrated in Figure 2 and outlined in more detail in the following sections.
Figure 2 The major project stages of the climate change risk assessment and adaptation action plan development
2.1 Project Inception and Confirmation of Project Objectives and Scope

Confirmation of the project objectives and scope occurred through a project inception meeting with Cairns Regional Council and targeted internal and external stakeholder interviews. The climate change scenarios considered in the risk assessment were also confirmed at this stage.

2.1.1 Project inception meeting

On commencement of the project, AECOM project team members met Cairns Regional Council’s project manager to discuss and confirm the intended project focus and major project phases. The key output of this was the preparation of a project management plan, supported by a project communications strategy.

2.1.2 Stakeholder interviews

As part of the research stage of the project, interviews were held with internal and external stakeholders. The outcomes of these interviews were used to refine the project definition of ‘urban management systems’ and identify the information and supporting materials that would need to be provided to participants in the climate change risk assessment workshop.

2.1.2.1 Internal stakeholders

Representatives from a broad range of Cairns Regional Council functional and service areas were interviewed in a semi-structured format to:

- Gain an insight to the level of awareness of climate change and its potential risks within Cairns Regional Council;
- Refine the project definition of ‘urban management systems’; and
- Determine the level of experience workshop participants had in risk assessment.

The Cairns Regional Council business areas that were interviewed included:

- Cairns Water and Waste;
- Planning and Environment;
- Community and Cultural Services;
- Corporate Services; and
- Works and Services (including Natural Disaster Management).

2.1.2.2 External stakeholders

A range of external stakeholders, who could influence how Cairns Regional Council adapts to climate change, were also interviewed in a semi-structured format to gauge the broader awareness of climate change and its potential risks. External stakeholders that were interviewed included:

- Department of Transport and Main Roads;
- Cairns Port Authority (emailed responses to questions);
- Department of Infrastructure and Planning;
- Department of Local Government, Sport and Recreation; and
- Emergency Management Queensland.
2.2 Background Briefing Paper

A pre-workshop briefing paper was prepared and distributed to all workshop participants. The purpose of the background briefing paper was to ensure that all of the participants had a common understanding of the climatic changes that might be experienced in the Cairns region, the project scope and the risk assessment methodology. The briefing paper included:

- A description of the project;
- Information on Cairns Regional Council’s risk management framework;
- Climate change projections for Queensland and the Cairns Region;
- The climate change scenarios to be used in the workshop; and
- Information on indicative climate change affects on local governments.

The development of the background briefing paper was informed by the outcomes of the project inception meeting and stakeholder interviews.

2.3 Risk Assessment Workshop

A qualitative assessment of potential climate change risks was undertaken consistent with the:

- Department of Climate Change’s (formerly the Australian Greenhouse Office) *Climate Change Impacts and Risk Management: A Guide for Businesses and Government*;
- Cairns Regional Council’s risk management policy and procedures; and
- *Australian and New Zealand Standard AS/NZS 4360 Risk Management.*
2.3.1 Cairns Regional Council’s risk management framework

The risk assessment was undertaken in accordance with Cairns Regional Council’s risk management framework, which is consistent with the Australian and New Zealand Standard AS/NZS 4360 Risk Management.

The key objectives of Council’s risk management framework are to:

- Implement effective risk management as a key element of good governance and rigorous performance management;
- Consider risk as an integral part of corporate and service delivery planning;
- Encourage considered and responsible risk taking as a legitimate response to opportunity and uncertainty;
- Achieve better outcomes for Council through a more realistic assessment of the challenges faced through improved decision-making and targeted risk treatment and control; and
- Engender, reinforce and replicate good practice in risk management.

Cairns Regional Council’s five-stage risk management framework is illustrated in Figure 3. The process provides a systematic approach to the identification, analysis, treatment and monitoring of risks. The five major steps include:

- Establishing the risk assessment context;
- Identifying the risks;
- Analysing the risks;
- Evaluating the risks; and
- Treating the risks.

The workshop briefing paper and interviews established the context for the risk assessment - stage one of Cairns Regional Council’s risk assessment framework. The climate change risk assessment workshop identified, analysed, evaluated and prioritised the climate change risks - stages two to four of the risk management framework. Possible risk treatments were identified in the climate change adaptation workshop - stage five of Cairns Regional Council’s risk assessment framework.
2.3.1.1 Assessing climate change risk likelihood and consequence

Because the risk assessment was qualitative, it relied on the application of experience, knowledge and intuition of the individuals who participated in the risk assessment workshop. When assessing the likelihood of a climate change risk, consideration was given to the probability of the event occurring. When assessing the consequence of a climate change risk, consideration was given to the outcome of the climate change impact. The likelihood and consequence of the climate change risks, along with the resulting risk rating were determined in accordance with the descriptors provided in the Cairns Regional Council risk management framework. Tables 1 and 2 provide the Cairns Regional Council risk likelihood and consequence descriptors.

### Table 1 Cairns Regional Council risk likelihood descriptors

<table>
<thead>
<tr>
<th>Level</th>
<th>Description (As per AS/NZS 4360)</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>The event is expected to occur in most conditions</td>
<td>Expected frequency range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greater than one or more per annum</td>
</tr>
<tr>
<td>Likely</td>
<td>The event will probably occur in most conditions</td>
<td>Expected frequency range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Between one in 5 years and one per annum</td>
</tr>
<tr>
<td>Possible</td>
<td>The event should happen at some time</td>
<td>Expected frequency range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Between one in 10 years and one in 5 years</td>
</tr>
<tr>
<td>Unlikely</td>
<td>The event could happen at some time</td>
<td>Expected frequency range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Between one in a 100 years and one in 10 years</td>
</tr>
<tr>
<td>Rare</td>
<td>The event may only occur in exceptional circumstances</td>
<td>Expected frequency range</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less than one in a hundred years</td>
</tr>
</tbody>
</table>
Table 2 Cairns Regional Council risk consequence descriptors

<table>
<thead>
<tr>
<th>Measure</th>
<th>Examples</th>
<th>Information &amp; Data</th>
<th>Property</th>
<th>People</th>
<th>Provision of Service / Performance</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Insignificant</td>
<td>Low financial loss (e.g. &lt;1% of revenue or budget).</td>
<td>Negligible loss of or damage to IT and communications. No loss of data.</td>
<td>Negligible damage to or loss of assets.</td>
<td>No significant injuries. No significant impact on personnel.</td>
<td>Short-term, localised interruption to service/performance. Negligible impact on reputation.</td>
<td>Minor breach of environmental policy/practices. Negligible impact on the environment.</td>
</tr>
<tr>
<td>2. Minor</td>
<td>Minor financial loss (e.g. 1% to 2% of revenue or budget).</td>
<td>Minor loss/damage to IT and communication. Some data catch-up may be required.</td>
<td>Minor loss/damage.</td>
<td>Small number of injuries; first aid or out-patients – treatment required. Some inconvenience to personnel.</td>
<td>Minor, temporary disruption to services. Minor inconvenience to client(s). May cause some complaints (justified or unjustified).</td>
<td>Minor localised impact; one-off situation easily remedied.</td>
</tr>
<tr>
<td>3. Moderate</td>
<td>High financial loss (e.g. 2% to 5% of revenue or budget).</td>
<td>Moderate to high loss of IT. Some data may be permanently lost. Workarounds may be required.</td>
<td>Moderate to high damage requiring specialist/contract or equipment to repair or replace.</td>
<td>A number of injuries requiring hospitalisation and long-term treatment. Moderate disruption to work routines and schedules.</td>
<td>Some serious disruption to services; some contravention of legal/contractual obligations. Significant complaints. Some adverse publicity.</td>
<td>Moderate impact on the environment; no long term or irreversible damage. May incur cautionary notice or infringement notice.</td>
</tr>
<tr>
<td>4. Major</td>
<td>Major financial loss (e.g. 5% to 10% of revenue or budget).</td>
<td>High risk of loss/corruption of data; significant catch-up will be required. Business continuity plans should be implemented.</td>
<td>Significant/permanent damage to assets and/or infrastructure.</td>
<td>Major disruption to work routines and practices. Additional resources may be required. Significant number of serious injuries requiring hospitalisation and long-term treatment. Small number of fatalities.</td>
<td>Major, long-term disruption to services. Serious breach of a legal/contractual obligations. Adverse publicity in regional/national media. Embarrassment to the organisation.</td>
<td>Severe impact requiring remedial action and review of processes to prevent re-occurrence. Penalties and/or direction or compliance order incurred.</td>
</tr>
<tr>
<td>5. Catastrophic</td>
<td>High financial loss (e.g. &gt; 10% of revenue or budget).</td>
<td>Extensive loss of/damage to assets and/or infrastructure. Permanent loss of data. Widespread disruption to the business.</td>
<td>Widespread, substantial/permanent damage to assets and/or infrastructure.</td>
<td>Long-term disruption to work practices and routines. Major disruption to work practices and routines. Major disruption to work practices and routines.</td>
<td>Long term/irreversible impact on ability to deliver client services. Widespread, ongoing national and possibly international media attention. Severe embarrassment to the organisation. Viability of the organisation in its current form is questionable.</td>
<td>Long-term, large-scale damage to habitat or environmental. Serious/repeated breach of legislation/licence conditions. Cancellation or licence and/or prosecution.</td>
</tr>
</tbody>
</table>
### 2.3.1.2 Rating climate change risks

Risk ratings were assessed by combining the likelihood and consequence rating for each risk, which enables a rating to be derived for each risk in accordance with the Cairns Regional Council risk assessment matrix. Figure 4 provides the Cairns Regional Council risk assessment matrix.

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequence</th>
<th>Insignificant</th>
<th>Minor</th>
<th>Moderate</th>
<th>Major</th>
<th>Catastrophic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Almost certain</td>
<td>M</td>
<td>52</td>
<td>H</td>
<td>64</td>
<td>E</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>36</td>
<td>M</td>
<td>48</td>
<td>H</td>
<td>60</td>
</tr>
<tr>
<td>Likely</td>
<td>M</td>
<td>44</td>
<td>H</td>
<td>56</td>
<td>E</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>28</td>
<td>L</td>
<td>40</td>
<td>M</td>
<td>52</td>
</tr>
<tr>
<td>Possible</td>
<td>L</td>
<td>20</td>
<td>L</td>
<td>32</td>
<td>M</td>
<td>44</td>
</tr>
<tr>
<td>Unlikely</td>
<td>L</td>
<td>20</td>
<td>L</td>
<td>32</td>
<td>M</td>
<td>44</td>
</tr>
</tbody>
</table>

**Legend**
- E: Extreme risk; immediate action required
- H: High risk; senior management attention needed
- M: Moderate risk; management responsibility must be specified
- L: Low risk; manage by routine procedures

**Note**
To assist in risk ranking, scores are allocated for each level of risk. The scores are derived from the following formula:

\[
\text{Risk} = (\text{Likelihood} \times 2) + (\text{Consequence} \times 3)
\]

(The result is multiplied by 4 to produce a scale of 20 to 100)

**Figure 4 Cairns Regional Council’s Risk Assessment Matrix**
2.3.2 Risk assessment workshop format

The risk assessment was conducted in a facilitated workshop format. Participants represented a broad range of Council business areas which have a functional interest in ‘urban management systems’. Within the workshop, four focus groups were formed to discuss the implications of climate change for urban management systems. The four focus areas were:

- Land use planning and development assessment;
- Council assets, infrastructure and operations;
- Governance and internal services; and
- Environment, recreation and community.

Within each focus area, risks were identified and assessed against a range of climate change variables. The variables that were considered included:

- Increasing average temperatures;
- More extremely hot days;
- Increasing evaporation;
- Average wind speed change;
- Sea-level rise;
- Increasing storm surges;
- More intense tropical cyclones;
- More intense rainfall;
- Declining average rainfall; and
- More frequent and more intense bushfires.

The risk assessment considered both changes to average weather conditions and extreme weather events. The risk assessment also considered the environmental, social and/or economic consequences of climate changes. A detailed description of the climate change scenarios considered in the workshop is provided in Appendix A of this action plan.

The initial workshop exercises focused on identifying and recording the broadest possible range of potential climate change risks through a ‘brainstorming’ process. These were subsequently refined over the course of the workshop, resulting in 51 risks defined and prioritised according to Cairns Regional Council’s risk management framework.

These risks were assessed for their likelihood and consequence in both 2030 and 2070. Tables 3 and 4 show the number of extreme, high, moderate and low rated risks for each of the workshop focus areas for 2030 and 2070 respectively.

As is the case with all risk assessments, the allocation of likelihood and consequence ratings against a risk and the subsequent risk rating is a subjective process. This is dependent on the experience and intuition of the individuals involved in the assessment. The uncertainties surround various aspects of climate change science, combined with the ongoing and long term nature of many of the potential impacts of climate change reinforce the subjective nature of these assessments. As a consequence, if different individuals assessed the same climate change risks, different risk ratings could potentially be derived.
Table 3 Extreme, high, moderate and low rated risks for each of the workshop focus areas for 2030

<table>
<thead>
<tr>
<th>Workshop Focus Group</th>
<th>Extreme Risk</th>
<th>High Risk</th>
<th>Moderate Risk</th>
<th>Low Risk</th>
<th>Total Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use planning and assessment</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Council assets, infrastructure and operations</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Governance and internal services</td>
<td>1</td>
<td>9</td>
<td>5</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Environment, recreation and community</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6</strong></td>
<td><strong>25</strong></td>
<td><strong>13</strong></td>
<td><strong>7</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>

Table 4 Extreme, high, moderate and low rated risks for each of the workshop focus areas for 2070

<table>
<thead>
<tr>
<th>Workshop Focus Group</th>
<th>Extreme Risk</th>
<th>High Risk</th>
<th>Moderate Risk</th>
<th>Low Risk</th>
<th>Total Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use planning and assessment</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Council assets, infrastructure and operations</td>
<td>7</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Governance and internal services</td>
<td>4</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>Environment, recreation and community</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
<td><strong>21</strong></td>
<td><strong>8</strong></td>
<td><strong>3</strong></td>
<td><strong>51</strong></td>
</tr>
</tbody>
</table>

As part of the post workshop review and data collation, the risks identified through the interview process were reviewed to confirm that all of the risks, which were discussed in the interviews, had been captured in the risk assessment workshop.

### 2.3.3 Interim report

The outcome of the risk assessment workshop was an interim report that:

- Presented the consolidated outcomes of the climate change risk assessment workshop;
- Sought whole-of-council feedback on the descriptions of the identified climate change risks;
- Confirmed the priority risks for the development of climate change adaptation actions; and
- Commenced identification of existing Council strategies and programs that could be used to treat the identified climate change risks.

The interim report presented the information and outcomes of the first four stages of Cairns Regional Council’s risk assessment framework and provided the foundations for the development of adaptation actions for the priority climate change risks.
For 2030, the six extreme risks are associated with socio-economic climate change implications on tourism, assets and infrastructure losses. For 2070, the 19 extreme risks are distributed relatively evenly across the four focus areas. However, the focus area with the highest number of extreme risks was Council assets, infrastructure and operations.

For both 2030 and 2070, the extreme risks are most commonly associated with one or more of the following climate change variables: sea-level rise; increasing storm surges; more intense tropical cyclones; and more intense rainfall.

Through the review of the interim report an additional climate change risk related to the psychological impacts on individuals and communities impacted by climate change was also identified. Two similar risks were also consolidated into one risk.

### 2.4 Climate Change Adaptation Workshop and Action Plan Development

#### 2.4.1 Application of the Cairns Regional Council risk management framework

The Cairns Regional Council risk management framework identifies that extreme risks require treatment strategies that reduce the residual risk to a manageable level, otherwise the risk will be considered intolerable. In a traditional risk assessment, risk treatment actions would need to be developed for all extreme or high risks.

However, as the purpose of this risk assessment was to inform the development of a climate change adaptation action plan, the development of risk treatments for every risk identified is not necessary. For example, investing in information and modelling to better understand the intensity and frequency changes for tropical cyclones and storm surges would be an appropriate initial adaptation action for a number of the identified risks. Additionally, there may be some lower rated climate change risks that Cairns Regional Council wished to development adaptation responses to, particularly where impacts are projected to occur in the near future.

Feedback on the interim report from Cairns Regional Council highlighted the climate change risks assessed as requiring adaptation action. These are presented in Appendix C to this action plan. In total, 29 climate change risks were assessed as requiring adaptation action planning.

#### 2.4.2 Climate change adaptation workshop format

The climate change adaptation workshop was conducted in a facilitated workshop format. The purpose of the workshop was to identify possible adaptation actions for the climate change risks confirmed as high priority for action through the feedback on the interim report.

Participants in the workshop represented a broad range of Council business areas which have a functional interest in ‘urban management systems’. Within the workshop, three focus groups were formed to discuss the possible climate change adaptation actions for ‘urban management systems’. The three focus areas were:

- Environment and community;
- Governance and disaster (planning and response); and
- Infrastructure and operations.

The two land use planning related risks identified for adaptation action where dealt with in the environment and community workshop focus area.

In preparing for the adaptation workshop, climate change risks that did not meet the project scope of ‘urban management systems’ were excluded, even if they were assessed as being high priority for adaptation action. Additionally, during the adaptation workshop, four flooding related risks were consolidated into two risks. The result of this is that adaptation action planning occurred for 27 risks.
Workshop discussions and activities focused on:

- Identifying existing policies, strategies or programs that could be used to treat the climate change risk;
- Assessing the relative effectiveness of the existing policies, strategies or programs in dealing with the climate change risk;
- Identifying modifications that would be required to existing policies, strategies or programs to ensure climate change is appropriately dealt with;
- Identifying new actions required to ensure climate change is appropriately dealt with;
- Evaluating the timeframe over which the adaptation action should occur;
- Identifying the positive and/or negative environmental, social and economic implications of the adaptation action; and
- Identifying any information gaps or barriers that might prevent the adaptation action being implemented.

Post workshop analysis resulted in this adaptation action plan for climate change risks to ‘urban management systems’ with the direct control and responsibility of Cairns Regional Council. Possible climate change adaptation actions are presented in Appendix D.
3.0 Possible Adaptation Actions

3.1 Possible Adaptation Actions

Possible adaptation actions have been identified for 27 climate change risks by the Cairns Regional Council officers attending the climate change adaptation workshop. These are presented in Appendix D to this action plan. The table also provides linkages to the current Cairns Regional Council Corporate Plan and the relevant departments nominally responsible for implementation, along with potential implementation timing.

The possible actions can be categorised into a number of key activity areas within Cairns Regional Council that require more detailed climate change adaptation attention, including:

- Corporate governance;
- Natural disaster planning and response;
- Land use planning and flooding;
- Assets and operations;
- Environment; and
- Community health.

The following sections provide a strategic overview of outcomes of the climate change adaptation workshop. It is not intended to be a detailed analysis of each possible adaptation action, but rather a higher level analysis that draws together and discusses common themes and directions across the various climate change risks and possible actions for each of the key areas.

The complete outcomes are presented in Appendix D. Cairns Regional Council workshop participants generated these possible adaptation actions and they do not represent specific recommended climate change actions by AECOM. They require collective and individual assessments to determine relative costs and benefits to Cairns Regional Council and the broader community. This process is discussed in section 3.2.

Once the preferred climate change adaptation actions have been identified, more detailed project planning can be undertaken within the context of Cairns Regional Council’s strategic, budgetary and operational planning procedures.

3.2 Corporate Governance

3.2.1 Identified climate change risks

Climate change risks to Cairns Regional Council's corporate governance and business practices that were assessed as being high priority for adaptation action can be generalised as relating to a:

- A failure to take the potential impacts of climate change into consideration in decisions;
- A need to change work practices and resourcing levels in the face of climate change; and
- Potential changes to Council’s liability exposure under changed climatic conditions.

3.2.2 Opportunities arising from climate change

Improved corporate governance and business practices were identified as a major opportunity arising from climate change adaptation initiatives. The necessity to identify mechanisms for climate change to be considered in Cairns Regional Council’s decision-making processes may identify efficiencies and improvements in the decision-making processes themselves.
3.2.3 Critical climate change adaptation response

The key climate change adaptation outcome that needs to be achieved is that the potential impacts of climate change are actively considered by Cairns Regional Council in its various decision-making processes. If potential climate change impacts are not actively considered, appropriate responses will not be identified or implemented. Experience has demonstrated that without formal ‘triggers’ to consider the potential impacts of climate change in decision-making processes, it is unlikely to occur.

3.2.4 Possible climate change adaptation actions

Possible climate change adaptation actions for Cairns Regional Council’s corporate governance span decision-making at the strategic, operational and tactical levels. Consideration of the potential impacts of climate change is required from planning through to program and project management activities. Identified climate change adaptation actions include:

Establishing Cairns Regional Council’s Climate Change Vision
- Recognising the challenge that climate change presents to Cairns, reflect this in the new Cairns Regional Council Corporate Plan. This will establish Council’s vision on how it will respond to climate change and confirm that the consideration of climate change will be embedded in its decision-making processes.

Requiring that agenda items presented to Council address climate change implications
- Making it a formal requirement that agenda items presented to Council discuss the implications of climate change within either the ‘Sustainability’ or ‘Risk’ sections of the agenda item template. To be effective, implementation of this initiative will need to be supported by staff capacity building and guidance materials to ensure it is applied in a consistent and rigorous manner.

Considering climate change in annual risk reviews
- Making it a formal requirement for climate change to be considered in annual risk reviews, business continuity, natural disaster, asset management and service delivery planning. Climate change presents new risks, but it also has the potential to amplify or dampen risks already included on Cairns Regional Council’s Corporate Risk Register and this needs to be considered when risk reviews occur. Climate change also has the capacity to affect the quality and continuity of Cairns Regional Council’s business, services and assets. Therefore it is an additional factor that needs active consideration. To be effective, implementation of this initiative will need to be supported by staff capacity building and guidance materials to ensure it is applied in a consistent and rigorous manner.

Planning for more flexible working and contracting arrangements
- Planning for more flexible working and contracting arrangements, including staff multi-tasking, will be important adaptation responses. Changed and more flexible work management practices could be required in the face of climate change to enable resources to be applied as either ‘pulse’ efforts in time of peak demand such as natural disaster response, or scheduled for times when climatic conditions are more suitable to certain types of work such as outdoor operations in the dry season. This will require discussion and negotiation with unions and possible amendments to enterprise workforce agreements.

Monitoring developments and legal precedents in climate change legislation and liability
- Monitoring developments and legal precedents in climate change legislation and liability and, as required, reassess Cairns Regional Council’s insurance requirements. This is required to ensure Cairns Regional Council has sufficient insurance for damage incurred to its assets, but also in recognition that claims may be lodged against Council in the future, based on its response to climate change.
Establishing a dedicated climate change team within Cairns Regional Council

- Establishing a dedicated climate change team within Cairns Regional Council to lead the Council’s climate change response. This will be important in ensuring consistency of effort in assessing climate change risks, and consistency in the assumed levels of climate change impacts (likelihood and consequence) across different areas in Council. It will also facilitate whole-of-council reporting on actions taken to plan for and adapt to climate change. This would also help to overcome the fact that many climate change strategies have failed to secure collective ownership and joint responsibility because they have been perceived as an ‘environmental’ issues, rather than an economic or community well-being issue.

Undertaking a ‘strategic review’ of Cairns Regional Council’s exposure to climate change

- Undertaking a ‘strategic review’ of Cairns Regional Council’s exposure to climate change. This project has assessed the potential climate change risks to ‘urban management systems’ and identified possible adaptation actions for priority climate change risks. The outcomes of this work will help mainstream the consideration of climate change impacts in specific work areas. However, it has not examined climate change risks to other areas such as the natural environment of the region, nor will it result in whole-of-council appreciation of how Cairns Regional Council is exposed to climate change. For example, what infrastructure and services will be required (or not required) in changed climatic conditions or the ability of Council to raise revenue in the face of climate change. It will also be necessary to assess climate change risks and opportunities for areas outside the scope of this project.

Developing an integrated Climate Change Strategy

- In progressing the possible climate change adaptation actions, linkages between them and work being or planned to be undertaken by Cairns Regional Council in reducing greenhouse gases will be identified. Care will need to be taken to ensure that action to adapt to climate change does not increase greenhouse gas emissions. If not planned appropriately, greenhouse gas mitigation measures can increase local vulnerability to climate change, and measures for adaptation can increase the local emissions of greenhouse gases. The development of an integrated strategy provides the framework for the required integrated approach. It also elevates the profile of the issue within Council and the community. This work could be lead by the dedicated climate change team to ensure climate change considerations are embed into corporate policies, strategies and operations.

Engaging with the Cairns community on climate change adaptation

- Engaging with the community on the possible impacts of climate change and the steps Cairns Regional Council has taken to better understand its exposure and prepare for it. This could be undertaken as part of the development of Cairns Regional Council’s integrated climate change strategy. Consideration will need to be given to the most appropriate engagement methods and forums.

Reviewing Cairns Regional Council’s climate change response

- Reviewing Cairns Regional Council’s approach to climate change adaptation and greenhouse gas mitigation in 2013. The science of climate change is evolving and it will be necessary to regularly review the adaptation approach to ensure that actions remain relevant and are being undertaken at the scale and intensity required to adapt to the projected climatic changes. In the long term, Cairns Regional Council’s climate change adaptation approach will need to accommodate the possible effect of any future acceleration of the projected changes, and the nominated review period enables these factors to be taken into consideration.
3.3 Natural Disaster Planning and Response

3.3.1 Opportunities arising from climate change

Improved natural disaster planning and response was identified as a major opportunity arising from climate change adaptation initiatives. Climate change also provides additional impetus for, and increases the importance of, a range of natural disaster planning and response activities that are being, or are planned to be, undertaken by Cairns Regional Council. The necessity to review and progressively incorporate climate change considerations in natural disaster planning and response was perceived as making Cairns better prepared for the range of natural hazards it is currently vulnerable to.

3.3.2 Identified climate change risks

The early impacts of climate change are most likely to be experienced through climatic and weather-related natural disasters related to more intense rainfall, tropical cyclones, storm surges, hail storms, landslips, bushfires and heatwaves. Climate change has the potential to change the frequency and intensity of these extreme weather and climatic events. The climate change risks that were assessed as being high priority for adaptation action can be generalised as a:

- Failure to plan for potentially more frequent and more intense extreme weather and climatic events; and
- Lack of capacity to respond to such events.

3.3.3 Critical climate change adaptation response

The critical climate change adaptation outcome that needs to be achieved is that the potential impacts of climate change are actively considered in natural disaster planning and management arrangements. This includes ensuring that Cairns Regional Council has a sufficient capacity to respond to potentially more frequent and more extreme natural hazards.
In the face of climate change, enhanced natural disaster planning, response and recovery all have elevated importance. The critical climate change adaptation responses include:

- Enhancing Cairns Regional Council’s natural disaster coordination capacities, including establishing a new flood immune disaster coordination centre;
- Updating storm surge maps to take account of projected changes in storm surge heights resulting from higher sea levels and more intense tropical cyclones;
- Preparing business continuity plans for essential Cairns Regional Council services;
- Ensuring flood immune evacuation routes are available;
- Enhancing community and business operator awareness of the risks associated with natural hazards and measures they can put in place to reduced their individual vulnerability and build their resilience;
- Enhancing Cairns Regional Council’s capacity to respond to potentially potential more frequent and more extreme natural hazards; and
- Engaging agencies that have an interest in natural disaster planning and response including the Queensland Department of Community Safety, the Bureau of Meteorology and other emergency planning and response organisations.
3.4 Land Use Planning and Development

3.4.1 Identified climate change risks

Climate change risks to Cairns Regional Council’s land use planning and development primarily related to flooding and can be generalised as a:

- Failure to consider climate change impacts in planning decisions because of inflexible planning legislation not being readily adaptable to incorporate new scientific and technological advancements;
- Lack of capacity in existing drainage systems to cope with more intense rainfall events;
- Failure of hydrological modelling and flood planning to incorporate climate change impacts; and
- Loss of land, infrastructure, assets and visual amenity from the impacts of climate change.

Photo courtesy of Cairns Regional Council
3.4.2 Case Study – Leading Practice in Considering Climate Change in Planning

A recent review of how land use planning and development assessment by local governments is dealing with climate change identified that ‘leading practice’ for planning for climate change is at an early stage of development (Gurran et al., 2008). Leading practice has included specifying climate change parameters for planning and development assessment purposes, such as what has occurred in Byron Shire where they have specified a 100 year planning period as the preferred planning period for any strategic study, document, policy or plan that may be affected by climate change. Byron Shire also nominated climate change scenarios for planning purposes including: temperature rise; more intense rainfall; sea level rise; increased storm surge heights; and tropical cyclone intensification. Box 1 provides an overview of current leading practice.

Box 1 Leading practice in land use planning for climate change mitigation and adaptation

The University of Sydney has reviewed current planning practice with respect to considering climate change for the National Seachange Taskforce in their report entitled ‘Planning for Climate Change: Leading Practice Principles and Models for Sea Change Communities in Coastal Australia’. Leading practice for plan making and development assessment for climate change mitigation and adaptation is detailed below from Gurran et al, 2008.

Plan making

When undertaking strategic land use allocation planning processes, the following specific considerations must be taken into account:

- The existing and potential exposure of particular locations/infrastructure to risks associated with climate change and the potential to reduce this vulnerability through specific building standards, development controls, or direct works;
- The potential impact of the settlement or infrastructure, including the location and configuration of development, on the vulnerability of existing settlements, natural habitat or biodiversity, including ‘downstream’ impacts;
- The location of existing and planned settlements/developments in relation to access routes, services, and infrastructure, and the likelihood of continued access to these facilities in the event of an emergency; and
- The ability to service locations with alternative transportation, including public transit, walking, and biking, and the general contribution of the location to reductions in auto trip numbers and length, to ensure that the location works toward climate change mitigation.

A formal climate change vulnerability assessment can be undertaken to support strategic land use planning decisions, and could even become a requirement to accompany applications that require major rezoning or other substantial changes to planning controls.

Development control

Consistent with the proposed strategic planning framework above, development assessment frameworks should require the following matters to be taken into account when proposals are considered:

- The scale and duration of the impact, both of the primary development itself (and associated construction), and potentially, any ‘downstream’ impacts. The assessment must also consider ways to avoid, negate, or offset the impact of the development on greenhouse gas emissions and any existing or potential legal duty of care to consider direct or indirect carbon impacts of the development;
- The vulnerability of the particular site and proposed development to existing or potential threats associated with climate volatility or long term change, and implications of the proposal for the vulnerability of surrounding areas;
- The potential to reduce risks and the potential to further adapt the development / activity if climate impacts accelerate or increase;
- The importance of the proposal for the community and whether the developer will bear the costs of any risk mitigation infrastructure work associated with it;
- Ways to monitor the impact of the development over time and to introduce new mitigating technologies when and if they become feasible; and
- The ability to service the site and proposed development with alternative transportation, including public transit, walking, and biking, and the general contribution of the development to reductions in auto trip numbers and length.


Additional information from Gurran et al. (2008) on leading practice in addressing environmental implications of climate change and planning for climate resilient economies, populations and infrastructure in coastal amenity areas through planning is at Appendix E.
3.4.3 Critical climate change adaptation response

Flooding from increased storm surge heights, resulting from rising sea-levels and more intense tropical cyclones, and flash flooding from higher intensity rainfall were identified as significant risks to Cairns Regional Council’s ‘urban management systems’ and considered a high priority for adaptation action. The critical adaptation responses will include ensuring that:

- Areas of the Cairns region vulnerable to the impacts of climate change, especially inundation from flash flooding and storm surge are identified;
- New development (including residential, community, recreational and commercial buildings) is not located in areas at high risk from the impacts of climate change and does not exacerbate impacts (e.g. create heat islands, create habitat for disease vectors, prevent migration of fishery habitat due to sea level rise);
- New development is designed and constructed to be resilient to the impacts of climate change;
- New development does not adversely affect natural ecosystem services that decrease the vulnerability of the Region to climate change impacts;
- An adaptive management approach is adopted to allow for progressive adaptation as advances in climate change projections become available; and
- Drainage and transport infrastructure is progressively upgraded in existing development areas, and where necessary protective infrastructure provided.

3.4.4 Possible climate change adaptation actions

Possible climate change adaptation actions for land use planning and flooding include:

Mapping the areas of Cairns Regional Council vulnerable to climate change impacts

- To effectively plan for, and respond to the impacts of climate change it is important to identify the parts of the Cairns region that are vulnerable to climate change impacts, the particular climatic variables to which they are potentially vulnerable and the regional and local spatial extent of vulnerability.

Assessing changing levels of flood immunity resulting from climate change

- Climate change has the potential to make development in areas not currently subject to flooding, at risk of flooding. Increasingly, Cairns Regional Council will be required to consider this risk across the full range of land use planning and development decisions, including planning scheme ‘preparation and amendment’, environmental impact assessments, development and building application assessment, conditioning and compliance checking. Having an understanding of the parts of Cairns that are vulnerable to flooding currently and how the level of vulnerability to flooding may vary with climate change will be critical to long-term climate change adaptation in the Cairns region.

Adopting an adaptive management approach

- An adaptive management approach will be necessary to enable the incorporation of new and better climate change information into planning and development decisions as it becomes available. This will allow Cairns Regional Council to be best prepared for these climate change impacts, rather than waiting to respond only when their affects are experienced. Active monitoring of technical standard documents such as the Queensland Urban Drainage Manual (QUDM) and the Australian Rainfall and Runoff (ARR) Handbook will be necessary, as it is likely that these will be amended over time to incorporate climate change considerations. It will also be necessary to monitor ‘leading practice’ in considering climate change in land use planning and development assessment by local government, and where appropriate, adopting changed practices in Cairns Regional Council’s land use planning and development assessment materials and decision-making.
Reviewing materials that guide planning and development

- Existing planning and management tools such as the Far North Queensland Regional Organisation of Councils Development Manual, Cairns Plan, flood overlays, storm surge maps and catchment management plans will, need to be progressively reviewed to ensure climate change impacts are an active consideration in planning and development assessment decisions, especially as they relate to flooding.

Engaging with the Cairns community on climate change adaptation

- In developing a climate change adaptation response for land use planning and development assessment, consideration of the direction provided in the Far North Queensland Regional Plan 2009-2031 on climate change will be necessary. This will require Cairns Regional Council to actively engage with the Queensland Department of Infrastructure and Planning, along with community and holders of development interests.

3.5 Assets and Operations

3.5.1 Identified climate change risks

The climate change risks to Cairns Regional Council’s assets and operations can be generalised as:

- Increased operational costs (e.g. higher cooling cost resulting from increased temperatures);
- Damage to infrastructure;
- Loss of service utility and amenity (e.g. disruptions to waste collections services or an inability to cater for an increase demand for waste management after extreme weather events);
- Environmental impacts resulting from climate change related affects on, and damage to, Council assets; (e.g. leachate from historic landfills in coastal locations because of salt water intrusion); and
- Socio-economic impacts resulting from climate change related affects on, and damage to, Council assets (e.g. road damage creating isolation, business disruption and an inability to evacuate flooded communities).

Photo courtesy of Cairns Regional Council
3.5.2 Opportunities arising from climate change

Improved asset management was identified as a major opportunity arising from adapting to climate change. The necessity to review and progressively incorporate climate change considerations into asset planning and management was perceived as making Cairns Regional Council’s assets better prepared for the range of natural hazards they are currently vulnerable to. Most infrastructure is built to last for several decades and this creates a significant hurdle in terms of the economical and logistical constraints of upgrading existing assets. The decision whether to do so will depend on a combination of considerations including the expected lifespan, significance of the infrastructure (and the services it delivers), costs and risks. The necessity to actively consider these factors within the context of climate change may identify efficiencies in Cairns Regional Council’s asset planning, design, delivery and management regime.

3.5.3 Critical climate change adaptation response

Critical climate change adaptation responses for assets and operations will include ensuring that:

- New infrastructure is not located in areas at high risk from the impacts of climate change;
- New infrastructure is designed and constructed to be resilient to the impacts of climate change (e.g. increase in frequency and severity of storm surges, floods and fires); and
- Existing infrastructure is maintained and upgraded where needed to ensure its functional and structural integrity, and retreat is planned and managed (removal/relocation) in a proactive and sensitive manner.

Photo courtesy of Cairns Regional Council
3.5.4 Possible climate change adaptation actions

Proactively considering adaptation strategies in asset management decisions can decrease the risk of asset damage and failure, which would represent an economic and social cost. Specific climate change impacts and consequent design, construction and operation adaptation strategies will depend on the physical elements and location of infrastructure and assets, along with the type and severity of the climate change impact to be avoided, and the inherent climate and landscape characteristics. Possible climate change adaptation actions for Cairns Regional Council’s assets and operations include:

Mapping Cairns Regional Council’s assets and operations that are vulnerable to climate change impacts
• Implementing adaptation actions requires an understanding of which Cairns Regional Council assets and operations are vulnerable to the potential impacts of climate change, their spatial location and the particular climatic variables to which they are potentially vulnerable.

Prioritising asset maintenance and upgrades to cater for climate change
• A prioritised approach to asset maintenance and upgrading for climate change will be necessary because of the potentially large financial impost that asset maintenance and upgrading for climate change could be. The timing of asset upgrades and replacement will be a function of the degree of vulnerability to climate change impacts, the life cycle stage of the infrastructure element (i.e. when upgrading and/or replacement has been planned), and an assessment of the relative importance of the infrastructure element (i.e. the socio-economic service provided by the infrastructure element).

Upgrading drainage and transport networks to provide a higher level of flood immunity
• Much of Cairns and its ‘urban management systems’ are located in low lying areas, which already experience periods of inundation in extreme climatic events. A range of mitigation practices exist to manage this, such as pumping of the Central Business District and backflow management. Climate change has the potential to increase both the frequency and intensity of local and flash flooding, exposing buildings and infrastructure to damage. The risk of personal injury and loss of life is also potentially elevated. The progressive upgrading of drainage and transport networks and, where necessary, providing protective infrastructure to achieve a higher level of flood immunity in existing development areas, will be a key climate change adaptation response.

Assessing climate change risks on individual projects
• Given the long life of infrastructure, and the potential to ‘lock in’ climate change vulnerabilities if it is not planned and designed with the impacts of climate change in mind, it is prudent to require climate change risk assessments for major projects on a project-by-project basis. In a similar vein, development and infrastructure standards controlled by Cairns Regional Council should be reviewed to determine their appropriateness in the face of climate change.

Adopting an adaptive management approach
• An adaptive management approach will be necessary to enable the incorporation of new and better climate change information into asset management decisions as it becomes available and to allow Cairns Regional Council to be best prepared for these climate change impacts, rather than waiting to respond only when their affects are experienced. Active monitoring of technical standards that influence infrastructure planning, design and construction will be necessary as it is likely that these will be amended over time to incorporate climate change considerations. Monitoring of technological developments in materials and construction techniques will also be required so that where new materials and techniques become available which are more resilient to climate change impacts, they can be applied by Cairns Regional Council.

This will need to be considered as a longer-term response because of the lack of detailed impact assessments contribute to the difficulties in planning for and managing assets in the face of climate change. The adaptation response is further challenged by the fact that the array of technical guidelines, standards and codes that underpin the planning and design of infrastructure do not currently incorporate climate change considerations because they are based on historic
climate information. These will need to be monitored and as appropriate (based on an analysis of cost and benefits) applied in infrastructure design and construction.

Engaging with other infrastructure providers in the Cairns region on climate change
- Climate change will impact the assets and operations of other government and non-government infrastructure providers, along with the holders of development interests. Cairns Regional Council should actively engage with these organisations to advocate for, and participate in, the development of a comprehensive assessment of climate change risks to the region’s infrastructure. This is especially relevant where disruption to their business from climate change could cause disruption to Cairns Regional Council’s business or influence its adaptation approach.

Engaging with the Department of Infrastructure and Planning on climate change and infrastructure
- The Far North Queensland Regional Plan 2009-2031 provides direction on how climate change should be considered in regional infrastructure planning and delivery. Cairns Regional Council should actively engage with the Department of Infrastructure and Planning to ensure its proposed climate change adaptation actions are consistent with the direction provided in the Far North Queensland Regional Plan 2009-2031.

Reviewing asset management plans to ensure climate change is considered
- Climate change has the potential to increase asset maintenance and repair costs. The consideration of climate change impacts in the development and review of asset management plans will be a critical adaptation response. Climate change is projected to result in more variable climatic conditions. These conditions will need to be considered during maintenance planning and works scheduling because the importance of different types of maintenance may vary according to the prevailing climatic conditions at any point of time. The maintenance regime may also have to become more reactive in the future, and an ability to rapidly transition from one maintenance strategy to another will be important.

Developing business continuity plans for operations that are not fixed spatially
- For operations not associated with fixed assets, the development of business continuity plans that consider the possible impact of climate change, along with appropriate risk mitigation strategies will be central to the adaptation response.

3.6 Environment

3.6.1 Identified risks
Two environment related climate change risks for ‘urban management systems’ were identified for adaptation action during the project. These risks related to:
- A loss of natural and visual amenity of the natural landscape in the urban setting; and
- Potentially increased sediment loads from development areas and settlements in waterways and the reef system.

Photo courtesy of Cairns Regional Council
3.6.2 Critical climate change adaptation response

Climate change is projected to compound existing threats to the natural environment. Natural environments that are under stress will also be less resilient to the impacts of climate change. The critical climate change adaptation response for the natural environment will be to reduce existing threats and enhance natural ecosystems and their supporting ecological processes to build their resilience to the expected impacts of climate change.

Because the Cairns area is experiencing rapid growth, which is projected to continue into the future, the management of vegetation, revegetation and setbacks will need to be actively considered in planning and development decisions as they will be central to the resilience of the region’s natural systems to climate change.

3.6.3 Possible climate change adaptation actions

Possible climate change adaptation actions for Cairns Regional Council’s environment-related climate change risks build on existing biodiversity, water quality, pest, coastal and erosion planning and management approaches. The identified possible climate change adaptation actions include:

Incorporating climate change considerations into natural resource and environmental strategies and plans

- As Cairns Regional Council’s natural resource management and environment strategies are periodically reviewed and updated, the potential impacts of climate change need to be considered and appropriate amendments made. The key to this adaptation approach is to ensure that the potential impacts of climate change are considered in natural resource management and environmental decision-making and, where appropriate, actively managed.

Engaging with natural resource management and environment agencies on climate change

- Climate change is being actively considered by the Wet Tropics Management Authority, Great Barrier Reef Marine Park Authority, the Association of Marine Park Tourism Operators, and Terrain Natural Resource Management in association with various stakeholders and interest groups. Cairns Regional Council should actively engage with these organisations to advocate for, and participate in, the development of a comprehensive assessment of climate change risks and adaptation action planning for the natural environment of the Cairns region.

Engaging with the Department of Infrastructure and Planning

- The Far North Queensland Regional Plan 2009-2031 provides direction on how regional natural resource and environment planning and management is to consider climate change. Cairns Regional Council should actively engage with the Department of Infrastructure and Planning to ensure its proposed climate change adaptation actions for the environment are consistent with the direction provided in the Far North Queensland Regional Plan 2009-2031.

Enhancing erosion management practices

- Higher erosion rates have the potential to adversely affect water quality in the region’s waterways and the reef system. More extreme rainfall will necessitate that a higher level of attention be applied to ensuring sediments do not enter the region’s waterways. This may require more stringent erosion and sediment management, including through development application assessment, conditioning and compliance checking.
3.7 Community Health

3.7.1 Identified climate change risks
Two community health related climate change risks for ‘urban management systems’ were identified for adaptation action during the project. These risks related to an increase in the demand for community health services such as mosquito control and consequent psychological affects when individuals and communities are impacted by climate change-relate health events such as infectious disease outbreaks.

3.7.2 Critical climate change adaptation response
Critical community health climate change adaptation responses will include ensuring that:

- Public health systems have improved disaster preparedness to cope with ‘surges’ in demand from weather extremes, infectious disease outbreaks etc. (e.g. heatwave response plans, early warning systems);
- Preventative public health programs are increased in areas of higher risk due to climate change (e.g. vaccines, mosquito control, food hygiene and inspection); and
- Potential increases in illnesses and other health effects of climate change are reduced by improving monitoring and surveillance of related health risk indicators (e.g. mosquito numbers) and health outcomes (e.g. infectious diseases outbreaks).

3.7.3 Possible climate change adaptation actions
Possible community health climate change adaptation actions build on the existing public health strategies and programs. However, there is a potential for a greater and more frequent demand in the face of climate change. Possible adaptation action include:

- Informing and educating the community about the increased public health risks that arise from climate change and the practical steps they can put in place to reduce their risks;
- Undertaking scenario-based planning to ensure appropriate strategies and sufficient resources are in place to response to potentially more frequent and more severe public health incidents;
- Reviewing existing public health management programs on a regular basis to ensure that are maintained at a level that is capable of meeting any additional demand arising from climate change;
- Clarifying Cairns Regional Council’s role in community health to determine where climate change, community health and ‘urban management systems’ intersect; and
- Engaging with other regional health agencies on climate change including the Queensland Department of Health, Queensland Department of Community Safety, Queensland Department of Communities and health related professional associations to comprehensively address the climate change impacts on community health in the region.
4.0 Moving forward on climate change adaptation

4.1 Selecting Preferred Adaptation Actions

Adapting to climate change is a long-term process, and this action plan presents possible adaptation actions for 27 high priority climate change risks to ‘urban management systems’ that Cairns Regional Council has direct responsibility for, and control of.

Cairns Regional Council workshop participants generated these possible adaptation actions as part of a qualitative methodology and they do not represent specific recommended climate change actions by AECOM. They require collective and individual assessments to determine relative costs and benefits to Cairns Regional Council and the broader community. This needs to occur within an agreed framework that is consistently applied by each of relevant the Cairns Regional Council departments and branches.

4.1.1 First pass qualitative assessment

Because there are no accepted methodologies for assessing the immediate costs of adapting to climate change against the long term benefits of implementing specific adaptation actions, a simplified and qualitative multi-criteria assessment is recommended.

Issues that should be evaluated include action:

- Timing;
- Cost;
- Adaptation potential;
- Greenhouse gas reduction potential;
- Technical feasibility; and
- Human capability.

Under this approach, scores can be allocated and the possible adaptation actions ranked, with the highest ranked actions nominally being the preferred actions. A suggested ranking system, is as follows:

- Timing:
  - Now, due to be completed within the next 12 months = 5
  - Medium-term (M) 1-3 years = 3
  - Long-term (L) 3-5 years = 1.

- Cost:
  - Low, up to $250,000 = 5
  - Medium, $250,000 to $2 million = 3
  - High, greater than $2 million = 1.

- Adaptation Potential:
  - High likelihood of reducing risk = 5
  - Moderate likelihood of reducing risk = 3
  - Low likelihood of reducing risk = 1.

- Mitigation Potential:
  - Potential to make significant greenhouse gas savings = 5
  - Potential to make moderate greenhouse gas savings = 3
  - Potential to make minor greenhouse savings = 1.

- Technical Feasibility:
  - Proven adaptation approach = 5
  - Limited application of adaptation approach to date = 3
Adaptation approach not applied to date = 1
Detailed technical investigations required = 1.

- Human Capability:
  - Capability exists in Cairns Regional Council = 5
  - Some external expertise or support required = 3
  - Delivery dependent on external expertise = 1.

An alternative approach can be found in the Canadian Communities’ Guidebook for Adaptation to Climate Change (Bizikova et al. 2008), which provides a suggested multi-criteria framework for evaluating climate change adaptation responses. Figure 5 provides an overview of its suggested approach.

![Figure 5: The suggested multi-criteria framework for evaluating climate change adaptation responses (Bizikova et al. 2008)](image-url)

<table>
<thead>
<tr>
<th>Category</th>
<th>Criterion</th>
<th>1 (low)</th>
<th>2 (medium)</th>
<th>3 (high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUSTAINABILITY: SOCIAL, ECONOMIC, ENVIRONMENTAL</td>
<td>Mitigation co-benefits</td>
<td>Results in increased greenhouse gas emissions</td>
<td>Would not affect greenhouse gas emissions</td>
<td>Would reduce greenhouse gas emissions</td>
</tr>
<tr>
<td></td>
<td>Environmental impacts</td>
<td>Result in net environmental costs</td>
<td>Result in no net loss of habitat or ecosystem services</td>
<td>Result in net environmental benefits</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>Benefits to few people</td>
<td>Benefits to many people</td>
<td>Significant benefits to many people</td>
</tr>
<tr>
<td></td>
<td>Implementation Cost</td>
<td>Cost of implementation is high relative to cost of abatement</td>
<td>Cost of implementation is moderate relative to cost of abatement</td>
<td>Cost of implementation is low relative to cost of abatement</td>
</tr>
<tr>
<td></td>
<td>Operating and Maintenance Cost</td>
<td>Cost of operation and maintenance is high</td>
<td>Cost of operation and maintenance is moderate</td>
<td>Cost of operation and maintenance is low</td>
</tr>
<tr>
<td></td>
<td>Robustness</td>
<td>Effective for a narrow range of plausible future scenarios</td>
<td>Effective across many plausible future scenarios</td>
<td>Effective across a wide range of plausible future scenarios</td>
</tr>
<tr>
<td></td>
<td>Reliability</td>
<td>This measure is uncertain</td>
<td>Experimental but low expert support</td>
<td>The effectiveness of this measure is proven</td>
</tr>
<tr>
<td>EFFECTIVENESS</td>
<td>Urgency</td>
<td>Risks are likely to occur in the long-term</td>
<td>Impact is beginning to occur, or is likely to occur in the near-to-mid-term</td>
<td>Impact is already occurring</td>
</tr>
<tr>
<td></td>
<td>Degree of risk or impact</td>
<td>Future risks are minor and reversible</td>
<td>Future risks are moderate and reversible</td>
<td>Future risks are potentially catastrophic or irreversible</td>
</tr>
<tr>
<td></td>
<td>Preventive</td>
<td>The risk is generally understood</td>
<td>Some uncertain risks</td>
<td>The risk is not well understood</td>
</tr>
<tr>
<td>RISK AND UNCERTAINTY</td>
<td>Ancillary benefits</td>
<td>This measure will contribute little or not at all to other goals for the community</td>
<td>This measure will contribute somewhat to other goals for the community</td>
<td>This measure will contribute significantly to other goals for the community</td>
</tr>
<tr>
<td>OPPORTUNITY</td>
<td>No-regret option</td>
<td>This measure will have little or no benefit if climate change impacts do not occur</td>
<td>This measure will have some benefit regardless of actual climate change impacts</td>
<td>This measure will result in significant benefits regardless of actual climate change impacts</td>
</tr>
<tr>
<td></td>
<td>Payback</td>
<td>A window of opportunity currently available</td>
<td>A window of opportunity currently available</td>
<td>A window of opportunity currently available</td>
</tr>
<tr>
<td></td>
<td>Window of Opportunity</td>
<td>There is no window of opportunity currently available</td>
<td>A window of opportunity could be created</td>
<td>A window of opportunity exists to implement</td>
</tr>
<tr>
<td></td>
<td>Public acceptance</td>
<td>Likely to face public opposition</td>
<td>Not likely to receive much public attention</td>
<td>Likely to receive public support</td>
</tr>
<tr>
<td></td>
<td>Funding sources</td>
<td>External funding sources required but have not been identified</td>
<td>External funding sources are required and likely to be secured</td>
<td>Funding is available</td>
</tr>
<tr>
<td>IMPLEMENTATION</td>
<td>Capacity (Human, technical, staff, resources)</td>
<td>Current capacity is insufficient and gaps cannot be easily addressed</td>
<td>Gaps exist in one or more areas but can be addressed</td>
<td>Current capacity is sufficient</td>
</tr>
<tr>
<td></td>
<td>Institutional</td>
<td>Implementation requires coordination with, or action by, other jurisdictions</td>
<td>Implementation requires external approval</td>
<td>Implementation is within local control</td>
</tr>
</tbody>
</table>

Figure 5 The suggested multi-criteria framework for evaluating climate change adaptation responses (Bizikova et al. 2008)
4.1.2 Detailed assessment of costs and benefits

Once the preferred climate change adaptation actions have been identified, more detailed project planning can be undertaken within the context of Cairns Regional Council’s strategic, budgetary and operational planning procedures. This assessment should include an evaluation of the costs and benefits to the community of Cairns resulting from adaptation actions. Some information on environmental, social and economic implications of the possible adaptation actions was collated as part of the climate change adaptation workshop, and this information can be used to inform this evaluation. This analysis needs to involve officers from Cairns Regional Council who have direct responsibility in the area of interest. Some issues that need to be considered in the cost-benefit analysis are outlined in Box 3.

Decision-makers should assess the economic implications of climate change and of potential adaptation (risk abatement) measures when making decisions, particularly those that require a significant investment and have a long life, such as infrastructure projects. Cairns Regional Council will increasingly need to assess the costs and benefits associated with implementing adaptation measures from both its perspective as a service provider, and from an awareness of the broader community implications for potential failure or degradation in service delivery.

Box 3 Economic cost and benefit considerations

In undertaking an economic assessment, there are a number of considerations to include when evaluating the merits of adaptation options, such as:

- Estimating the cost of climate change impacts – An assessment needs to be made of the climate change impacts on the specific infrastructure under consideration and how it will affect the required level of service, as well as maintenance and repair costs.

- Unit values for indirect cost impacts - As well as the direct costs of damage to infrastructure due to climate change, there will be indirect social welfare cost impacts due to the loss of service or failure of an asset, many of which will be non-tangible costs. Unit values required to estimate these indirect impacts include values of time and values of statistical life will be needed.

- Discount rate - Selecting an appropriate discount rate will be a key issue, particularly given the intergenerational issues associated with climate change and infrastructure. Some argue that society has a duty of care to future generations to avoid these adverse consequences. The Australian Greenhouse Office recommended applying a low or zero discount rate when considering climate change.

- Appraisal period - Given the long life associated with infrastructure, it is suggested that the appraisal period should cover the full expected lifespan of the infrastructure or out to 2100 where appropriate. The length of the appraisal period will be influenced by the choice of discount rate.

In assessing the costs and benefits of adaptation measures, there needs to be sensitivity to the uncertainty of climate change science and the range of climatic projections. There also needs to be a recognition that some climate change projections are probabilistic (e.g. there may be more category 5 cyclones in the future, but that does not mean that every north Queensland city or town will experience them).

Importantly in deciding which actions are preferred, a consideration of the various trade-offs may be necessary. Environmental, social and economic considerations will be important in this regard. In moving forward on a preferred adaptation action, difficult decisions will need to be made, many of which will be values based, such as the degree of environmental amenity that could need to be sacrificed in order to provide infrastructure a higher level of flood immunity through protective works such as sea walls.

When assessing the preferred actions, cognisance should also be had of the likely effectiveness in treating the climate change risk. Information on both of these was captured in the climate change adaptation action workshop, but detailed analysis of the information has not been undertaken as part of this project. The information is presented in Appendix D.
4.2 Review and Performance Reporting

To ensure that this action plan remains relevant and responsive to the needs of Cairns Regional Council and reflects improvements in the understanding of the impacts of climate change, regular review and reporting is necessary.

There are two dimensions to review and performance reporting. At a strategic level, Cairns Regional Council needs to have an ongoing appreciation of how well it is adapted to climate change at a whole-of-organisational level. At the operational level, Cairns Regional Council needs to have an understanding of how well individual adaptation actions are being implemented and the outcomes they are achieving.

However, the collective understanding of adaptation to climate change by local governments across the country and indeed the world is not yet sufficiently developed to recommend ‘outcome’ based performance indicators to measure how well or otherwise a local government is adapted to climate change from a whole-of-organisational perspective.

4.2.1 Strategic performance reporting

It has been indentified by the United Kingdom Government (2008) that because climate impacts are local it is impossible to have a generic outcome indicator which is applicable to all areas. It further concluded that without the evidence to determine outcome based targets, the best indicator available for climate change adaptation is a measure of organisational progress.

Local authorities in the United Kingdom are required to publicly report their climate change preparedness. They have been directed to publicly report their performance against a five-level reporting framework, graded from 0 to 4. A higher number represents further progress made in planning to adapt to climate change, as listed below:

- Level 0 - Getting started;
- Level 1 - Public commitment and impacts assessment;
- Level 2 - Comprehensive risk assessment;
- Level 3 - Comprehensive action plan; and
- Level 4 - Implementation, monitoring and continuous review.

The essence of the performance indicator is to provide evidence that mechanisms have put in place to proactively manage climate risks and take appropriate actions. Guidance on the use of this reporting framework can be found in *Adapting to Climate Change Guidance notes for National Indicator 188* DEFRA (2008).

Adoption of a ‘process based’ performance reporting approach to climate change adaptation is recommended for strategic level reporting.

4.2.2 Operational performance reporting

Implementation of each climate change adaptation action needs to be monitored and reported. Each of the possible adaptation actions needs to be subjected to an assessment of the associated costs and benefits of taking the action. Risk and adaptation action specific performance indicators should be developed as part of this process. In undertaking this work it will be necessary to develop an assessment and reporting framework that is applied consistently across Cairns Regional Council. It is recommended that this be undertaken as part of Council’s ongoing risk management approach and oversighted by the Cairns Regional Council Risk Management Steering Committee.
4.3 Barriers and Information Gaps

A range of barriers and information gaps were identified in the climate change adaptation workshops. They have been captured in Appendix D, but detailed analysis of them has not been undertaken. It will be necessary for Cairns Regional Council to identify how best to overcome these barriers and information gaps as part of the broader climate change adaptation response. This may necessitate either action directly by Cairns Regional Council, and/or were appropriate representation to the level of government which is in the best position to address the barrier(s).

4.3.1 Lack of local scale and uncertain climate change projections

The most pervasive information gap that was identified is the lack of climate change information at a scale or in a form suitable for Cairns Regional Council to plan for and manage climate change, along with the inherent uncertainties in the scientific information that is currently available. This is an issue that is relevant to the majority of the identified climate change risks and possible adaptation actions. The absence of this information also makes it difficult to engage with the various local and regional government and non-government interests on whose support ongoing adaptation will require.

This is compounded by that fact that in the absence of local climate change projections, there are currently no ‘accepted benchmarks’ - based on the latest climate change science – that provide the level of guidance needed to specifically address climate change impacts. There is also a lack of guidance for the varying professions within Cairns Regional Council about how to address climate change in their area of expertise, such as through scenario planning.

Planning for climate change related flooding – be it from more intense rainfall events or higher storm surges - in new development areas presents a significant climate change challenge and will need to reconcile uncertainties in climate change projections at the local level. This will also be the case for mitigating flooding in existing development areas. This will need to be considered as a longer-term response because of a lack of detailed impact assessments contribute to the difficulties in planning for and mitigating climate change influenced flooding.

4.3.2 Development cannot be prohibited under land use planning legislation

In Queensland, the Integrated Planning Act 1997 generally does not allow a local planning instrument to prohibit development. This will impede the ability of Cairns Regional Council to prohibit development in areas that may be at high risk from climate change impacts. Instead, the onus will be placed on Cairns Regional Council to demonstrate why development on the site is not appropriate or to place conditions of approval on the development to ameliorate the risk to the development and community. However in most circumstances climate change information is not available at the scale or in the form needed to do this effectively.

4.3.3 Changes to planning instruments to take into account the future impacts of climate change may trigger compensation processes or create legal liability exposure

Making changes to planning instruments to take into account climate change impacts (e.g. changes to land use zonings) that result in the diminishing of perceived existing land use rights for specific parcels of land may result in some form of compensation or negotiated settlement.

During the course of the project, it was also highlighted that under Queensland’s land use planning legislation, Cairns Regional Council can not prohibit development and that changes to planning instruments to take into account the future impacts of climate change may trigger compensation processes or create legal liability exposure. Additionally, the prescribed statutory processes to make and amend planning schemes makes them difficult to change, and does not provide sufficient flexibility to incorporate updated climate change science. This is further compounded because State and regional strategic planning frameworks do not provide adequate guidance for local government on how to address climate change impacts in local planning instruments.
4.3.4 State and regional strategic planning frameworks do not provide adequate guidance for local government on how to address climate change impacts in local planning instruments

Cairns Regional Council is required to respond to a range of State and regional planning frameworks that include directions on considering climate change. However, translating high-level policy into local level planning instruments and applying policy to day-to-day development assessment decision making is challenging. While there are benefits in having policies that are flexible enough to take into account local circumstances, climate change presents a range of new challenges, such as dealing with the uncertainty of climate change projections, and limited guidance has been provided to local government on how to address these issues.

4.3.5 Existing land use planning frameworks do not provide adequate and consistent benchmarks for key climate change variables to inform planning decisions

The absence of clear criteria or benchmarks for climate change that can be applied to land use planning decision making is a barrier to adapting to climate change. This is further compounded by the fact that ‘leading practice’ in considering climate change in land use planning is still emerging. While the best approaches for addressing climate change in land use planning are still to be determined, a set of planning benchmarks based on the latest science would potentially provide the level of guidance needed to support changes to regulatory frameworks to specifically address climate change. Advisory materials on how to implement these benchmarks would also be required.

4.3.6 Technical guidelines, codes and standards do not consider climate change

A barrier to climate change adaptation is the array of technical guidelines, standards and codes that underpin the planning and design of infrastructure do not currently incorporate climate change considerations because they are based on historic climate information, or only provide limited guidance. This is equally the case for information and guidance materials that underpin planning, design and development assessment. Many of these have statutory standing and until these are amended to incorporate climate change considerations, the delivery of climate change sensitive infrastructure and developments will be impeded.

The Queensland Urban Drainage Manual suggests an additional 0.3 of a metre allowance for the design of stormwater outfalls to tidal ways to account for climate change, and it is almost inevitable that this will be reviewed in the future. There is currently no guidance on how this allowance should be implemented. The ARR Handbook is currently being revised to incorporate new data and technical and scientific advances in hydrology engineering to account for the potential effects of climate change on water resources, infrastructure planning, flood prediction and emergency management.

With respect to infrastructure planning and design, there is limited information about the long-term structural integrity of materials due to climate change, such as how specific materials are likely to change to due to more extreme temperatures or more intense rainfall.

4.3.7 Inability to evaluate the economic costs and benefits of climate change adaptation actions

With respect to planning and constructing infrastructure that is more resilient to the impact of climate change, the costs and benefits of design options are difficult to accurately identify and quantify. This is compounded by the fact that higher capital costs upfront may be incurred, and economic models do not account for long term benefits of higher standards.

4.3.8 No established protocols to assess the impacts of climate change in asset management decisions

The most cost-effective time to upgrade an asset is often a critical question. It could be more costly and difficult to upgrade an asset as it nears the end of its life, however if the asset is ‘retired’ earlier than it could have been, costs are borne through the loss of income/utility and the requirement for a new asset to be built earlier than it would have otherwise been. In some cases, the cost of upgrading existing assets may not be feasible. Assumptions about the level of service and life of assets may also
need to be reconsidered. A response to uncertain climate change science might be to build infrastructure that provides a lower level of service for a shorter lifespan, requiring earlier replacement at a time when the certainty around climate change has improved. Additionally, deliberate decisions may be taken to extend the life of an asset through upgrading and enhanced maintenance rather than replacing it for similar reasons.

While some assets and operations have some built in resilience to climate change impacts, it is likely that in some locations infrastructure will be exposed to storm surges, sea-level rise, flooding and high temperatures that go beyond current experience.

4.3.9 Limited financial capability to implement climate change adaptation actions

When an adaptation response is considered appropriate, the financial ability to implement it will be challenging given local governments limited revenue raising capabilities. This is further compounded by the fact that funding for climate change adaptation will need to be balanced against funding for other Council services and functions.

Climate change is likely to test existing assumptions about asset maintenance, upgrading and replacement, especially where climatic considerations are a factor. Limited resources are typically available for maintaining or upgrading existing assets, increasing their vulnerability to damage from climate change impacts. This is compounded by a limited ability to raise the additional revenue needed to respond to climate change.

4.3.10 Emerging legal framework for climate change

Adapting to climate change will also generate an array of legal considerations. Areas that were identified include: duty of care; litigation; insurance; workforce agreements; and commercial contracts with service providers. In many instances, the consideration of climate change in these frameworks is evolving and/or has not commenced.

4.3.11 Role and influence of other levels of government in climate change adaptation

In many instances the responsibility for ‘urban management systems’ is shared across two or even three levels of government and there is perceived to be a lack of leadership – in either a legislative or policy sense - and support, especially funding, provided to local government to adapt to climate change. This is especially relevant because in many instances agencies of other levels of government have the capacity to influence the adaptation approach adopted by Cairns Regional Council, both positively and negatively. For example, adapting the road and drainage network to better cope with flooding can not be undertake in isolation from the Queensland Department of Transport and Main Roads.
4.4 Development of an Integrated Climate Change Strategy

In progressing the possible climate change adaptation actions, linkages between them and work being undertaken or planned by Cairns Regional Council to reduce greenhouse gas emissions will be identified. Care will need to be taken to ensure that climate change adaptation actions do not increase greenhouse gas emissions. If not planned appropriately greenhouse gas mitigation measures can increase local vulnerability to the impacts of climate change, and measures for adaptation can increase the local emissions of greenhouse gases.

To ensure the linkages and synergies between Cairns Regional Council’s greenhouse gas emissions mitigation measures and climate change adaptation measures are identified and acted on, it is recommended that Cairns Regional Council develop an integrated climate change strategy. Development of an integrated climate change strategy will provide greater coherence and clarity around Council’s climate change response.

Development of an integrated greenhouse and climate change strategy for Cairns Regional Council will be resource intensive and require a coordination mechanism to ensure sufficient focus on responding to climate change across all of Council’s departments. A small team within Cairns Regional Council should be established to guide the development of, and coordinate the preparation of the strategy.

The role of the team would include providing resource support and advice – including capacity building and the development of guidance materials - to other parts of Council. As an emerging issue with few widely ‘accepted’ or ‘best’ practices, there is a significant risk of inconsistent approaches being applied across different departments when undertaking adaptation planning. A dedicated team can lead the development of the practices and protocols to be applied, to ensure a consistent approach to assessing climate change risks, application of the ‘accepted’ climate change science, and recording and reported actions taken to reduce climate change impacts.

Consideration needs to be given to the most appropriate department within Cairns Regional Council to host the team and sponsor the development of the climate change strategy. Many climate change strategies have failed to secure collective ownership and joint responsibility because they have been perceived as an ‘environment’ issue, rather than an economic or community well-being issue. The most successful climate change strategies are those that adopt a whole-of-organisation approach and have shared corporate ownership and responsibility.

Close liaison with Cairns Regional Council’s Corporate Services Department will also be required to ensure climate change considerations are also embed into corporate policies, strategies and operations. Additionally, sufficient time needs to be provided and appropriate consultation instituted across Cairns Regional Council to facilitate collective ownership and joint responsibility.
5.0 Conclusions

Far North Queensland is one of six key ‘hot spots’ in Australia where the impacts of climate change are likely to be significant, with potentially large losses to the built environment from flooding, sea-level rise and storm surges associated with tropical cyclones (IPCC, 2007).

People in the Cairns region are projected to be affected, with climatic change causing more heat-related health problems, a higher incidence of mosquito borne diseases, and increased exposure to catastrophic events, such as cyclones, flooding and droughts. Climate change is also likely to compound the effects of existing threats, such as development-related habitat loss and fragmentation (DIP, 2009). The IPCC has indicated that the implications of climate change can be reduced with adaptation measures (IPCC, 2007).

Through its Corporate Sustainability Policy, Cairns Regional Council has committed itself to applying the principles of sustainability to all of its decision-making and activities. One of the stated intents of the Council’s Corporate Sustainability Policy is to ‘respond to the challenge of climate change’.

Research indicates that there are significant economic benefits to responding early to climate change. The Stern Review on the Economics of Climate Change (2006) highlighted that adaptation will be crucial to reducing vulnerability to climate change, and is the only way to cope with its inevitable impacts over the next few decades (OCC, 2008).

A qualitative risk assessment has been undertaken and possible climate change adaptation actions identified for risks that were assessed as being a high priority for climate change adaptation action. For both 2030 and 2070, the extreme risks are most commonly associated with:

- Sea-level rise;
- Increasing storm surges;
- More intense tropical cyclones; and
- More intense rainfall.

The management of climate change risk and opportunity should be an integrated responsibility within all areas of Cairns Regional Council’s decision-making. Council’s governance arrangements will need to reflect its commitment to the treatment of climate change risks and its desire to take up relevant opportunities. This will require a coordinated and collaborative approach. An adaptive management framework providing support for of Cairns Regional Councils departments to deliver climate change adaptation will be required.

Cairns Regional Council workshop participants generated these possible adaptation actions provided in Appendix D. They do not represent specific recommended climate change actions by AECOM. They require collective and individual assessments to determine their relative costs and benefits to Cairns Regional Council and the Cairns community. Once the preferred climate change adaptation actions have been identified, more detailed project planning can be undertaken within the context of Cairns Regional Council’s strategic, budgetary and operational planning procedures. This needs to occur within an agreed framework that is consistently applied by each of the relevant Cairns Regional Council departments. The analysis needs to involve officers from Cairns Regional Council who have direct responsibility in the area of interest.

Adaptation actions taken over the next three to five years will directly influence the viability and success of adaptation to long-term climate change impacts. In the long term, the Cairns Regional Council’s climate change adaptation approach will need to accommodate the effect of any future acceleration of the projected changes.
A range of barriers and information gaps in were identified that will affect the short to medium term implementation of a number of the possible climate change adaptation actions identified in this project. The identified barriers and information gaps include:

- Lack of local scale and uncertain climate change projections;
- Development cannot be prohibited under land use planning legislation;
- Changes to planning instruments to take into account the future impacts of climate change may trigger compensation processes or create legal liability exposure;
- Existing land use planning frameworks do not provide adequate and consistent benchmarks for key climate change variables to inform planning decisions;
- State and regional strategic planning frameworks do not provide adequate guidance for local government on how to address climate change impacts in local planning instruments;
- Technical guidelines, codes and standards do not consider climate change;
- Inability to evaluate the economic costs and benefits of climate change adaptation actions;
- Limited financial capability to implement climate change adaptation actions;
- The emerging legal framework for climate change; and
- The role and influence of other levels of government in climate change adaptation.

It will be necessary for Cairns Regional Council to identify how best to overcome these barriers and information gaps as part of the broader climate change adaptation response. This may necessitate either action directly by Cairns Regional Council, and/or were appropriate representation to the level of government which is in the best position to address the barrier(s).
6.0 Recommendations

The recommendations below provide a ‘blueprint’ for Cairns Regional Council to move forward on climate change adaptation in a comprehensive manner, both within its own operations and more broadly in the Cairns region. Many of the actions entailed in these recommendations will be beyond the current financial capacity of Cairns Regional Council. Cairns Regional Council should prioritise the actions it wishes to implement directly, and seek funding support for them. Seeking funding support can occur both proactively through representation and advocacy to Queensland and Commonwealth Governments, and opportunistically by having the business case developed and ready for submission to funding programs as they arise.

6.1 Corporate governance

1. Directly recognise the challenge that climate change presents to the Cairns region in the new Cairns Regional Council Corporate Plan.

2. Establish a dedicated climate change team within Cairns Regional Council to coordinate the Council’s ongoing climate change response.

3. Develop a climate change awareness raising program within Cairns Regional Council to build the capacity of officers to consider climate change impacts in their daily decisions.

4. Prepare climate change guidance materials to support Cairns Regional Council’s decision-making on climate change and ensure consistency in assessing climate change risks, and consistency in the assumed levels of climate change impacts across different areas in Council.

5. Require agenda items presented to Council to discuss the implications of climate change (both adaptation and greenhouse gas emissions) within either the ‘Sustainability’ or ‘Risk’ sections of the agenda item template.


7. Engage with the community on the possible impacts of climate change and the steps Cairns Regional Council has taken to better understand its exposure and prepare for it.

8. Require the outcomes of this assessment of climate change risks and opportunities to be considered in the annual review of the corporate risk register.

9. Develop an assessment and evaluation framework to evaluate the relative costs and benefits to the community of Cairns resulting from adaptation actions.

10. Require Cairns Regional Council’s departments to evaluate the possible climate change adaptation actions relevant to them against the assessment framework and identify the preferred climate change adaptation actions for their business.

11. Require relevant departments to undertake detailed project planning for their preferred adaptation actions, including the development of performance indicators and measures within the context of Cairns Regional Council’s strategic, budgetary and operational planning procedures.
12. Make it a formal requirement for climate change to be considered in business continuity, natural disaster, asset management and service delivery planning.

13. Adopt a ‘process based’ performance reporting approach for whole-of-council reporting on climate change adaptation action.

14. Plan for, and negotiate with staff and unions for more flexible working and contracting arrangements, including staff multi-tasking.

15. Monitor developments and legal precedents in climate change legislation and liability and, as required, reassess Cairns Regional Council’s insurance requirements and potential liabilities.


6.2 Land Use Planning and Development

17. Assess and map the areas within the jurisdiction of Cairns Regional Council that are vulnerable to climate change impacts.

18. Assess the changing levels of flood immunity resulting from climate change, especially from more intense rainfall events and higher storm surge heights.

19. Review the materials and information that guides Cairns Regional Council’s land use planning and development assessment activities to determine where amendments are necessary to incorporate the consideration of climate change impacts.

20. Monitor developments and amendments to technical standards, codes and guidelines to accommodate climate change considerations (especially with respect to flooding). As appropriate, based on an analysis of cost and benefits, apply them in land use planning, development assessment and infrastructure design processes.

21. Engage with the Department of Infrastructure and Planning to ensure Cairns Regional Council’s adaptation approach for land use planning and development is consistent with the direction provided on how climate change should be considered in regional infrastructure planning and delivery in the Far North Queensland Regional Plan 2009-2031.

6.3 Assets and Operations

22. Assess and map the assets and operations of Cairns Regional Council that are vulnerable to climate change impacts.

23. Require climate change risk assessments to be undertaken for major Council projects on a project-by-project basis.

24. Prioritise the assets and operations of Cairns Regional Council that require maintenance or upgrades to cater for changing climatic conditions.

25. Progressively upgrade Cairns Regional Council’s drainage and transport networks to provide a higher level of flood immunity.
26. Monitor technological developments in materials and construction techniques to make infrastructure more resilient to climate change impacts. As appropriate, based on an analysis of cost and benefits, apply them in land use planning, development assessment and infrastructure design processes.

27. Review Cairns Regional Council’s asset management plans to ensure climate change is considered in decisions about asset maintenance, upgrading and replacement.

28. Review Cairns Regional Council’s business continuity plans for essential operations that are not fixed spatially to ensure the possible impacts of climate change on service delivery are considered.

29. Engage with the Department of Infrastructure and Planning to ensure Cairns Regional Council’s adaptation approach for assets and infrastructure is consistent with the direction provided on how climate change should be considered in regional infrastructure planning and delivery in the Far North Queensland Regional Plan 2009-2031.

30. Engage with other infrastructure and service planners and providers in the Cairns region, where disruption to their business from climate change could cause disruption to Cairns Regional Council’s business or influence its adaptation approach.

31. Advocate for, and participate in the development of a comprehensive assessment of climate change risks and an adaptation action plan for infrastructure in the region.

### 6.4 Natural disaster planning and response

32. Enhance Cairns Regional Council’s natural disaster coordination capacities, including establishing a new flood immune disaster coordination centre.

33. Enhance Cairns Regional Council’s natural disaster response capacity to cater for potentially more frequent and more extreme natural disasters.

34. Update storm surge maps for the Cairns region to take account of projected changes in storm surge heights resulting from higher sea levels and more intense tropical cyclones.

35. Ensure the potential impacts of climate change are considered in the development of business continuity plans for essential Cairns Regional Council services.

36. Identify flood immune community evacuation routes, taking into consideration the changing patterns of flood immunity arising from climate change.

37. Enhance community and business awareness of the risks associated with natural hazards and measures they can put in place to reduced their individual vulnerability and build their resilience.

38. Engage with agencies that have responsibilities for natural disaster planning and response including the Queensland Department of Community Safety, the Bureau of Meteorology and other emergency planning and response organisations to ensure a regional approach is taken in planning for potentially more frequent and more intense natural disasters.
6.5 Environment

39. As Cairns Regional Council’s natural resource management and environment strategies and management plans are reviewed and updated, incorporate consideration of the potential impacts of climate change.

40. Engage with natural resource management and environment agencies in the Cairns region to advocate for, and participate in the development of a comprehensive assessment of climate change risks and an adaptation action plan for the natural environment of the Cairns region.

41. Engage with the Department of Infrastructure and Planning to ensure that Cairns Regional Council’s proposed climate change adaptation actions for the environment are consistent with the direction provided in the Far North Queensland Regional Plan 2009-2031.

42. Review Cairns Regional Council’s erosion and sediment control management practices to determine if they are adequate to cater for projected increase in intense rainfall events.

6.6 Community health

43. Enhance community and business awareness of the public health risks arising from climate change and the practical steps they can put in place to reduce their risks.

44. Undertake scenario based planning to ensure appropriate strategies and sufficient resources are in place to response to potentially more frequent and more severe public health incidents.

45. Review public health management programs on a regular basis to ensure that are maintained at a level that is capable of meeting any additional demand arising from climate change.

46. Clarify Cairns Regional Council’s role in community health to determine where climate change, community health and ‘urban management systems’ intersect.

47. Engage with other regional health agencies including the Queensland Department of Health, Queensland Department of Community Safety, Queensland Department of Communities and health related professional associations to advocate for, and participate in, the development of a comprehensive assessment of climate change risks and the development of an adaptation action plan for community health in the region.
7.0 Literature Review


Appendix A  Climate Change Risk Assessment Scenarios

Introduction
Climate projections prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) in 2007 informed the climate change risk assessment. These suggest that the future climate of eastern Australia will generally be characterised by:

- Lower average rainfall;
- More intense extreme rainfall events;
- Higher sea-level and storm surge events;
- Higher average temperatures;
- More frequent occurrence of extreme temperatures, and
- More frequent extreme fire danger days.

Small changes in annual and seasonal temperature and rainfall conditions can be associated with large changes in extreme weather events, such as heatwaves, storms, stronger winds, increased lightning and higher intensity rainfall, which are potentially of greater significance than changes in average conditions. Changes in extreme weather events that are projected for eastern Australia include:

- An increase in the frequency of hot days and warm nights, and a decrease in the frequency of cold nights;
- An increase in both daily precipitation intensity (rain per rain-day) and the number of dry days, leading to longer dry spells interrupted by heavier rainfall events; and
- El Niño events becoming drier and La Niña events becoming wetter (CSIRO and BoM, 2007).

The science highlights that it can be expected that there will be changes in the flood, bushfire, and storm risk associated with the above changes in average climate conditions and extreme weather events.

Risk Assessment Scenarios
The climate change projections (scenarios) used in the risk assessment were extracted from the *Climate Change in Australia: Technical Report* (CSIRO and BoM, 2007). These are the most recent, and most widely available climate change projections for Australia. Where appropriate these projections were supplemented with more recent reports prepared by the CSIRO and other scientific organisations.

This risk assessment was undertaken for the 2030 and 2070 planning horizons. The 2070 planning horizon adopted a high greenhouse emissions scenario as a precautionary approach. The following sections provide an overview of the different climate change variables that were considered in the risk assessment workshop. The climate change variables considered in the risk assessment workshop included:

- Temperature (average and extreme);
- Rainfall;
- Extreme rainfall;
- Evaporation;
- Wind speed;
- Sea-level rise;
- Extreme sea-level events (storm surges); and
- Bushfire.

The projections give an estimate of the average climate around 2030 and 2070, but individual years can vary markedly within any climate period, so the values can be taken as representative of the decade around the single year stated (i.e. projections for 2030 are representative of 2026-2035). Even then, natural variability may also modify the actual means for the decade, particularly for a small region (CSIRO and BoM, 2007).

The scenarios used in the risk assessment workshop are illustrated graphically on a State-wide basis in the following sections. Information is also provided for a range of specific locations in Queensland, the most relevant for this risk assessment being for Cairns.

Table 5 provides an overview of the best-estimate (50% percentile) climate change projections for the Cairns Region for 2030 and 2070. Where relevant these figures are also provided in graphical form in the subsequent sections to aid interpretation.

### Table 5 Projected best-estimate (50% percentile) climate changes for the Cairns Region

<table>
<thead>
<tr>
<th>Climatic variable</th>
<th>Season</th>
<th>2030</th>
<th>2070</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Temperature (°C)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>0.9</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>0.9</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Autumn</td>
<td>0.9</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>0.9</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>0.9</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td><strong>No. days over 35°C (current 1.0)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>6.6</td>
<td>44.4</td>
<td></td>
</tr>
<tr>
<td><strong>Rainfall (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>0</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Autumn</td>
<td>-1</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>-1</td>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>-5</td>
<td>-16</td>
<td></td>
</tr>
<tr>
<td><strong>Potential evaporation (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>+3</td>
<td>+10</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>+3</td>
<td>+10</td>
<td></td>
</tr>
<tr>
<td>Autumn</td>
<td>+3</td>
<td>+11</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>+3</td>
<td>+11</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>+3</td>
<td>+9</td>
<td></td>
</tr>
<tr>
<td><strong>Wind-speed (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>+1</td>
<td>+4</td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td>+1</td>
<td>+4</td>
<td></td>
</tr>
<tr>
<td>Autumn</td>
<td>+1</td>
<td>+2</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>+1</td>
<td>+4</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>+2</td>
<td>+6</td>
<td></td>
</tr>
<tr>
<td><strong>Relative humidity (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>-0.3</td>
<td>-0.8</td>
<td></td>
</tr>
<tr>
<td>Solar radiation (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>
Temperature

Queensland is projected to be warmer on average, although coastal regions may warm less quickly due to the moderating influence of the ocean. The CSIRO and BoM (2007) best estimate (50th percentile) projected changes for eastern Australia (relative to a baseline period 1980-1999) include:

- An increase of annual mean temperatures of around 1°C by 2030; and
- An increase in annual mean temperatures of between 1.8°C and 3.5°C by 2070.

This increase in temperature is projected to have minimum seasonal variation, with warming in winter only slightly less than in the other seasons.

Projected annual temperature increases for Queensland for 2030 and 2070 are provided in Figure 6 - the deeper the red, the higher the temperature increase.

![Figure 6 Projected annual temperature change for 2030 (left) and 2070 (right), (CSIRO and BoM, 2007) – the deeper the red, the higher the temperature increase](image)

By 2030, annual average temperatures in Queensland's coastal areas are projected to increase by about 0.9 °C relative to the climate of recent decades. Inland areas are projected to increase by about 1.1°C.

By 2070, annual average temperatures are projected to increase by about 1.7°C across the state under a low emissions scenario but as high as 3°C under a high emissions scenario, with warmings slightly larger in the south-west.

The declining trends in extremely cold temperatures and increasing trends in extremely hot temperatures are expected to continue in the future across the State.

It is important to note that associated with the warming is a projected strong increase in frequency of hot days and warm nights (CSIRO and BoM, 2007). The number of days per annum where daily temperatures are projected to be over 35°C for 2030 and 2070 are provided for a range of locations in Table 6.
Table 6 Projected average number of days above 35 °C for Cairns, Brisbane and St George in 2030 and 2070 high emissions scenario (CSIRO, 2008)

<table>
<thead>
<tr>
<th>Number of days &gt;35°C</th>
<th>Cairns</th>
<th>Brisbane</th>
<th>St George</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>3.8</td>
<td>1</td>
<td>52.7</td>
</tr>
<tr>
<td>2030 average (mid emissions)</td>
<td>6 (5-8)</td>
<td>2 (1-2)</td>
<td>71 (64-81)</td>
</tr>
<tr>
<td>2070 average (high emissions)</td>
<td>31 (13-72)</td>
<td>6 (4-14)</td>
<td>116 (90-152)</td>
</tr>
</tbody>
</table>

Projected temperature change for the Cairns Region for 2030 and 2070 (high emissions) is graphed in Figure 7. The best estimate if the 50th percentile.

Figure 7 Projected temperature increase for the Cairns Region in 2030 and 2070

Rainfall

There is greater uncertainty with rainfall projections than with temperature projections. This is because, unlike temperature, there is not a direct relationship between greenhouse gas concentrations and rainfall.

Future rainfall levels are dependent on a number of factors therefore there are discrepancies between rainfall projections. Climate model results show both decreases and increases in the amount of rainfall across Australia.

The CSIRO and BoM (2007) best estimate (50th percentile) projected changes for rainfall in eastern Australia include:

- A decrease in annual rainfall of between 2% to 5% by 2030; and
- A decrease in annual rainfall of between 5% to 10% by 2070.

In Queensland, the most recent projections indicate that winter and spring rainfall is likely to decrease, especially in central and southern areas. Changes in summer and autumn rainfall are less certain.

The future climate of eastern Australia is projected to be drier on average.

Projected annual rainfall changes for Queensland for 2030 and 2070 are provided in Figure 8 - red indicates rainfall decline, whereas blue indicates rainfall increases.
Projected rainfall change for the Cairns Region for 2030 and 2070 (high emissions) is graphed in Figure 9. The best estimate if the 50th percentile.

Figure 8 Projected annual rainfall change for 2030 (left) and 2070 (right), (CSIRO and BoM, 2007) - red indicates rainfall decline, whereas blue indicates rainfall increases.

Figure 9 Projected annual rainfall change for the Cairns Region for 2030 and 2070
Extreme Rainfall

The future climate of many parts of the State is projected to not only be drier but the character of daily rainfall is also likely to change.

An increase in daily rainfall intensity (rain per rain-day), intensity of extreme rainfall and the number of dry days is likely. The climate is projected to have longer dry spells interrupted by heavier precipitation events (CSIRO and BoM, 2007).

Regional studies also indicate a likely increase in the proportion of tropical cyclones in the more intense categories potentially decaying further south, but a possible decrease in the total number of cyclones.

Evaporation

The CSIRO and BoM (2007) best estimate (50th percentile) for potential evaporation changes for eastern Australia are:

- An increase in annual potential evaporation of 2% by 2030; and
- An increase in annual potential evaporation of between 6% and 10% by 2070.

Projected annual evaporation changes for Queensland for 2030 and 2070 are provided in Figure 10 – red indicates the areas of greatest increase.

![Evaporation Changes](image)

**Figure 10** Projected annual evaporation change for 2030 (left) and 2070 (right), (CSIRO and BoM, 2007) – red indicates the areas of greatest increase
Projected evaporation change for the Cairns Region for 2030 and 2070 (high emissions) is graphed in Figure 11. The best estimate if the 50th percentile.

![Projected Evaporation for Cairns 2030 and 2070](image)

**Figure 11** Projected evaporation change for the Cairns Region in 2030 and 2070

**Wind Speed**

Projections of future climate conditions indicate that average wind speeds in eastern Australia on an annual basis by 2030 or 2070 will increase (CSIRO and BoM, 2007).

Projected annual wind-speed changes for Queensland for 2030 and 2070 are provided in Figure 12 - purple indicates the areas of greatest increase.

![Projected annual wind-speed change for 2030 and 2070](image)

**Figure 12** Projected annual wind-speed change for 2030 (left) and 2070 (right), (CSIRO and BoM, 2007) – purple indicates areas of greatest increase
Projected wind speed change for the Cairns Region for 2030 and 2070 (high emissions) is graphed in Figure 12. The best estimate if the 50th percentile.

Figure 13 Projected wind speed change for the Cairns Region in 2030 and 2070 (CSIRO and BoM 2007)

Sea-Level Rise

Global sea-level rise is projected by the Intergovernmental Panel on Climate Change to be 18-59 cm by 2100, with a possible additional contribution from ice sheets of 10 to 20 cm or more. Global climate models indicate that mean sea-level rise on the east coast of Australia may be greater than the global mean sea-level rise (OCC, 2008).

Global sea level rise is projected by the IPCC to be 18-59 cm by 2100, with a possible additional contribution from ice sheets of 10 to 20 cm or more. However, further ice sheet contributions that cannot be quantified at this time may increase the upper limit of sea level rise substantially. Global climate models indicate that mean sea level rise on the east coast of Australia may be greater than the global mean sea level rise (OCC, 2008). Furthermore, recent developments since the release of the IPCC’s projections indicate that observed sea level is tracking near the upper limit of the projections for the current time period (Church et al., 2009).

As a precautionary approach, 79 cm of sea-level rise by 2100 was adopted for the risk assessment.

Professor Garnaut (2008) reported that future sea-level rise could be much worse that projected by the IPCC as a consequence of uncontrolled climate change, and could result in global sea-level rise of up to 1.4 metres by 2100.

Extreme Sea-level Events

The frequency and height of storm surges are expected to change with climate change. The effect of rising mean sea-levels will be felt most profoundly during extreme storm conditions when strong winds and falling pressure bring about a temporary and localised increase in sea-level known as a storm surge (CSIRO and BOM, 2007).

A recent study has highlighted that for every 0.1 m sea-level rise the frequency of extreme events increase by a factor of three. It further concludes that sea-level rise during the 21st century will result in annual events becoming daily events (Hunter, 2008). For many locations, sea level rise means that the present 1 in 100 year event could potentially occur more than once a year by 2100 (Church et al., 2009).

In Queensland, scientists predict that storm surges will occur more frequently (OCC, 2008). A 2004 study by Hardy et al. of the east coast of Queensland showed that a 30 cm sea-level rise, a 10% increase in cyclone intensity and a 130 km shift southwards in cyclone tracks could add an average of 0.37 m to the 1-in-100 year storm surge event in Cairns (Hardy et. al., 2004).
**Tropical Cyclones**

Australian region studies indicate a likely increase in the proportion of the tropical cyclones in the more intense categories, but a possible decrease in the total number of cyclones.

Substantial disagreement remains between climate models concerning future changes in tropical cyclone intensity, although the highest resolution models show evidence of an increase in tropical cyclone intensity in a warmer world.

A study based on CSIRO simulations found that the number of tropical cyclones off the east Australian coastline will decrease by 9%. The simulations also show an increase in long-lived eastern Australian tropical cyclones.

Studies have also shown that there will be a marked increase in the severe category 3-5 storms, and an increase of 60% and 140% in the intensity of the most extreme storms for 2030 and 2070 respectively (Abbs et al 2006).

**Bushfire**

Fire weather conditions are expected to worsen due to climate change. A study of Eastern and Southern Australia by Lucas et al (2007) found that climate change can exacerbate the fire-weather risk of any given day (leading to increased frequency or intensity of extreme fire weather days) and result in a longer fire season.

The findings of the study also suggest that fire seasons will start earlier and end slightly later, while being generally more intense throughout their length. This effect is most pronounced by 2050, although it should be apparent by 2020 (note the shift in timeframe).
Appendix B  Identified Climate Change Risks
## Appendix B  Identified Climate Change Risks

The risks identified in the risk assessment workshop for each focus area along with their associated climate change variable and risk rating for both 2030 and 2070 are presented in the following table.

<table>
<thead>
<tr>
<th>Focus Group</th>
<th>Risk</th>
<th>Risk Description</th>
<th>Climate Change Variable</th>
<th>2030 Risk Level</th>
<th>2070 Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use planning and assessment</td>
<td>L1</td>
<td>More Intense tropical cyclones and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>✓</td>
<td>64 (L2:C4)</td>
<td>72 (L3:C4)</td>
</tr>
<tr>
<td></td>
<td>L2</td>
<td>Increasing storm surges and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>✓</td>
<td>60 (L3:C3)</td>
<td>72 (L3:C4)</td>
</tr>
<tr>
<td></td>
<td>L3</td>
<td>More intense rainfall and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>✓ ✓ ✓ ✓</td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>L4</td>
<td>Storm surge and flooding as flood models fail to incorporate sea-level rise, storm surge and an increase in rainfall intensity</td>
<td>✓ ✓ ✓ ✓ ✓</td>
<td>56 (L4:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>L5</td>
<td>Liability risk from coastal erosion due to a failure to incorporate climate change in future planning decisions</td>
<td>✓ ✓ ✓ ✓ ✓</td>
<td>56 (L4:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>L6</td>
<td>Sea-level rise and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>✓</td>
<td>52 (L2:C3)</td>
<td>80 (L4:C4)</td>
</tr>
<tr>
<td></td>
<td>L7</td>
<td>All future and current developments are at risk of climate change impacts due to limited spatial representation of predicted effects of climate change</td>
<td>✓ ✓ ✓ ✓</td>
<td>48 (L3:C2)</td>
<td>68 (L4:C3)</td>
</tr>
</tbody>
</table>

Positive Change - Climate Change Risks and Opportunities for the Cairns Region
3 June 2009
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<table>
<thead>
<tr>
<th>Focus Group</th>
<th>Risk</th>
<th>Risk Description</th>
<th>Climate Change Variable</th>
<th>2030 Risk Level</th>
<th>2070 Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Council assets, infrastructure and operations</td>
<td>L8</td>
<td>Declining average rainfall and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>Increasing average temperatures: ✓  More extremely hot days: ✓  Increasing evaporation: ✓  Average wind speed change: ✓  Sea-level rise: ✓  Increasing storm surges: ✓  More intense tropical cyclones: ✓  More intense rainfall: ✓  Declining average rainfall: ✓  Bushfires: ✓</td>
<td>48 (L3:C2)</td>
<td>56 (L4:C2)</td>
</tr>
<tr>
<td></td>
<td>L9</td>
<td>Bushfires and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>Increasing average temperatures and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>✓</td>
<td>48 (L3:C2)</td>
</tr>
<tr>
<td></td>
<td>L10</td>
<td>Increasing average temperatures and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>Increasing average temperatures and resulting impacts are not considered in planning decisions as planning legislation is not adaptable to incorporate new scientific and technological advancements as they are developed</td>
<td>✓  ✓</td>
<td>40 (L2:C2)</td>
</tr>
<tr>
<td></td>
<td>I1</td>
<td>Lack of capacity in drainage system and higher intensity run-off and submerged outlets</td>
<td>Lack of capacity in drainage system and higher intensity run-off and submerged outlets</td>
<td>✓  ✓  ✓  ✓</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>I2</td>
<td>Greater infiltration/inflow into system resulting in increased operational costs</td>
<td>Greater infiltration/inflow into system resulting in increased operational costs</td>
<td>✓  ✓  ✓  ✓</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>I3</td>
<td>Bitumen deterioration leading to increased maintenance costs</td>
<td>Bitumen deterioration leading to increased maintenance costs</td>
<td>✓</td>
<td>72 (L3:C4)</td>
</tr>
<tr>
<td></td>
<td>I4</td>
<td>Beach erosion resulting in damage or loss of Council assets and property</td>
<td>Beach erosion resulting in damage or loss of Council assets and property</td>
<td>✓  ✓  ✓  ✓</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>I5</td>
<td>Dam failure (water supply) resulting in infrastructure damage</td>
<td>Dam failure (water supply) resulting in infrastructure damage</td>
<td>✓  ✓</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>I6</td>
<td>Water damage to pavement resulting in damaged assets and loss of services</td>
<td>Water damage to pavement resulting in damaged assets and loss of services</td>
<td>✓</td>
<td>64 (L5:C2)</td>
</tr>
<tr>
<td></td>
<td>I7</td>
<td>Increase in operating costs due to increased energy consumption on hot days</td>
<td>Increase in operating costs due to increased energy consumption on hot days</td>
<td>✓  ✓  ✓</td>
<td>64 (L5:C2)</td>
</tr>
<tr>
<td></td>
<td>I8</td>
<td>Beach erosion resulting in loss of visual beach amenity</td>
<td>Beach erosion resulting in loss of visual beach amenity</td>
<td>✓  ✓  ✓  ✓</td>
<td>64 (L5:C2)</td>
</tr>
<tr>
<td>Focus Group</td>
<td>Risk</td>
<td>Risk Description</td>
<td>Climate Change Variable</td>
<td>2030 Risk Level</td>
<td>2070 Risk Level</td>
</tr>
<tr>
<td>-------------</td>
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</tr>
<tr>
<td></td>
<td>I9</td>
<td>Damage to buildings resulting in loss of service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I10</td>
<td>Council resources and service levels compromised because resources are diverted to climate change incident response</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>60 (L3:C3)</td>
<td>80 (L4:C4)</td>
</tr>
<tr>
<td></td>
<td>I11</td>
<td>Saturated road base resulting in road failure (especially in the central business district) resulting in an inability to gain access to areas</td>
<td>✓ ✓</td>
<td>52 (L2:C3)</td>
<td>60 (L3:C3)</td>
</tr>
<tr>
<td></td>
<td>I12</td>
<td>Waste services disruption resulting in decrease of sanitation</td>
<td>✓ ✓ ✓</td>
<td>52 (L2:C3)</td>
<td>52 (L2:C3)</td>
</tr>
<tr>
<td></td>
<td>I13</td>
<td>Damage to and/or loss of landscape, vegetation, ecological biodiversity and visual amenity</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>48 (L3:C2)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>I14</td>
<td>Quicker and/or greater deterioration of buildings resulting in increased maintenance costs and decreased asset value</td>
<td>✓ ✓ ✓</td>
<td>32 (L1:C2)</td>
<td>40 (L2:C2)</td>
</tr>
<tr>
<td></td>
<td>I15</td>
<td>Current water supply planning does not take into account climate change resulting in uncertainty of supply</td>
<td>✓ ✓ ✓</td>
<td>28 (L2:C1)</td>
<td>48 (L3:C2)</td>
</tr>
<tr>
<td>Governance and internal services</td>
<td>G1</td>
<td>Rapid decrease in tourism confidence due to significant disaster events impacting local economy</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>84 (L3:C5)</td>
<td>84 (L3:C5)</td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>Failure to supply adequate evacuation routes to storm surge vulnerable areas resulting in the potential loss of life</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>68 (L1:C5)</td>
<td>76 (L2:C5)</td>
</tr>
<tr>
<td></td>
<td>G3</td>
<td>Severe weather event causing failure of essential services and supplies in the central business district</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>68 (L1:C5)</td>
<td>76 (L2:C5)</td>
</tr>
<tr>
<td></td>
<td>G4</td>
<td>Failure to take into account climate change issues in policy formulation causing an unprepared community</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>68 (L4:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>G5</td>
<td>Failure to provide a disaster co-ordination centre resulting in uncoordinated response/failure/insufficient response and recovery</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>64 (L2:C4)</td>
<td>64 (L2:C4)</td>
</tr>
<tr>
<td></td>
<td>G6</td>
<td>Decline in tourist numbers due to decrease in length of tourism season and attractiveness of region (beaches compromised, decrease in trips to reef, flooding)</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td>Focus Group</td>
<td>Risk</td>
<td>Risk Description</td>
<td>Climate Change Variable</td>
<td>2030 Risk Level</td>
<td>2070 Risk Level</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increasing average temperatures</td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>More extremely hot days</td>
<td>60 (L3:C3)</td>
<td>60 (L3:C3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increasing evaporation</td>
<td>56 (L4:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average wind speed change</td>
<td>56 (L4:C2)</td>
<td>56 (L4:C2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sea-level rise</td>
<td>52 (L2:C3)</td>
<td>60 (L3:C3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increasing storm surges</td>
<td>52 (L2:C3)</td>
<td>52 (L2:C3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>More intense tropical cyclones</td>
<td>52 (L2:C3)</td>
<td>52 (L2:C3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>More intense rainfall</td>
<td>48 (L3:C2)</td>
<td>56 (L4:C2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Declining average rainfall</td>
<td>48 (L3:C2)</td>
<td>48 (L4:C2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bushfires</td>
<td>40 (L2:C2)</td>
<td>40 (L2:C2)</td>
</tr>
<tr>
<td>G7</td>
<td>Failure to take into account climate change variables in business contingency planning across council departments e.g. asset location, de-centralised operations for continuing essential services</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
<td></td>
</tr>
<tr>
<td>G8</td>
<td>Failure to adequately plan for population growth due to migration from other areas due to climate change issues impacting infrastructure</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>60 (L3:C3)</td>
<td>60 (L3:C3)</td>
<td></td>
</tr>
<tr>
<td>G9</td>
<td>Failure to modify Council governance to accommodate climate change</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>56 (L4:C2)</td>
<td>76 (L5:C3)</td>
<td></td>
</tr>
<tr>
<td>G10</td>
<td>Failure to supply adequate evacuation routes due to roads flooding causing isolation</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>56 (L4:C2)</td>
<td>56 (L4:C2)</td>
<td></td>
</tr>
<tr>
<td>G11</td>
<td>Occurrence of environmental refugees due to climate change variables (i.e. sea-level rises) causing need to relocate local residents</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>52 (L2:C3)</td>
<td>60 (L3:C3)</td>
<td></td>
</tr>
<tr>
<td>G12</td>
<td>Failure to provide a disaster co-ordination centre resulting in un-coordinated response/insufficient response and recovery</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>52 (L2:C3)</td>
<td>52 (L2:C3)</td>
<td></td>
</tr>
<tr>
<td>G13</td>
<td>Essential services and supplies compromised in central business district - due to flooding from intense rainfall compromising emergency services ability to respond and affecting food and fuel supplies at the Hospital and Airport</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>52 (L2:C3)</td>
<td>52 (L2:C3)</td>
<td></td>
</tr>
<tr>
<td>G14</td>
<td>Fail to modify work patterns resulting in injury and health risk to staff</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>48 (L3:C2)</td>
<td>56 (L4:C2)</td>
<td></td>
</tr>
<tr>
<td>G15</td>
<td>Increase in public liability exposure due to sea-level rise causing financial claims to local council</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>48 (L3:C2)</td>
<td>56 (L4:C2)</td>
<td></td>
</tr>
<tr>
<td>G16</td>
<td>Increase in public liability exposure due to flooding causing financial claims to council</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>40 (L2:C2)</td>
<td>40 (L2:C2)</td>
<td></td>
</tr>
<tr>
<td>Environment, recreation and</td>
<td>Increased storm surge, increased intensity of cyclones and sea-level rise caused increased coastal erosion resulting in loss of housing, land, assets and amenities</td>
<td>✓ ✓ ✓ ✓ ✓ ✓ ✓</td>
<td>80 (L4:C4)</td>
<td>88 (L5:C4)</td>
<td></td>
</tr>
<tr>
<td>Focus Group</td>
<td>Risk</td>
<td>Risk Description</td>
<td>Climate Change Variable</td>
<td>2030 Risk Level</td>
<td>2070 Risk Level</td>
</tr>
<tr>
<td>-------------</td>
<td>------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>community</td>
<td>E2</td>
<td>Increased storm surge, increased intensity of cyclones and sea-level rise causing increased coastal erosion resulting in loss of housing, land, assets and amenities</td>
<td>Increasing average temperatures, More extremely hot days, Increasing evaporation, Average wind speed change, Sea-level rise, Increasing storm surges, More intense tropical cyclones, More intense rainfall, Declining average rainfall</td>
<td>72 (L3:C4)</td>
<td>92 (L4:C5)</td>
</tr>
<tr>
<td></td>
<td>E3</td>
<td>More intense cyclones and rainfall causes erosion of creeks, exposed land etc. resulting in increased sediment load to estuaries and reef</td>
<td></td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>E4</td>
<td>All variables result in reduced industry productivity causing economic loss to region and unemployment</td>
<td></td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>E5</td>
<td>Increased average temperatures, increased tropical cyclones and storm surges, more intense rainfall, increase in tropical disease causes illness, death, impact on public health resources</td>
<td></td>
<td>60 (L3:C3)</td>
<td>60 (L3:C3)</td>
</tr>
<tr>
<td></td>
<td>E6</td>
<td>Increased temperature results in increased energy for cooling of houses and indoor public facilities resulting in increased costs</td>
<td></td>
<td>56 (L4:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>E7</td>
<td>Inundation of sewage treatment plants causing environmental and public health impacts</td>
<td></td>
<td>52 (L2:C3)</td>
<td>60 (L3:C3)</td>
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<tr>
<td></td>
<td>E8</td>
<td>Increased storm surge, increased intensity of cyclones and more intense rainfall causes inundation of sporting fields resulting in loss of access</td>
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<td>40 (L2:C2)</td>
<td>48 (L3:C2)</td>
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<tr>
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<td>Sea-level rise causes contamination from historic landfills under sporting fields to rise to surface resulting in exposure of contaminants to users of field</td>
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<td>48 (L3:C2)</td>
</tr>
<tr>
<td></td>
<td>E10</td>
<td>Increased temperature or increased storm events cause migration away from region (downward population trend gradual)</td>
<td></td>
<td>40 (L2:C2)</td>
<td>40 (L2:C2)</td>
</tr>
</tbody>
</table>

**Legend**

- **E**: Extreme risk
- **H**: High risk
- **M**: Moderate risk
- **L**: Low risk
- ✓ Relevant climate change variable
- L Likelihood e.g. L2 = likelihood rating 2
- C Consequence e.g. C4 = consequence rating 4

Positive Change - Climate Change Risks and Opportunities for the Cairns Region
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Appendix C  Climate Change Risks Assessed as High Priority for Adaptation Action Planning
## Appendix C  Climate Change Risks Assessed as High Priority for Adaptation Action Planning

<table>
<thead>
<tr>
<th>Focus Group</th>
<th>Risk</th>
<th>Risk Description</th>
<th>Priority for Adaptation Action</th>
<th>2030 Risk Level</th>
<th>2070 Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use planning and assessment</td>
<td>L1</td>
<td>More Intense tropical cyclones and resulting impacts are not considered in planning decisions as planning legislation is not readily adaptable to incorporate new scientific and technological advancements as they are developed.</td>
<td>L</td>
<td>52 (L2:C3)</td>
<td>72 (L3:C4)</td>
</tr>
<tr>
<td></td>
<td>L2</td>
<td>Increasing storm surges, more intense rainfall and resulting impacts are not considered in planning decisions as planning legislation is not readily adaptable to incorporate new scientific and technological advancements as they are developed.</td>
<td>M</td>
<td>60 (L3:C3)</td>
<td>72 (L3:C4)</td>
</tr>
<tr>
<td></td>
<td>L3</td>
<td>Storm surge and flooding, as flood models fail to incorporate sea level rise, storm surge and an increase in rainfall intensity.</td>
<td>H</td>
<td>68 (L4:C3)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>L4</td>
<td>Liability risk from a failure to consider climate change variables in future planning decisions.</td>
<td>L</td>
<td>48 (L3:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>L5</td>
<td>Sea level rise and resulting impacts are not considered in planning decisions as planning legislation is not readily adaptable to incorporate new scientific and technological advancements as they are developed.</td>
<td>L</td>
<td>52 (L2:C3)</td>
<td>80 (L4:C4)</td>
</tr>
<tr>
<td></td>
<td>L6</td>
<td>All future and current developments are at risk of climate change impacts due to limited spatial representation of predicted effects of climate change.</td>
<td>L</td>
<td>48 (L3:C2)</td>
<td>68 (L4:C4)</td>
</tr>
<tr>
<td></td>
<td>L7</td>
<td>Declining average rainfall and resulting impacts are not considered in planning decisions as planning legislation is not readily adaptable to incorporate new scientific and technological advancements as they are developed.</td>
<td>L</td>
<td>48 (L3:C2)</td>
<td>56 (L4:C2)</td>
</tr>
<tr>
<td></td>
<td>L8</td>
<td>Bushfires, increasing average temperature and resulting impacts are not considered in planning decisions as planning legislation is not readily adaptable to incorporate new scientific and technological advancements as they are developed.</td>
<td>L</td>
<td>48 (L3:C2)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td>Council assets, infrastructure and operations</td>
<td>I1</td>
<td>Lack of capacity in drainage system and higher intensity run-off and submerged outlets.</td>
<td>H</td>
<td>76 (L5:C3)</td>
<td>88 (L5:C4)</td>
</tr>
<tr>
<td></td>
<td>I2</td>
<td>Greater infiltration and inflow into system resulting in increased operational costs.</td>
<td>M</td>
<td>76 (L5:C3)</td>
<td>76 (L5:C4)</td>
</tr>
<tr>
<td>Focus Group</td>
<td>Risk</td>
<td>Risk Description</td>
<td>Priority for Adaptation Action</td>
<td>2030 Risk Level</td>
<td>2070 Risk Level</td>
</tr>
<tr>
<td>-------------</td>
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</tr>
<tr>
<td></td>
<td>I3</td>
<td>Bitumen deterioration leading to increased maintenance costs.</td>
<td>L</td>
<td>72 (L3:C4)</td>
<td>52 (L2:C3)</td>
</tr>
<tr>
<td></td>
<td>I4</td>
<td>Beach erosion resulting in damage or loss of Council assets and property.</td>
<td>H</td>
<td>68 (L4:C3)</td>
<td>76 (C5:L3)</td>
</tr>
<tr>
<td></td>
<td>I5</td>
<td>Dam failure (water supply) resulting in infrastructure damage</td>
<td>L</td>
<td>68 (L1:C5)</td>
<td>68 (L1:C5)</td>
</tr>
<tr>
<td></td>
<td>I6</td>
<td>Water damage to pavement resulting in damaged assets and loss of services</td>
<td>M</td>
<td>64 (L5:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>I7</td>
<td>Increase in operating costs due to increased energy consumption on hot days</td>
<td>H</td>
<td>64 (L5:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>I8</td>
<td>Beach erosion resulting in loss of visual beach amenity</td>
<td>L</td>
<td>64 (L5:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>I9</td>
<td>Damage to Council buildings resulting in loss of service</td>
<td>H</td>
<td>60 (L3:C3)</td>
<td>80 (L4:C4)</td>
</tr>
<tr>
<td></td>
<td>I10</td>
<td>Council resources and service levels compromised because resources are diverted to climate change incident response</td>
<td>H</td>
<td>56 (L4:C2)</td>
<td>56 (L4:C2)</td>
</tr>
<tr>
<td></td>
<td>I11</td>
<td>Saturated road base resulting in road failure (especially in the central business district) resulting in an inability to gain access to areas</td>
<td>H</td>
<td>52 (L2:C3)</td>
<td>60 (L3:C3)</td>
</tr>
<tr>
<td></td>
<td>I12</td>
<td>Waste services disruption resulting in decrease of sanitation</td>
<td>M</td>
<td>52 (L2:C3)</td>
<td>52 (L2:C3)</td>
</tr>
<tr>
<td></td>
<td>I13</td>
<td>Damage to and/or loss of landscape, vegetation, ecological biodiversity and visual amenity</td>
<td>M</td>
<td>48 (L3:C2)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td>Focus Group</td>
<td>Risk</td>
<td>Risk Description</td>
<td>Priority for Adaptation Action</td>
<td>2030 Risk Level</td>
<td>2070 Risk Level</td>
</tr>
<tr>
<td>-------------</td>
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<td>-----------------</td>
</tr>
<tr>
<td></td>
<td>I14</td>
<td>Quicker and/or greater deterioration of buildings resulting in increased maintenance costs and decreased asset value</td>
<td>L</td>
<td>32 (L1:C2)</td>
<td>40 (L2:C2)</td>
</tr>
<tr>
<td></td>
<td>I15</td>
<td>Current water supply planning does not take into account climate change resulting in uncertainty of supply</td>
<td>L</td>
<td>28 (L1:C1)</td>
<td>48 (L3:C2)</td>
</tr>
<tr>
<td>Governance and internal services</td>
<td>G1</td>
<td>Rapid decrease in tourism confidence due to significant disaster events impacting local economy</td>
<td>H</td>
<td>64 (L3:C5)</td>
<td>84 (L3:C5)</td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>Failure to supply adequate evacuation routes to storm surge vulnerable areas resulting in the potential loss of life</td>
<td>H</td>
<td>68 (L1:C5)</td>
<td>76 (L2:C5)</td>
</tr>
<tr>
<td></td>
<td>G3</td>
<td>Severe weather event causing failure of essential services and supplies in the central business district. Police, Fire, Ambulance, communications, hospital, airport, co-ordination centre.</td>
<td>H</td>
<td>68 (L1:C5)</td>
<td>76 (L2:C5)</td>
</tr>
<tr>
<td></td>
<td>G4</td>
<td>Failure to take into account climate change issues in policy formulation causing an unprepared community</td>
<td>M</td>
<td>68 (L4:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>G5</td>
<td>Failure to provide a disaster co-ordination centre resulting in uncoordinated response/failure/insufficient response and recovery</td>
<td>H</td>
<td>64 (L2:C4)</td>
<td>64 (L2:C4)</td>
</tr>
<tr>
<td></td>
<td>G6</td>
<td>Decline in tourist numbers due to decrease in length of tourism season and attractiveness of region (beaches compromised, decrease in trips to reef, flooding) impact on local economy</td>
<td>H</td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>G7</td>
<td>Failure to take into account climate change variables in business contingency planning across council departments e.g. asset location, de-centralised operations for continuing essential services</td>
<td>M</td>
<td>60 (L3:C3)</td>
<td>68 (L4:C3)</td>
</tr>
<tr>
<td></td>
<td>G8</td>
<td>Failure to adequately plan for population growth due to migration from other areas due to climate change issues impacting infrastructure</td>
<td>L</td>
<td>60 (L3:C3)</td>
<td>60 (L3:C3)</td>
</tr>
<tr>
<td></td>
<td>G9</td>
<td>Failure to modify Council governance to accommodate climate change.</td>
<td>H</td>
<td>56 (L3:C2)</td>
<td>76 (L5:C3)</td>
</tr>
<tr>
<td></td>
<td>G10</td>
<td>Failure to supply adequate evacuation routes due to roads flooding causing isolation</td>
<td>M</td>
<td>56</td>
<td>56</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Focus Group</th>
<th>Risk</th>
<th>Risk Description</th>
<th>Priority for Adaptation Action</th>
<th>2030 Risk Level</th>
<th>2070 Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>H = high</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M = medium</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>L = low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G11</td>
<td></td>
<td>Occurrence of environmental refugees due to climate change variables (i.e. sea level rises) causing need to relocate local residents</td>
<td>L</td>
<td>52</td>
<td>60</td>
</tr>
<tr>
<td>G12</td>
<td></td>
<td>Fail to modify work patterns resulting in injury and health risk to staff</td>
<td>H</td>
<td>48</td>
<td>56</td>
</tr>
<tr>
<td>G13</td>
<td></td>
<td>Increase in public liability exposure due to sea level rise causing financial claims to local council</td>
<td>L</td>
<td>48</td>
<td>56</td>
</tr>
<tr>
<td>G14</td>
<td></td>
<td>Increase in public liability exposure due to flooding causing financial claims to council</td>
<td>M</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>Environment, recreation and community</td>
<td>E1</td>
<td>Increased storm surge, increased intensity of cyclones and sea level rise caused increased coastal erosion resulting in loss of housing, land, assets and amenities.</td>
<td>H</td>
<td>80</td>
<td>88</td>
</tr>
<tr>
<td>E3</td>
<td></td>
<td>More intense cyclones and rainfall causes erosion of creeks, exposed land etc. resulting in increased sediment load to estuaries and reef.</td>
<td>M</td>
<td>60</td>
<td>68</td>
</tr>
<tr>
<td>E4</td>
<td></td>
<td>All variables result in reduced industry productivity causing economic loss to region and unemployment.</td>
<td>H</td>
<td>60</td>
<td>68</td>
</tr>
<tr>
<td>E5</td>
<td></td>
<td>Increased average temperatures, increased tropical cyclones and storm surges, more intense rainfall, increase in tropical disease causes illness, death, impact on public health resources.</td>
<td>H</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>E6</td>
<td></td>
<td>Increased temperature results in increased energy for cooling of houses and indoor public facilities resulting in increased costs.</td>
<td>L</td>
<td>56</td>
<td>76</td>
</tr>
<tr>
<td>E7</td>
<td></td>
<td>Inundation of sewage treatment plants causing environmental and public health impacts.</td>
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<td>52</td>
<td>60</td>
</tr>
<tr>
<td>E8</td>
<td></td>
<td>Increased storm surge, increased intensity of cyclones and more intense rainfall causes inundation of sporting fields resulting in loss of access.</td>
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<td>48</td>
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<td>Focus Group</td>
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</tr>
<tr>
<td>E9</td>
<td></td>
<td>Sea level rise causes contamination from historic landfills under sporting fields to rise to surface resulting in exposure of contaminants to users of field.</td>
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<td>48 (L3:C2)</td>
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<tr>
<td>E10</td>
<td></td>
<td>Increased temperature or increased storm events cause migration away from region (downward population trend gradual)</td>
<td>L</td>
<td>40 (L2:C2)</td>
<td>40 (L2:C2)</td>
</tr>
<tr>
<td>E11</td>
<td></td>
<td>Psychological devastation to communities in low lying areas caused by loss of life of loved-ones or loss of home/shelter.</td>
<td>H</td>
<td>56 (L4:C2)</td>
<td>76 (L5:C3)</td>
</tr>
</tbody>
</table>

**Legend**

- **E**: Extreme risk
- **H**: High risk
- **M**: Moderate risk
- **L**: Low risk

- **L**: Likelihood e.g. L2 = likelihood rating 2
- **C**: Consequence e.g. C4 = consequence rating 4
Appendix D  Possible Climate Change Adaptation Actions
<table>
<thead>
<tr>
<th>Risk</th>
<th>Risk Description</th>
<th>CRC Corporate Focus Area</th>
<th>Responsible CRC Department(s)</th>
<th>Existing Treatment Strategies</th>
<th>Effectiveness of existing strategies in dealing with climate change</th>
<th>Changes and/or modifications required to the existing strategies, or new actions required to ensure climate change is appropriately dealt with</th>
<th>Timing</th>
<th>Environmental, social and economic implications of the action</th>
<th>Information gaps and potential barriers to implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L2</strong></td>
<td>Increasing storm surges, more intense rainfall and resulting impacts are not considered in planning decisions as planning legislation is not readily adaptable to incorporate new scientific and technological advancements as they are developed.</td>
<td>• Environment</td>
<td>• Planning &amp; Environment</td>
<td>- Flood overlays</td>
<td>- Wet Tropical Coast Regional Coastal Management Plan.</td>
<td>- Currently new developments must be above Q100.</td>
<td>Medium</td>
<td>- All future redevelopment on coastal areas to make buyers aware of the risk – potential for inclusion over title (same for flooding)</td>
<td>- Between 2 and 4 years</td>
</tr>
</tbody>
</table>

- **Services and Infrastructure**<br>- **Works & Services**<br>- **Planning & Environment**<br>- Storm tide mapping currently being done by Disaster Management / current storm tide maps.<br>- SPP’s, FNQROC development manual, Flood modelling<br>- Shoreline management plan

- **L3** Storm surge and flooding, as flood models fail to incorporate sea level rise, storm surge and an increase in rainfall intensity. | • Environment | • Planning & Environment | - Storm tide mapping currently being done by Disaster Management / current storm tide maps. | - SPP’s, FNQROC development manual, Flood modelling | - Shoreline management plan | Medium | - What fall water level should be used? - develop manual<br>- Frequency and intensity of events - how will climate change affect this? (may need to review with certainty of science<br>- Carry out review and monitoring program - need state support (scenario management, do we protect or retreat?, who bears the cost?, what have other local governments done with loss of assets due to coastal erosion, how far back do we have data?)<br>- Hydrologic is based on past whereas climate change is prediction | - Develop manuals - between 2-4 years<br>- Review and monitoring programs - ongoing/across all time periods | - Big economic implications<br>- Increased pressure from state government agencies<br>- Environmental implications from coastal works<br>- Note: can’t always rely on NDRA | - Scientific agreement<br>- Community support<br>- State/political support<br>- Resources |
### Council assets, infrastructure and operations

| **11** Lack of capacity in drainage system and higher intensity run-off and submerged outlets. | **Services and Infrastructure** | **Works & Services** | **FNQROC Development Manual** determines drainage capacity – need figures to reflect climate change considerations. – QUDM instrument also has a role  
- Considerations at planning DA stage, requirements of drainage infrastructure based on surface area, peak demand etc. in Mt Peter  
- Need to check that developments comply with conditions and drainage is suitable.  
- Drainage management in existing developments  
- Catchment management plans | **Low to Medium** | **Need strategies for retrofitting brownfield sites on:**  
- Infrastructure failure and redevelopment (need to review current council approach - preparedness)  
- Historical approvals needing to comply with existing development conditions or require link to climate change applies across the board including landslips  
- IFD charts from BOM need review in the Development Manual - perhaps need to pull out of Manual and get developers to review | **Longer than 5 years** | **Property devaluation**  
- Loss of environmental values | **Legal implications**  
- State legislation  
- Actual quantum - do you go precautionary and risk loss of credibility?  
- Need universal agreement (state needs to lead the way)

| **12** Greater infiltration/inflow into system resulting in increased operational costs. | **Services and Infrastructure** | **Works & Services** | **Water & Waste** | **Infiltration Investigation program** detects leaks and ensures that systems keep up with city growth  
- Undertake a strategic forecasting exercise to determine if an increase in resourcing is needed  
- Plumbing inspections are carried out and certified  
- Sewer overflow inspections and strategy (strategy to reduce backflow at residential areas)  
- Smoke testing – checks if rivers are hooked into the sewer system – check the program and see if it could be more resourced or the program more rigorous  
- Note: there is a fair amount of infiltration from heavy rainfall events, and inundation 4-5 times every wet season | **Low to Medium** | **More rigorous and improve standards to reduce the backflow and carry out retrofitting**  
- Higher resourcing, staff to carry out  
- More sewer inspection points  
- Have more release points of the sewer overflows  
- Looking at past flow records, and modelling - idea of what flows they should have, and be able to track through system  
- Look at recycling technologies and industry available for recycling to reduce the overflow load  
- Review existing waste treatment plants  
- Greater use of recycled water | **Backflow device and inspections – 1 year**  
- Undertake a strategic forecasting exercise - 1 year  
- Planning instantly and ongoing implementation | **Higher fees to customer which could potentially increase cost to council and residents**  
- Less social issues as people won't be getting sick and backed up with sewerage  
- Less overflows into the creeks  
- High probability that overflow will not be backed up into people's backyards  
- Stormwater system dealing with more water because it is being diverted down the sewer system (this is different to infiltration - check this)  
- Environmental benefit on net waterways, algae, nitrogen, reef  
- Larger area requiring maintenance and treatment – more resourcing,  
- infrastructure required | **Models to show the areas that might be affected by increased storm surge or flooding/ hydrological studies and predictions**  
- Aging sewer system and the environment that the sewer systems sits in and the increase in breaks in the system.  
- Greater pressure on stormwater drainage as it is diverted away from sewage  
- Lack of knowledge of history of infrastructure in Douglas, so lots of work to do  
- Proactive
<table>
<thead>
<tr>
<th>Risk</th>
<th>Environment Services and Infrastructure</th>
<th>Works &amp; Services Planning &amp; Environment</th>
<th>Low to Medium</th>
<th>High to Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td>I4</td>
<td>Beach erosion resulting in damage or loss of Council assets, property and amenity (including visual).</td>
<td>Rock walls at beaches, sand replenishment, vegetation protection, groins.</td>
<td>Strategic review of coastal assets, and determine if the shoreline erosion management plan and determine if it considers climate change impacts, and if not, incorporate these considerations</td>
<td>Strategic review, education and fines - 1 year</td>
</tr>
<tr>
<td></td>
<td>• Environmental Services and Planning &amp; Environment</td>
<td>• Current shoreline erosion management plan</td>
<td>• Planning strategy and developments not being built so close to the foreshore</td>
<td>• State Coastal Policy, Develop scenario planning and foreshore infrastructure - 2-4 years</td>
</tr>
</tbody>
</table>
|      | • Rock walls at beaches, sand replenishment, vegetation protection, groins. | • Revegetation Strategies | • Heritage fines for vegetation removal | • State Coastal 
Policy | • Flood risk management 
and Development 
areas - council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Education for residents to stop veg removal and to stop driving on beaches/public access |
<p>|      | • Current shoreline erosion management plan | • State Coastal Policy | • Education for residents to stop veg removal and to stop driving on beaches/public access | • In planning, consider foreshore infrastructure and consider future erosion/storm surge data, and determine if existing treatments can be moved back from the foreshore |
|      | • Revegetation Strategies | • Tinaroo Dam - Russel Heads – Joyce Creek excavator – They dredge sand around Russel Heads and removes sands and places it somewhere else | • Increased fines for vegetation removal | • Increased fines for vegetation removal |
|      | • State Coastal Policy | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Review existing strategies more frequently | • Review existing strategies more frequently |
|      | • Tontype 2 – Russel Heads – Joyce Creek excavator – They dredge sand around Russel Heads and removes sands and places it somewhere else | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Apply State Coastal Policy to a regional level | • Apply State Coastal Policy to a regional level |
|      | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Develop scenario planning – road and units start falling into water, identify a process for what is going to be done. | • Develop scenario planning – road and units start falling into water, identify a process for what is going to be done. |
|      | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • In planning, consider foreshore infrastructure and consider future erosion/storm surge data, and determine if existing treatments can be moved back from the foreshore | • In planning, consider foreshore infrastructure and consider future erosion/storm surge data, and determine if existing treatments can be moved back from the foreshore |
|      | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Taking areas under subdivision areas – council has agreed to undertake the ongoing responsibility and replenishment of state land that is in a subdivision | • Increased fines for vegetation removal | • Increased fines for vegetation removal |
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| I5   | Dam failure (water supply) resulting in infrastructure damage | Maximum flood level is known – no residents; alternate water supply; restricted supply. Consider the Tinaroo Dam | • Predictive modelling based on dam release, king tides and intense rainfall events based on climate change predictions that will reduce localised flooding to residents | • Research - 2-4 years |
|      | • Services and Infrastructure | • Dam failure response strategy – required under legislation | • Research into future recycling technologies and potential industries – Mount Peter a good opportunity to consider water supply that will not be impacted by shortage of water and climate change | • Development restrictions: 1 year |
|      | • Works &amp; Services | • Assume that within this strategy integrity testing is undertaken | • Development of residential areas below dam areas should be considered and restricted (relate to modelling) | • Likelihood of flooding downstream will increase as rainfall intensity will increase and increase likelihood of overflow impacting on residents |
|      | • Water &amp; Waste | • Engineering integrity testing | • Spillway excess = renewable energy | • Alternative water sources environmental implications |
|      | | • FNO Regional Water Strategy - Studies undertaken to determine aquifer recharge areas | | • Economic implications with pumping costs |
|      | | • Water recycling for residential use | | • Reduced water supply – demand management – social – with plants dying, and gardens dying, a few social implications. Culture Change |
|      | | • Do keep building the levies up each year | | • Social safety impacts of inundation, cut off from areas, restricted supply has social impact on landscaping, cultural change |
|      | | | | • Cost of dam infrastructure |
|      | | | | | Information that would come out of the predictive modelling |
|      | | | | | • How more intense the rainfall events |
|      | | | | | • Hydrological modelling for the area. Information of CC scenarios |</p>
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<tr>
<th></th>
<th>Water damage to pavement resulting in damaged assets and loss of services</th>
<th>• Services &amp; Infrastructure</th>
<th>• Works &amp; Services</th>
<th>• Funding; better drainage.</th>
<th>• Review existing maintenance program and desired service level (what are we able to maintain) – Define and Fund – asset management plans</th>
<th>• FNQ ROC development manual – review gradings, materials, infrastructure in relation to new materials</th>
<th>• Focus on high prone flood areas</th>
<th>1 year</th>
<th>• Barrier is what Council contracts service of waste collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Increase in operating costs due to increased energy consumption on hot days</td>
<td>• Council Governance and Operations</td>
<td>• Corporate Services</td>
<td>• Water &amp; Waste</td>
<td>• Works &amp; Services</td>
<td>• Community &amp; Cultural Services</td>
<td>• Planning &amp; Environment</td>
<td>• Currently reviewing work times and schedules for staff.</td>
<td>High</td>
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<tr>
<td>19</td>
<td>Damage to Council buildings resulting in loss of service</td>
<td>• Services and Infrastructure</td>
<td>• Works &amp; Services</td>
<td>• Community &amp; Cultural Services</td>
<td>• Council has various buildings; provision for temporary offices; IS systems for staff to work from home.</td>
<td>• Developing asset management plans for our buildings – deterioration of buildings, and need for them to be knocked over and rebuilt etc are being assessed. Asset mgmt plans take into account storm surge/cyclone resistance</td>
<td>• Generators in place to accommodate loss of electricity</td>
<td>• Council does have a number of buildings in a number of areas, so could potentially relocate</td>
<td>Medium</td>
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<td>10</td>
<td>Council resources and service levels compromised because resources are diverted to climate change incident response</td>
<td>• Council Governance and Operations</td>
<td>• Corporate Services</td>
<td>• Water &amp; Waste</td>
<td>• Works &amp; Services</td>
<td>• Community &amp; Cultural Services</td>
<td>• Planning &amp; Environment</td>
<td>• Backfill staff positions form agencies; different staff support doing different tasks.</td>
<td>Low – we are more reactive than proactive.</td>
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<td>I11</td>
<td>Saturated road base resulting in road failure (especially in the central business district) resulting in an inability to gain access to areas</td>
<td>Services &amp; Infrastructure</td>
<td>Works &amp; Services</td>
<td>Flood mitigation project and pumps in place; pumps currently require an upgrade in increase capacity which be done in next 12 months.</td>
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|     | - Are using more stabilised materials which are less likely to saturate                                                        |                          |                 | - Are improving and upgrading our drainage systems for road networks  
|     | - Different types of asphalts for turning areas to waterproof the roads – rescaling programs, having more frequent reseals, greater emphasis on rescaling programs to waterproof road bases |                          |                 | - Different types of asphalts for turning areas to waterproof the roads – rescaling programs, having more frequent reseals, greater emphasis on rescaling programs to waterproof road bases  
|     | - Incident response to road failure is relatively fast                                                                         |                          |                 | - Incident response to road failure is relatively fast  
|     | - FNQROC development manual that sets out road design                                                                        |                          |                 | - FNQROC development manual that sets out road design |
| Low | Keep up to date with new technologies to improve road based                                                                   |                          |                 | Keep up to date with new technologies to improve road based  
|     | - Invest in resources to catch up on roads that are currently infiltrated – increase intensification program of rescaling programs |                          |                 | - Invest in resources to catch up on roads that are currently infiltrated – increase intensification program of rescaling programs  
|     | - Trail new technologies and being a pilot project council – different techniques, using different materials                    |                          |                 | - Trail new technologies and being a pilot project council – different techniques, using different materials  
|     | - Review existing maintenance program and desired service level. Council may decide that they are prepared to accept road failure once every 5 years. Must define this desired service level so that we can identify. |                          |                 | - Review existing maintenance program and desired service level. Council may decide that they are prepared to accept road failure once every 5 years. Must define this desired service level so that we can identify.  
|     | - Review FNQROC development manual that sets out road design – Look particularly for high flood prone areas – no point having one standard – make sure that it is suburb specific  
|     | - Audit of areas requiring regular upkeep                                                                                  |                          |                 | - Audit of areas requiring regular upkeep  
|     | - Pilot for new products and technologies to ascertain which products are more effective in preventing road failure            |                          |                 | - Pilot for new products and technologies to ascertain which products are more effective in preventing road failure |
|     | New technologies, New product pilot, suburb specific road design- 1 year                                                    |                          |                 | New technologies, New product pilot, suburb specific road design- 1 year  
|     | Maintenance program and development manual- 2-4 years                                                                       |                          |                 | Maintenance program and development manual- 2-4 years  
|     | Positive is getting people back out on the road more quickly if teams are available and aware of the issues                  |                          |                 | Positive is getting people back out on the road more quickly if teams are available and aware of the issues  
|     | Public safety issue                                                                                                         |                          |                 | Public safety issue  
|     | Saves money in long-term as water saturation destroys pavement more frequently                                               |                          |                 | Saves money in long-term as water saturation destroys pavement more frequently  
|     | Social impact is that people can access areas usually cut off from floods – increase rapid response in flood incidents       |                          |                 | Social impact is that people can access areas usually cut off from floods – increase rapid response in flood incidents  
|     | Less road base into creeks and natural environment                                                                          |                          |                 | Less road base into creeks and natural environment  
|     | Improve hydrological data available for better designing drainage systems                                                    |                          |                 | Improve hydrological data available for better designing drainage systems  
|     | Reliant on industry for new technology around road base                                                                        |                          |                 | Reliant on industry for new technology around road base  
|     | Council has increased services, reducing budget for rates, roads and rubbish                                                 |                          |                 | Council has increased services, reducing budget for rates, roads and rubbish  
|     | Positive Change - Climate Change Risks and Opportunities for the Cairns Region                                               |                          |                 | Positive Change - Climate Change Risks and Opportunities for the Cairns Region  
| 3 June 2009 | Positive Change - Climate Change Risks and Opportunities for the Cairns Region                                               |                          |                 | Positive Change - Climate Change Risks and Opportunities for the Cairns Region  
| Page D-6    | Positive Change - Climate Change Risks and Opportunities for the Cairns Region                                               |                          |                 | Positive Change - Climate Change Risks and Opportunities for the Cairns Region  
| AECOM      | Positive Change - Climate Change Risks and Opportunities for the Cairns Region                                               |                          |                 | Positive Change - Climate Change Risks and Opportunities for the Cairns Region  

| I12 | Waste services disruption resulting in decrease of sanitation | • Environment • Services & Infrastructure | • Water & Waste | • Instead of having no formal records, we don’t have any formal strategies • Education Officer in the Department of Waste • Green waste service to collect before cyclone season | Low | • Education program to minimise the amount of putrescible waste such as organic worm farms etc – ensure residents are a lot more vigilant to reduce the overall amount of waste that needs to be collected. • Looking at the sorting and managing of waste at the household level – i.e. rinsing off meat containers • Waste management strategy is currently being written - ensure covers information on safe disposal during extreme events, education on disposal, management of waste • Incorporate waste management into event management, so incorporate advice into cyclone brochures • Free rubbish dump scheme • Flooding in the CBD – timeline for acceptable services – council commits to a desired service level post a particular event • Marketing campaign to ensure residents are aware that there will be a change in level of service after a particular event so that expectations are not as prevalent as normal – manage expectations • Build requirements as part of the contract management to contract service providers. Therefore build council expectations into the contract. • Have a policy that allows people to clean out their yards before cyclones • Education on composting and worm farms (rebates through Council) for organic matter • Develop timeframe for desired service level after event - manage expectation – manage and include these details into waste contract | • Education program- 1 year • Waste management strategy- 2-4 years | • Council contracts the service out to service providers, however oversees the contract and are responsible for the contract • Ensure the Waste Management Strategy incorporates waste minimisation in the case of loss of services • Free dump days cost money - $ for increased service level for waste vouchers • Diverts waste from landfill and reduce GHG • Increased safety of community from waste on street and sanitation issues | • Barrier is that Council contracts service of waste collection |

<p>| I13 | Damage to and/or loss of landscape, vegetation, ecological biodiversity and visual amenity | • Environment • Planning &amp; Environment • Works &amp; Services | • Revegetation plans • Draft Regulations Pest Management Strategy- local action plans • Water strategy/ecosystem services (complex, condition assessment, setbacks) | Low to Medium | • Shoreline Erosion Management Plan should also address this • Coastal Management Plans? Coverage? • Needs more work does not include rest/impact pressure from climate change, needs to address current issues • Note: EOI for risk assessment: Wet and Dry Tropics under LAPP round 2 | • Resources to enforce |</p>
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<th>G2</th>
<th>Failure to supply adequate evacuation routes to storm surge vulnerable areas resulting in the potential loss of life</th>
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<td>G3</td>
<td>Severe weather event causing failure of essential services and supplies in the central business district. Police, Fire, Ambulance, communications, hospital, airport, co-ordination centre.</td>
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<td>G4</td>
<td>Failure to take into account climate change issues in policy formulation causing an unprepared community</td>
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<td>G5</td>
<td>Failure to provide a disaster co-ordination centre resulting in uncoordinated response/failure/insufficient response and recovery</td>
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<td>Better social and economic response for our community following a disaster event.</td>
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<td>Lack of support at State/Federal level</td>
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<td>Proposed Action</td>
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<tr>
<td>G7: Failure to take into account climate change variables in business contingency planning across council departments e.g. asset location, de-centralised operations for continuing essential services</td>
<td>• Community and Lifestyle Services and Infrastructure • Works &amp; Services • Corporate Services • Water &amp; Waste • Planning &amp; Environment • Community &amp; Cultural Services • Move around some assets in the wet season • EMT agreed to doing the Depo Strategy to review resources and functions of various Depo. • Have outdated and unimplemented Business Continuity Plan</td>
</tr>
<tr>
<td>G8: Failure to modify Council governance to accommodate climate change.</td>
<td>• Council Governance and Operations • Corporate Services • Need to be clear on what we are responsible for • Overarching commitment that underpins a lot of things that we are doing, but not explicit in some of the hard targets – evolving area • Commitment to sustainability/ climate change is explicit in vision statements – evolving</td>
</tr>
<tr>
<td>G9: Failure to supply adequate evacuation routes due to roads flooding causing isolation</td>
<td>• Community and Lifestyle Services and Infrastructure • Works &amp; Services • Council has applied to natural disaster mitigation program for funding to create an evacuation strategy. To be based on current evacuation routes (which are susceptible to flooding). • Tsunami Maps sent out to all residents so they know where to go • Education strategy – emergency kit • Flood proofing of roads • Alternative access- linking roads</td>
</tr>
<tr>
<td>G10: Failure to modify work patterns resulting in injury and health risk to staff</td>
<td>• Council Governance and Operations • Corporate Services • WH&amp;S Policies- working in the sun • Providing insect repellent to staff in the field • Flexible working hours</td>
</tr>
<tr>
<td>G11: Overarching Busines Continuity Plan - how do you link it with Depo Strategy and Continuity Planning - how do you link it with Depo Strategy and Continuity Planning</td>
<td>• Positive economic and social outcomes. • Council operations more effective and efficient • Filling the information gap for the community.</td>
</tr>
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</table>

**Resource Allocation**

- **Reduction in demand on electricity**
- **Resource issues/ huge financial pressure**
- **Need a new department – don’t have a coordinated team**
- **100 000 people moving into the region, growing financial pressure, this is on the list of many others. Have to prove that this stacks up as a strategic path forward.**
- **Must show long term benefits of doing it, and long term risks of doing it.**
- **Social awareness and education increase**
- **Financial/resources – ability to quantify and long-term financial benefit of sustainability/climate change action for Council**

**Key Considerations**

- **Lack of control over the State Roads**
- **Regional Issue**
- **Community complacency**
- **Localised adverse Impacts.**
- **Need to base the Tsunami Maps on science not just on contours what impact would the reef have on a Tsunami?**

**Notes**

- **EBA / Unions**
- **End of Page D-9**
Positive Change - Climate Change Risks and Opportunities for the Cairns Region

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Environment, recreation and community

E1 Increased storm surge, increased intensity of cyclones and sea level rise caused increased coastal erosion resulting in loss of housing, land, assets and amenities (including visual).
- Environment Services and Infrastructure
- Planning & Environment Works & Services
- Wet Tropical Coast Regional Coastal Management Plan.
- Rock walls at beaches, sand replenishment, vegetation protection, groins.

NOT COMPLETED AS HAS BEEN ADDRESSED IN OTHER RISKS

E3 More intense cyclones and rainfall causes erosion of creeks, exposed land etc. resulting in increased sediment load to estuaries and reef.
- Environment Planning & Environment Works & Services
- Sediment and Erosion Control Plans, partnerships with other agencies, development control conditions.
- Water Quality Improvement Plans across the region prepared by Terrain – undertake a gap analysis
- River Improvement Trusts

Medium

- Staff to undertake compliance is needed
- Accreditation not required
- Need to slow and retain water flows, potentially water sensitive urban design guidelines
- Finalise revegetation specifications and guidelines (Regional/FNQROC)
- Develop manual to reference revegetation specifications and guide
- Need strategic framework
- Need to shift responsibilities to developers in regards to off-setting/revegetation

E5 Increased average temperatures, increased tropical cyclones and storm surges, more intense rainfall, increase in tropical disease causes illness, death, impact on public health resources.
- Community and Lifestyle Planning & Environment Environment
- Rainbow Fish Breeding program
- Fogging
- Partnerships/Education
- Enforcement $400 on the spot fine
- Inspection Regime – DART Team

Medium however it is reactive and should come back to better scenario planning pulling all the groups together.

- Multi – tasking of staff to different programs
- Need better resources to deal with outbreaks and more people on full time.
- Better education of the community
- Scenario planning rather than being reactive - use scenario planning to develop response plan
- Community accept the responsibility for keeping houses free of Mozzie breeding areas.
- Screening of people who come in from high risk areas to prevent outbreaks.
- Compliance checking
- Rainwater tanks - proper management/maintenance
- Work with partners on vaccine
- Engaging community

- Scenario Planning - 2-4 years
- Create Civic community - 5+

- Do nothing option is meaning that the situation is very hard to combat.
- If we get it right we can have community confidence. Community accept responsibility
- Service level focus on operational planning/budgeting

Low socio-economic areas are generally in vulnerable area and may not have insurance,
- Social impacts of alert community to level of risk

- What is our service level?
- Operational Plan
- Putting up new initiatives for budget.
- Create Civic community involvement in the issue.
- Current mandatory rainwater tank policy may cause breeding place if not maintained.
- Engaging community
- Information/assistance for renovators who are repairing/improving houses to be more responsive to cyclonic conditions eg new roofs, shutters. Building inspections what category cyclone it is built to

2031 Insurance verses compensation from changes of planning areas.
- Lack of control

Monitor and set intervention levels
- Are our insurance excess levels right, are our level of cover.
- Operational Plans
- Information outputs from risk adaptation gets included in annual risk review
- Awareness program – notations on rates notice

Review risk register, operational plans, Insurance- 1 year

ADDRESSED IN OTHER RISKS

ADDRESSED IN OTHER RISKS

ADDRESSED IN OTHER RISKS
<table>
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<tr>
<th>E6</th>
<th>Increased temperature results in increased energy for cooling of houses and indoor public facilities resulting in increased costs.</th>
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</table>
| Services and Infrastructure | Works & Services  
Planning & Environment  
Corporate Services | Cities for Climate Protection action plan to reduce Council Energy Consumption.  
Partnerships with Queensland Government Climate Change and awareness to community on Federal rebates for insulation and SHW  
Sustainable Housing in QDC (5 star ratings)  
Sustainability Street  
Federal rebates that are accessed when available  
5 star rating  
Vegetation Guide | Low to Medium | Ensure indoor public facilities – use sustainable building design criteria  
Sustainable design policy in council and a sustainable design strategy for new council buildings  
Retrofitting strategy  
Urban Design Advisory Group – Ensure that Climate change considerations are included in the ToR  
Consider regional renewable resources  
Resilient building design for cyclones – retrofitting  
Integrate landscaping with housing design | Sustainable  
building design policy,  
retrofitting strategy, advisory group- 1 year  
Building design for cyclones- 5+ years  
Sustainable building design criteria- ongoing | Most exercises are about PR exercises rather than a streamlined long term outcomes approach  
Reduce energy operational costs  
Reduce peak demand, society equity and power cost  
Reduce impact of climate change, pollution | Barrier – PR overrides long term outcomes – need to ensure benefits and PR balanced  
Costs of building sustainable building is a barrier to Council – need cost benefit analysis of Green Star ratings balanced triple bottom line score card approach  
Staff- need staff employed or trained in sustainable design Education | |
| E9 | Sea level rise causes contamination from historic landfills under sporting fields to rise to surface resulting in exposure of contaminants to users of field. |
| Environment  
Community & Lifestyle | Water & Waste | Look for funding to do an audit on sporting – core samples on current sporting roles/ leachate testing  
Develop a strategy on how to deal with sites/ mitigation measure for low medium and high risks.  
In the absence of knowledge, take a precautionary approach during flooding do not allow sporting to occur until testing carried out – Sport and recreation policy need to be developed  
GIS layer to compliment the flood layer to determine and identify where they all are  
Opportunity to use facilities at schools, which could be an integration bonus so that the school gets paid to use the facilities to fund other activities, and sporting association gets grounds that they don't have to carry out after care with | Low | 2-4 years | Public health is improved  
Ligitation for council  
Cost- opportunity for external funding  
Once you know it’s there, people may potentially not want top play there  
Encourage more mixed use recreational areas | No space for rec fields to replace sick fields  
Lack of histories knowledge of where old landfills are and what went into them  
Knowing contamination and leachate potential, and cleanup measures | |
| E11 | Psychological devastation to communities in low lying areas caused by loss of life of loved-ones or loss of home/shelter. |
| Community and Lifestyle  
Services and Infrastructure | Works & Services  
Community & Cultural Services | Council capacity building.  
Open up the showground for people.  
What are Councils responsibilities we do not have the lead role.  
Partnership and Education with Department of Communities  
Provide sign posting eg web, phone, restore services- return to ‘normal’ | Not directly our responsibility however we can partner with other organisation.  
Using internet and our resources ie Libraries/phones that can tell the community information.  
Informing the community  
Restoration of service levels and return to normality – Council responsible.  
Open up the showground for people.  
Partner with RSPCA for pets and no pets allowed in evacuation shelters | 2-4 years | Better restore community capacity and social cohesion | Who does what and the ownership is a barrier |
Appendix E  Leading Practice for Planning for Climate Change Adaptation and Mitigation
Appendix E Leading Practice for Planning for Climate Change Adaptation and Mitigation
From Gurran et. al., (2008)

Addressing environmental implications of climate change for coastal amenity communities

Plan to enhance the resilience of coastal processes and features by:

- Identifying existing pressures to natural landscapes, habitat, catchment values and biodiversity as well as potential threats relating to climate change and placing areas of important vegetation and coastal habitat within an environmental protection zone or equivalent, if not already protected. Regional coastal settlement plans taking a more integrated approach to future development will be critical.

- Using coastal setback areas as opportunities to reintroduce and restore local biodiversity and creating planning system incentives and requirements for new developments to retain and restore local biodiversity.

Plan to enhance the resilience of coastal processes and features by:

- Identifying low lying and exposed areas, and assessing the potential to reintroduce natural ‘soft’ defence measures through direct works or as a planning requirement when frontal coastal areas are developed.

- Ensuring that planning regulations prohibit development that may exacerbate the vulnerability of coastal processes through changed hydrological patterns, migration of dunal systems, filling or dredging of wetlands or mangroves. Provide for consultation with expert agencies for development in particularly vulnerable areas or for development of a certain scale.

- Introducing special environmental assessment requirements for areas where existing information is insufficient to determine the impact of potential development scenarios without additional and costly research. Such research may have become available at the time an application is lodged or might be funded by the developer.

Plan to enhance the resilience of coastal amenity communities to natural hazards by:

- Identifying a range of sea level/natural hazard thresholds or indicators as a basis for setting coastline building setbacks and requirements for removal/retreat of buildings. A graduated approach responding to changes in these thresholds allows for flexibility.

- Reviewing existing natural hazard requirements – e.g. relating to flooding, cyclones, or bushfires, bearing in mind likely increases in the intensity or frequency of major events. Consider reorienting natural hazard assessment methodologies contained in plans from historical events to the range of forecasted impacts associated with climate change scenarios.

- Revise land use designations and permitted building forms in the light of this natural hazard assessment. As well as the location of housing or other built infrastructure within revised potential hazard areas, consider the availability of access ways and congregation spaces for emergency evacuation.

- Establish mechanisms to re-situate land uses that may become unsafe or unsuitable in the future due to climate change. These range from public infrastructure – like water treatments systems or land fill sites, which may pose significant risks to public health and, in the event of a coastal flood, to private property at risk of inundation or landslip. A system of ‘transferable development rights’, used within an appropriate ‘receiving area’ may provide a prudent long term option for relocating land uses from areas that face unacceptable levels of risk.
Planning for climate resilient economies in coastal amenity areas

Regional and Local plans should:

• Ensure that future employment and industrial lands are situated in areas of low climate risk.

• Strengthen design or development controls requirements for industry to withstand natural hazards and for thermal comfort.

• Assess new proposals to ensure resilience to the impacts of climate change.

• Identify opportunities to capitalise on carbon friendly industries – from green technology to renewable energy production or carbon sequestration.

Plan to maintain and enhance tourism appeal, and strengthen resilience to climate change impacts by:

• Ensuring that areas for new tourism development are situated in locations that are not at long term risk of climate change impacts and revising construction, safety and emergency standards for visitor facilities and tourism infrastructure, including landscaping requirements.

• Identifying major tourism attractions and significant contributing landscapes or natural features, and ensuring that these assets are appropriately protected through planning requirements. Recognising and protecting scenic integrity may also have the benefit of buffering natural attractions to increase their resilience.

• Improving the climatic comfort of key destinations through planning policies requiring shading, urban vegetation, building configuration to take advantage of ventilation and breezes, and climate sensitive building forms.

• Appealing to eco tourism markets, by featuring climate friendly design requirements for new tourism developments, including renewable energy and energy saving design requirements, on site water retention, recycling, and demand reduction strategies, and best practice waste reduction, recovery, and treatment approaches.

Plan to preserve and enhance viable local and regional agricultural production in coastal amenity communities by:

• Preserving existing agricultural lands through planning controls and incentives to support viable agricultural production, while permitting compatible economic activities to coexist in agricultural areas.

• Enabling multi function use of agricultural lands, provided that additional uses do not threaten the long term quality of the land for agricultural production. Examples of additional uses include decentralised energy or power plants such as wind or solar farms.

• Consider evaluating different forms of agriculture based on the likely repercussions of storm events, so that agricultural operations that would contribute to problematic outcomes are regulated or placed into low risk areas.

Plan to maximise new opportunities arising from changed climatic conditions and or climate change technology for settlement design and operation by:

• Identifying sites or precincts where climate technology can be developed or demonstrated, and ensure that zoning or development controls support these activities – tourism resorts, science or business parks might all be encouraged to demonstrate renewable energy forms, onsite waste recovery, water harvesting and recycling.
• Identifying opportunities for climate change adaptation approaches – such as wetland protection or reconstruction, or increased coastal setback and re-vegetation works – to support existing and potential economic activities relating to leisure or tourism.

Planning for climate resilient populations in coastal amenity communities

Plan to minimise potential health risks associated with climate change by:

• Ensuring that housing is located in areas of low risk from natural hazards and able to be easily accessed by emergency services.

• Ensuring that design standards applying to manufactured home estates and caravan parks afford suitable protection for extreme storm or hurricane events. Siting must enable safe and easy evacuation for residents.

• Tailoring urban design guidelines and building codes for public and private buildings to ensure that in case of a power outage during severe heat, residents can open windows or otherwise cool their homes and workplaces. Generally encourage appropriate design that maximises cross-breezes and natural building interior cooling.

• Tailoring urban design guidelines and building codes for public and private buildings to minimise urban heat island effects arising from hotter temperatures and heatwaves. This may include encouraging more trees, ‘green’ (planted) roofs, attention to building and paving colours, and similar actions. It may also mean moving towards designing ‘green precincts’, not just individual buildings.

• Design public space to address more severe local climatic conditions and to reduce urban heat island effects. Require shading, shelter, and appropriate vegetation to cool areas of open space and walkways or cycle paths, and consider ways to design public amenities for safety and storage during storm events.

• Consider the impact of planning requirements (such as those relating to water sensitive urban design) and the placement of infrastructure on the potential for the spread of water borne and vector borne diseases.

Coastal amenity communities can strengthen their capacity to withstand and recover from natural emergencies by:

• Maintaining spaces for emergency access, congregation, shelter and evacuation.

• Planning ahead for evacuation, including public transit evacuation of non-car owning public (especially the elderly, the frail and the young). Special communication strategies may be needed for these vulnerable groups (Cutter and Rich 2007).

• Identifying and reserving locations for intermediate post emergency recovery (these locations should be resilient to natural hazards but may be multi-function). Actively planning ahead for settlement reorientation or design following a major natural disaster, and ensuring that land use decisions do not compromise these future intentions.

• Ensuring that water, energy and communication services and infrastructure are likely to withstand most emergency situations and / or promoting smaller and more decentralised sources of water and power.
Planning for climate resilient infrastructure in coastal amenity areas

Plan to strengthen the resilience of community infrastructure to climate change impacts by:

- Assessing the location of existing and planned infrastructure (roads, utilities, recreation centres, swimming pools, hospitals, schools, libraries and community centres etc), and vulnerability to climate change impacts.

- Identifying future locations for relocation of major infrastructure or establishment of new, decentralised energy, water, or waste management plants to service existing or planned development. Ensure that land use plans reserve these sites or indicate the need to include them within new release or redevelopment areas. Retrofitting existing urban centres to accommodate renewable energy options including cogeneration possibilities.

- Reviewing the design standards for public buildings and infrastructure items and private buildings (houses, apartments, commercial and industrial buildings etc) to minimise risk in case of more extreme weather events as well as more cumulative impacts of climate change, such as increased temperatures or drought.

- Revising infrastructure capacity plans to take future climate scenarios into account (for instance, likelihood of drought), rather than historical weather events, and adjust settlement thresholds accordingly (for instance, thresholds based on availability of water supply).

- Maximising multifunction opportunities, by prioritising the introduction of new infrastructure that delivers multiple environmental services as well as serving basic settlement needs wherever possible. For instance, wastewater management strategies that utilise natural or constructed wetlands, and may also provide recreational opportunities and contribute to biodiversity and landscape. These strategies have multiple quality of life benefits for amenity communities.

- Similarly, include clear land use planning objectives for new infrastructure forms to have minimal or no net carbon impact. Where such infrastructure is to be provided by private developers, include planning based incentives to support this provision (for instance, increased development potential on the site, or the elimination of other infrastructure levies).

- Emphasise potential for major developments to self provide basic infrastructure services – like energy, water, waste management, through strategies such as micro energy generation, water retention, demand reduction technologies, reuse, and recycling; and waste minimisation, reuse, and disposal. If technology is not currently available, ensure future opportunities are retained to introduce more carbon friendly and climate resilient forms of infrastructure in the future.

Plan for water security in coastal amenity communities by:

- Protecting the integrity of existing water supply by prioritising catchment protection in land use and development planning decisions, by adopting the principles of water sensitive urban design, and by considering other local or regional catchment management plans when decisions are made.

- Prioritising water supply options that are associated with minimal contributions to climate change impacts, so that major forms of intervention like desalination plants (associated with increased energy requirements and some increase in sea temperatures) are considered only if alternative technologies and strategies (including slower growth in certain areas) are not viable.

- Implementing water demand management strategies and requirements for new urban developments, particularly developments associated with major water needs, such as tourist facilities. Requirements might include mandatory use of water savings devices, planting of native species, water capture, recycling, and onsite water treatment (depending on other state government requirements and health standards). Increased rate payments or a special levies on tourism / visitor infrastructure might be required to offset the water impacts of tourist facilities during peak seasons.
• Maintain spaces for floods and water retention in regions where rainfall patterns are likely to become more volatile, characterised by fewer overall rainy periods, interspersed by sudden intense rainfall.

Plan to make transportation improvements a central component of mitigation as well as more resilient to climate change within coastal amenity communities by:
• Designing new settlements and reconfiguring existing settlements to reduce the need for trip generation and to maximise potential viability of public transport.
• Assessing the transportation impacts of all major new developments.
• Ensuring that new settlements are accessible by all weather roads or alternative routes.
• Prioritising attractive and well shaded walkways and cycle paths within existing and planned areas, linking residential, retail, and recreational precincts.

Plan to capitalise on opportunities for renewable and low carbon energy generation, and to increase resilience to climate change impacts for energy requirements by:
• Identifying and reserving sites or locations that may become suitable for renewable energy plants either now or in the future. Drafting renewable friendly energy planning and building codes, that enable broader environmental benefits to be assessed alongside local impacts on landscape, amenity, and economy.
• Creating planning incentives or requirements for major new developments to utilise local sources of renewable energy as much as possible, or provide offset payments to stimulate investment in local energy generation if technology is not currently available. Reviewing current pricing policy for renewable energy will be critical in making it cost effective to invest in urban renewable energy options.
• Protect solar access to ensure that developments retain capacity for onsite solar energy generation.
• Enforcing building and urban design requirements that minimise energy requirements and maximise thermal comfort.

Plan for carbon neutral and climate resilient waste management in coastal communities by:
• Auditing the location of existing and future landfill sites, and assessing the vulnerability of these sites to major weather events.
• Establishing provisions for composting at site and or neighbourhood level, to reduce waste in land fill and to assist in reducing the water requirements of local gardens. Require major developments to include a sustainable waste strategy as a condition of planning approval – or a special contribution to local waste management and recovery fund.
• In some cases, reserving larger local sites to accommodate waste sorting, recycling and reuse. Minimise the amount of waste in landfill sites, while exploring sustainable ways to harness the energy it represents, such as methane recovery and biomass plants.