



**Byron and Tweed Shire
Councils**

Climate Change
Adaptation Action Plan

Assessing Climate Change Risk and
Adaptation Strategy Development in the NSW
Northern Rivers Region

June 2009



Australian Government
Department of Climate Change

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1. Executive Summary and Next Steps

'Adaptation is an essential component of truly sustainable development'.(TCPA, 2007)

The assessment was conducted using the prescribed methodology as defined in *Climate Change Impacts and Risk Management: A Guide for Business and Government* (AGO¹, 2006), which is aligned with the Australian Standard for Risk Management (AS/NZS 4360:2004). The risk framework utilised was based on the consequence and likelihood criteria defined in the Australian Government Department of Climate Change (DCC) documentation. The climate change adaptation matrix has been developed by GHD for the purposes of the Australian Government Department of Climate Change (DCC) Local Adaptation Pathways Program (LAPP). In this process participants were asked to assess which assets and activities are sensitive to climate change and then based upon the judgement of the workshop participants were asked whether climate change is a significant risk to these assets and activities. Climate change is not anticipated to create new risks but rather increase the frequency and severity of existing climate related risks.

The climate change variables considered in the Byron and Tweed included sea level rise (and associated storm surge), increased temperature, rainfall changes and extreme weather events, with the level of risk and then adaptation options for each risk scenario analysed for the present (2009), 2030 and 2070.

In order to carry out an assessment of the risks of climate change it is necessary to define how the climate for the region is projected (or assumed) to change in the future. This is achieved through using climate change projections. Both the Australian Commonwealth Scientific and Research Organisation (CSIRO) and the of Environment and Climate Change NSW (DECC) have produced regional climate change projections, which present broad regional climate change projections that have been used in this assessment. For consistency a 'High' emissions scenario only was selected for 2030 and 2070. This also means that the Councils are taking a consistent approach and applying a precautionary approach to this assessment².

Adaptation is needed now because the climate is already changing. Many of the climatic changes forecast for the Byron and Tweed local region in the next 30–40 years are 'locked in' and are the result of past greenhouse gas (GHG) emissions and some climate change is therefore inevitable. Many of each Council's assets have a design life of 40–100 years, which makes climate change a current, rather than a future issue. In order to increase each Council's and its community's resilience to these predicted future changes in climate Byron and Tweed Shire Councils need to commence taking these future conditions into account for new developments, planning process and/or policy. Climate change is a fast-moving policy area, and will increasingly be a requirement of planning and design guidance, for instance the NSW Government recently published its *Draft Sea Level Rise Policy* (2009) guidelines.

¹ Please note that the AGO no longer exists and many of the functions of the AGO have been transferred with the recently formed Australian Government Department of Climate Change (DCC). The Local Adaptation Pathways Program is under the control of the DCC.

² This assessment utilizes the 'High' emissions scenarios for two future dates; 2030 and 2070 as scientific consensus is that observed carbon dioxide concentration; global mean temperatures and sea level rise have been tracking at the upper end of the IPCC scenario range from 1990 to 2006 (see Section 4.1 for further information). The CSIRO advises that although this '17-year' period to 2030 is very short, the mid and low projections may be less likely than the high projections, with significant implications for risk management (CSIRO, 2007)..



The adaptation planning process identified a number of opportunities for each Council to rethink its approach and to potentially create remodeled communities that are more resilient in the face of future climates. Many adaptation strategies offer multiple benefits and many of the adaptation actions identified are closely aligned to existing actions in each Council’s suite of sustainability plans and policies and as such offer the potential to contribute to enhancing quality of life in the Byron and Tweed Shires in future. Therefore climate change presents opportunities to develop new services and approaches that respond to the challenges of sustainability and climate change in tandem. Adaptation options identified in this plan also have the potential to contribute to greenhouse gas emissions reduction. As an example, managed realignment of hard flood defenses can improve biodiversity as well as managing flood risks and water sensitive urban design is more resilient to a climate with reduced rainfall and also delivers benefits both in terms of sustainability and greenhouse gas emissions reduction. Adaptation options with these co-benefits are identified in this Report.

The assessment identified twenty-two risks. The risk level summary is given in Table 1, where two risks were rated as ‘High’ for 2009, six for 2030 and eight for 2070. The Adaptation Workshop selected the ‘Extreme’ and ‘High’ risks from the Risk assessment process and analysed and prioritised controls for each of these risks. In the workshops the risk rating was reassessed once all new and augmented controls had been considered, with these controls in place, two ‘High’ (residual³) risks remained. Residual Risk is the remaining risk after all relevant controls have been taken into account.

Any risk which received an ‘Extreme’ or ‘High’ priority level demands urgent attention at the most senior level of Council and should not be accepted as part of the routine operation of Council.

Table 1 Number of Risks in Each Category

Risk Level	2009	2030	2070	Residual Risk
Low	10	3	2	7
Medium	10	13	6	12
High	2	6	8	2
Extreme	0	0	6	0
Residual risk not rated				1*
Total	22	22	22	22

It is important to note that only the “Extreme” and “High” risks were carried through to the adaptation stage due to their perceived high priority for both Councils. The following ‘High’ and ‘Extreme’ risks were identified in the risk assessment and analysed further in the adaptation planning process:

- 2009 ‘High’: Increased temperature – The Introduction or proliferation of exotic species
 Increased storm activity– Increased flood level and frequency

³ Residual Risk is defined as the risk or danger of an action or an event, where residual means “the quantity left over at the end of a process; a remainder”. It is therefore the remaining risk after all relevant controls have been taken into account.



2030 'High':	Increased temperature –	The Introduction or proliferation of exotic species
	Sea level rise –	Loss of current or existing biodiversity
		Effect on freshwater supply
		Increased flood level and frequency
		Coastal erosion
	Increased storm intensity-	Increased flood level and frequency
2070 'High':	Increased temperature –	The Introduction or proliferation of exotic species
		Increased bushfire events/intensity
		Higher evaporation and longer drought
	More severe weather -	Decline in the local economy
		Increased flood level and frequency
	Increased temperature -	Habitat displacement
	Increased storm intensity-	Increased flood level and frequency
	Decreased rainfall-	Drought
2070 'Extreme'	Sea level rise –	Loss of current or existing biodiversity
		Effect on freshwater supply
		Impacts on coastal development
		Increased flood level and frequency
		Flooding
		Coastal erosion

(Noting Increased storm intensity is used interchangeably with an increase in extreme events)

This risk assessment exercise and the adaptation planning was carried out in workshops that are described briefly in Section 4 of this report. The workshops were high level assessments based on the knowledge of the participants in the workshops. They were reliant on the data available at the time, and it is quite possible that the qualitative evaluation may change as knowledge and understanding improve in this dynamic area. Climate change is an emerging issue and the workshop team sought to qualitatively understand the effects and risks using reasonable assumptions. It is recommended that further assessment of some of the identified impacts and controls will need to be undertaken prior to implementation.

The risk assessment and adaptation planning workshops were successful in bringing together a number of staff from different departments in each Council to recognise that climate change has immediate and future impacts on Council assets, operations and services.

Adaptation actions identified by the Council participants to address climate change risks were largely focused on policy/planning, engineering and engagement. In order to implement many of the identified controls it is recommended that the Councils initiate and enhance relationships with the Australian and State Governments, as well as other bodies such as Universities, CSIRO and the Bureau of



Meteorology. Many of the adaptation actions identified which involved implementation of engineering and procedural practices, should be incorporated as early as possible in the design stage of initiatives and projects. Given the cost of implementing some of the engineering solutions it is recommended that more detailed analysis be undertaken, including possibly localised modelling, of some of the identified impacts and adaptation approaches. It is understood that both Council's are finalising flood studies that will provide valuable quantified information to supplement this largely qualitative risk assessment and adaptation planning process. Please refer to Table 10 for a summary of the potential controls explored at the Adaptation Workshop.

For each potential control the workshop participants considered the control type in accordance with a control hierarchy from elimination, to prevention and reduction through to mitigation. The timeframes, costs, benefits, community acceptance, flexibility, effectiveness and adequacy were assessed for each control. When these were ranked using a purpose build multi criteria analysis the controls which rated most highly according to these criteria included: the *Bushfire Management Plan*, upgrade of design standards for infrastructure, alliances with key research bodies, protection of prime agricultural land, public education, integrated water cycle management, increasing scales for water rates, new *Heatwave Management Plan*, planned retreat and improved planning and development.

The majority of controls identified by the Councils aimed to prevent the impacts and to mitigate the severity and consequence of the risk. Ideally a risk management approach should consist of a range of controls across the hierarchy, with a greater focus on elimination or prevention rather than mitigation. Where possible indicative costs for controls were developed.

Most of the controls require short-term implementation. These controls tended to reflect those requiring implementation during the design and planning phases of Council projects and programs. These controls will require implementation in the near future, as any delay in implementation may prove to be costly and unviable. Numerous controls require implementation in the medium term. These controls tended to reflect those needing further detailed planning or research or requiring the support of other tiers of government. It is important to note that even though these particular controls will still need some immediate attention to ensure implementation is viable in the future. There were also a number of on-going controls, such as public education on pest management, which require the Councils to adapt the current programs to reflect the outcomes of this assessment and any future reviews of this work on an on-going basis.

This adaptation planning process identified a forward plan for each Council of policymaking, planning, capital works, monitoring and research and education. These actions relate to Council business planning processes as well as work with the Australian Government, State Government and other bodies. Where possible indicative resource needs have been identified, in case, such as with drainage and coastal works, these resource allocations become considerable. Opportunities for community education to assist in engaging the community in each Councils future climate change adaptation work have also been identified; priority areas for enhanced community education include pest management, heat stress and sea level rise/flooding. Priority areas for monitoring and research include proliferation of exotic species and biodiversity at risk from climate change.

Overall the analysis of controls identified how well current Council Business Plans address climate change risk. It is recommended that each Council reviews their key strategic documents and plans such as the Byron Shire Council '*Management Plan*', '*Settlement Strategies*', '*Local Environmental Plan*' and '*Coastal Zone Management Plan*' and for Tweed Shire Council it's '*7 Year Infrastructure and Services Plan*', '*Urban Stormwater Management Plan*', '*Economic Development Strategy*', '*Coastline Management*

Plan” and *Local Environmental Plan*’ in light of the identified climate change risks. There is a need to integrate the identified adaptations actions into these key Council planning frameworks. It is also important for the Councils to commit to review this exercise, and undertake a further risk assessment in the future in order to consider any further risks and adaptation controls in light of future developments in technology, knowledge and research. Ongoing reviews of risks are required as more clarity and certainty regarding the climate change effects emerge.

The intent of the adaptation planning is to develop strategies for better managing risks and build resilience into Council planning, operations and management by developing adaptive actions. The following high priority overarching recommendations are made:

- » It is recommended that both Councils conduct in depth assessments as identified in this project, such as a cost benefit analysis and/or a detailed adequacy assessment of existing controls. This should include more detailed, localised impact studies, particularly of potential sea level rise, storm surge and severe events to inform the identified flooding, coastal zone management and land use planning adaptation measures;
- » Use an integrated approach to climate change risk assessment that highlights the multiple benefits in terms of contribution to each Councils’ sustainability and greenhouse gas reduction plans and policies;
- » Review strategic plans in light of the identified climate change risks and integrate potential controls and adaptation actions;
- » Develop a plan that explicitly addresses the implementation of the controls including resources, funding and timeframes required;
- » Develop a long-term position for each Council on climate change, this should include an assessment of the overlay of a number of compounding potential climate change impacts on the local government areas (LGAs), this should build on the more detailed climate change risk assessments;
- » Further develop the collection and evaluation of climate change forecasts and local measurements, for the purposes of strategic planning and ongoing adaptation of operational procedures;
- » Develop a monitoring program of the local environmental variables identified in this project that are sensitive to climate change;
- » Identify environmental, social and economic thresholds and therefore associated initiation points for associated adaptation controls, potentially working with local universities to collect this information;
- » Review the identified controls in light of future research, knowledge and technology, and;
- » Ensure ongoing climate change risk assessment at key points is incorporated into all strategic planning and operational and other management plans.





2. Introduction

The Far North Coast encompassing Tweed Shire Council and Byron Shire Council is a biologically diverse region of NSW. The region has a number of icons including Mount Warning and Cape Byron. Byron Council administers a geographic area of 567 square kilometres, providing essential services, facilities and infrastructure for a population of over 30,329 people (excluding significant visitor numbers). The retail, hospitality, agricultural and tourism industries are major employers for the local government areas (LGAs), while construction, fishing, and light industries are other significant contributors to the local economies. Tweed Council covers 1,303 square kilometers and has a population of 81,953. The region has a substantial development pressure from its close proximity to the major growth area of South East Queensland and the area has witnessed strong economic and population growth over the past decade. The area is likely to experience ongoing continued growth from Southeast Queensland and other regions as those areas further develop. The Far North Coast Regional Strategy for the north coast includes a range of aims including the limiting of future urban development; the strategy also has a set of sustainability criteria for future development in the region.

Climate Change is a topical issue for the communities of Tweed and Byron with broad expression of concern in relation to water security, coastal retreat and property encroachment, flooding issues, and impacts to agriculture and tourism business. In response to this, each Council has developed a number of sustainability and greenhouse gas minimisation initiatives. The ongoing pressures of growth in the area will require a strategic approach to managing economic and population growth while minimising greenhouse gas emissions and adapting to changing climatic conditions.

The CSIRO and DECC have produced regional climate change projections under differing greenhouse gas emission scenarios for 2030, 2050 and 2070 which have been used in this assessment. The summary of climate change variables provided in this report been referenced from the two main regional NSW government published documents relevant to the Byron and Tweed Shires. The most recent data is the DECC (2008) Summary of Climate Change Impacts, North Coast Region (for 2050), NSW Climate Change Action Plan, prepared by the University of NSW for DECC. The second data set is derived from the CSIRO (2007) 'Climate Change in the Northern Rivers Catchment (for 2030 & 2070),' prepared for the NSW Government by CSIRO. CSIRO projections for rainfall and temperature were updated by UNSW to adjust for rainfall variability, and it is these figures that have been adopted by the NSW Government. Please also note that the CSIRO present day rainfall conditions are based on long-term averages from the Bureau of Meteorology (BOM), temperature is based on the maximum January and maximum July temperature for 1990, extreme temperature days are averaged from 1964 to 2003 data and the number of drought days is centred on 1990 data.

CSIRO climate change projections prepared for the New South Wales Government (*Climate Change in the Northern Rivers Catchment 2007*) for the Northern Rivers Catchment had advised that: *“although changes in average temperature, rainfall and evaporation will have long-term consequences for the catchment, the impacts of climate change are more likely to be felt through extreme weather events. Projections suggest there may well be more hot days, bushfires, droughts and intense storms”*. In the future (to 2100), it is likely to be between 0.2°C and 1.8°C warmer, annual average rainfall is likely to increase by between seven and twenty per cent, and sea-levels are likely to be 90-880 mm higher (CSIRO 2007). DECC 2008 projections for the region are given in Figure 3-2 and Figure 3-3. For comparative summary of CSIRO and DECC projections, please refer to Table 2.

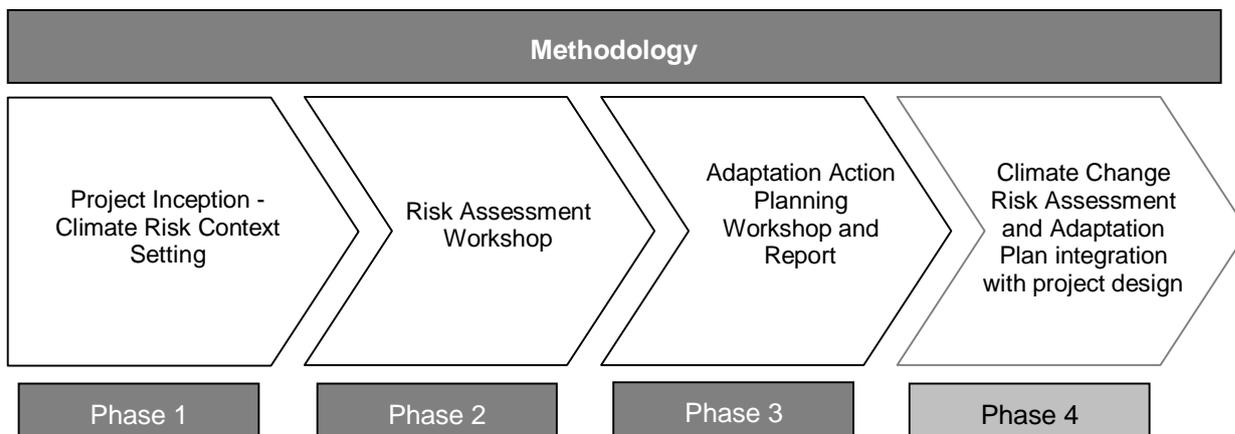


In the context and risk assessment phases of this work Council representatives provided a list of concerns they would like to be addressed. Similar issues across both Councils included flooding, coastal erosion and inundation. Flooding is of particular concern to Byron Shire as a result of recent modeling carried out by Byron Council. Tweed Shire were concerned with water security but were also particularly concerned about the rising sea levels which may lead to seawater breaking over the Bray Park Weir and the resultant contamination of fresh water supplies. In addition emergency response for small communities and bushfire risk were also of particular concern to the Tweed Shire Council.

2.1 Objectives

The objective of this project was to undertake a risk assessment and adaptation planning consistent with that outlined in the Australian Government Department of Climate Change (DCC, formerly AGO) document *Climate Change Impacts & Risk Management – A Guide for Business and Government 2006* to examine the potential impacts of climate change on the Byron and Tweed Shire Councils, and seek adaptation strategies to reduce or mitigate this risk, and the potential impacts should an event occur.

The phases of the project are summarised below, with a detailed methodology provided in Appendix D for the risk assessment process and Appendix F for the adaptation planning process.



2.2 Risk Assessment

A one-day risk assessment workshop, held on 19 November 2008, aimed to identify, analyse, evaluate and treat risks related to climate change. Risk is commonly referred to as a combination of the likelihood of an occurrence and the consequence of the occurrence. Publications by DCC (2006) suggest that climate change is not expected to create new risks, but potentially change the frequency and intensity of existing risks. There are a range of uncertainties around global climate scenarios and modelling which results in varying degrees of confidence in the available climate change projections.

The outcomes of the workshop and further analysis by GHD's climate change risk assessment team were documented in *Climate Change Risk Assessment Report* March 2009 and were used in the development of this Adaptation Action Plan.



2.3 Adaptation Planning

The one- day Adaptation Workshop was conducted on 23rd April 2009 at the Byron Civic Hall. Refer to Appendix C for a list of the workshop participants.

The Adaptation Workshop was conducted based on the knowledge obtained from workshop participants and on information gathered during the Context and Risk Assessment phases of this project as outlined in Section 1 of this Report. Please refer to Table 10 for a summary of the potential controls explored at the Adaptation Workshop.

2.4 Report Structure

This report documents the available information, the methodology followed and the outcomes of the risk assessment and adaptation planning in the following sections:

- » Section 3 provides the contextual information for this project;
- » Section 4 details the outcomes of the risk assessment process;
- » Section 1 documents the outcomes of the adaptation planning process;
- » Section 6 discusses the outcomes of the adaptation planning process; and
- » Section 7 provides recommended next steps for consideration by Byron and Tweed Councils.



3. Contextual Information

3.1 Background Information

3.1.1 Climate Change Scenarios

There is mounting scientific evidence that human activities are leading to adverse changes in the global and regional climates as a result of the emission of carbon dioxide and other greenhouse gases from the burning of fossil fuels and other sources. Climate change may affect Council assets, infrastructure, natural areas and services due sea level rise, changes to temperature and changes in the frequency and intensity of extreme weather events. Severe weather events and storm surges (coupled with sea level rise may have significant impact on coastal communities such as Byron and Tweed. Prolonged instances of heat, wind and rainfall, and increased variations in these phenomena, can also lead to the acceleration of structural fatigue for infrastructure and assets, disturbance of natural ecosystems and disruption to council services.

As mentioned earlier in this report CSIRO and DECC have produced regional climate change projections under differing greenhouse gas emission scenarios for 2030, 2050 and 2070 which have been used in this assessment.

3.1.2 Climate Change Variables

The risk evaluation took into account the level of risk now (2009) and for 2030 and 2070 based on the high scenario climate change predictions as per Table 2. The climate change variables investigated were changes in temperature, rainfall, sea level rise and extreme weather events (e.g. storms, extreme rainfall events, drought days and number of fire days).

Table 2 Summary of Climate Variables for the North Coast from NSW Government Supported Studies

Climate Variable		Current Average	Predicted Change		
			CSIRO (2007) 2030	UNSW (2008) 2050	CSIRO (2007) 2070
Temperature	Annual Average Temperature (°C)	CSIRO 1990 base line - avg max July and max Jan temp Armidale: 12 - 27°C Coffs Harbour: 19 - 27°C Lismore: 20 - 30°C Yamba: 19 - 27°C (CSIRO Northern Rivers projections)	+0.2 - +1.8°C (CSIRO Northern Rivers projections)	+1 to +3°C	+0.7 - +5.6°C (CSIRO Northern Rivers projections)
			+0.2 to +2.8°C (CSIRO NSW projections)		+0.7 to +6.4°C (CSIRO NSW projections)
Summer Temperature	Average	See BOM data in Appendix	+0.2 to +2.3 °C (CSIRO NSW projections)		+0.7 to + 7.1 °C (CSIRO NSW projections)
	Average Max	See BOM data in Appendix	Data not available	+1.5 to +2°C	Data not available



	Average Min	See BOM data in Appendix	Data not available	+2 to +3°C	Data not available
Autumn Temperature	Average	See BOM data in Appendix	+0.2 to +1.9 °C (CSIRO NSW projections)		+0.7 to +5.6 °C (CSIRO NSW projections)
	Average Max	See BOM data in Appendix	Data not available	+1.5 to +2°C	Data not available
	Average Min	See BOM data in Appendix	Data not available	+2 to +3°C	Data not available
Winter Temperature	Average	See BOM data in Appendix	+0.2 to +2.3 °C (CSIRO NSW projections)		+0.7 to +5.6 °C (CSIRO NSW projections)
	Average Max	See BOM data in Appendix	Data not available	+2 to +3°C	Data not available
	Average Min	See BOM data in Appendix	Data not available	+2 to +3°C	Data not available
Spring Temperature	Average	See BOM data in Appendix	+0.2 to +2.1 °C (CSIRO NSW projections)		+0.7 to +7.1 °C (CSIRO NSW projections)
	Average Max	See BOM data in Appendix	Data not available	+1.5 to +2°C	Data not available
	Average Min	See BOM data in Appendix	Data not available	+2 to +3°C	Data not available
Extreme Temperature (CSIRO, data averaged 1964 to 2003)	Annual average number of cold days (below 0°C)	Yamba: 0 (CSIRO Northern Rivers projections)	Yamba: 0 (CSIRO Northern Rivers projections)	Data not available	Yamba: 0 (CSIRO Northern Rivers projections)
	Annual average number of hot days (over 35°C)	Yamba: 1 (CSIRO Northern Rivers projections)	Yamba: 1-2 (CSIRO Northern Rivers projections)	Data not available	Yamba: 1-7 (CSIRO Northern Rivers projections)
	Annual average number of hot days (over 40°C)	Yamba: 0 (CSIRO Northern Rivers projections)	Yamba: 0 (CSIRO Northern Rivers projections)	Data not available	Yamba: 0 (CSIRO Northern Rivers projections)
Rainfall	Annual average rainfall	Armidale: 790 mm Coffs Harbour: 1,647 mm Lismore: 1,343 mm Yamba: 1,457 mm (CSIRO Northern Rivers projections)	-7 -+7% (CSIRO Northern Rivers projections) -13 to +7 % (CSIRO NSW projections)		-20 - +20% (CSIRO Northern Rivers projections) -40 to +20 % (CSIRO NSW projections)
Summer Rainfall	Average	See BOM data in Appendix	-13 to +13 % (CSIRO NSW projections)	-5 to +5 %	-40 to +40 % (CSIRO NSW projections)
Autumn Rainfall	Average	See BOM data in Appendix	-13 to +13 % (CSIRO NSW projections)	-5 to +5 %	-40 to +40 % (CSIRO NSW projections)
Winter Rainfall	Average	See BOM data in Appendix	-13 to +7 % (CSIRO NSW projections)	-10 to +5 %	-40 to + 20 % (CSIRO NSW projections)



Spring Rainfall	Average	See BOM data in Appendix	-20 to +7 % (CSIRO NSW projections)	-10 to +5 % [Please note the seasonal rainfall distribution indicates that Tweed may experience a -5 to +5% change, whilst Byron may experience dryer conditions with a change of -10 to +5%]	-60 to + 20 % (CSIRO NSW projections)
Extreme Rainfall	1 in 40 year 1-day rainfall	Refer to other studies if available	-10-+5% (CSIRO Northern Rivers projections)	Data not available	+5 - +10% (CSIRO Northern Rivers projections)
Evaporation	Annual Average (%)	Refer to other studies if available	+1 - +13% (CSIRO Northern Rivers projections)	Data not available	+4 – +40% (CSIRO Northern Rivers projections)
Number of droughts per decade (CSRIO, centred on 1990 data)		2 (CSIRO Northern Rivers projections)	2-4 (CSIRO Northern Rivers projections)	Data not available	1-9 (CSIRO Northern Rivers projections)
Wind Speed	Average Annual Wind Speed (%) 50 th percentile	See BOM data in Appendix	-2 to +2% CSIRO online database	Data not available	+2 to +5% CSIRO online database
Extreme Wind		Refer to other studies if available	-5 to +8 % (CSIRO Northern Rivers projections)	Data not available	-16 to +24% (CSIRO Northern Rivers projections)
Number of Fire days		Coffs harbour: 4 (CSIRO Northern Rivers projections)	Coffs harbour: 5 - 6 (CSIRO Northern Rivers projections)	10 to 15	Coffs harbour: 5 - 8 (CSIRO Northern Rivers projections)
Sea Level Rise	Above 1990 base line	Globally, the average sea level has risen since 1961 at an average rate of 1.8 [1.3 to 2.3] mm per year and since 1993 at 3.1 mm [2.4 to 3.8 mm per year, with contributions from thermal expansion, melting glaciers and ice packs, and the polar ice sheets].IPCC		+40cm	+90cm (by 2100, UNSW data and level adopted by NSW Govt)
Sea Surface Temperature Change	Average (°C)	Refer to other studies if available	+0.3 to +0.6 °C		+1.5 to +2 °C

*Data sourced from CSIRO data (published in 2007) and DECC data (published in 2008), Bureau of Meteorology and the Australian Government Department of Climate Change & CSRIO's OzClim online database

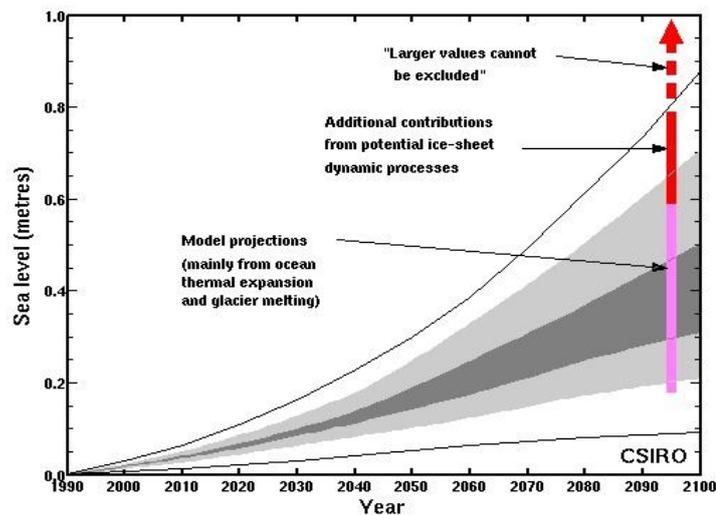
The indications from the latest scientific analysis associated with the Copenhagen round of the Kyoto Protocol discussions is that climate change is occurring in line with the upper scenarios (greater change/impact occurring sooner) put forward in the Intergovernmental Panel on Climate Change (IPCC)

Fourth Assessment report⁴. For the purposes of this assessment the high global warming scenario was selected and agreed by both Councils as it was determined to be the conservative representation of the future changes.

3.1.3 Sea Level Rise

Globally sea levels are predicted to rise due to ocean thermal expansion and glacier / ice sheet melting. Figure 3-1 shows the projected global sea level rise up to 2100 from the CSIRO (based on IPCC models). The central dark shading represents an average of models for the range of Special Report on Emission Scenarios (SRES) greenhouse gas emission scenarios with the light shading representing all models and all SRES scenarios. It is important to note that in all cases the sea-level is predicted to rise. By 2100, global projected sea level rise (by the IPCC) is 18-59 cm with a possible 10-20 cm additional increase from icesheets.

Figure 3-1 Predicted Global Average Sea-Level Rise⁵

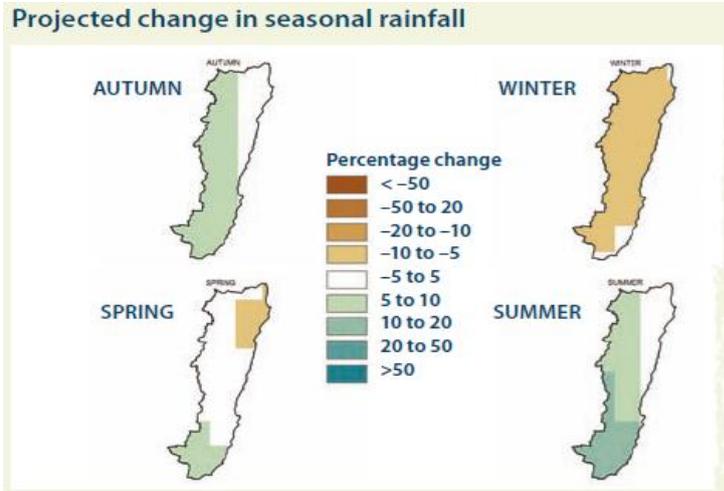


“The major impact on the coastal zone of the region is likely to be from sea level rise and resulting inundation and erosion. Rising seas are likely to have a significant impact on all beaches, coastal rivers and estuaries in the North Coast. Settlements adjacent to estuaries and the coast are likely to be at additional risk of flooding as sea levels rise. Private and commercial property and major infrastructure will be affected. Saltwater migrating further upstream is like to have implications for farm irrigation and groundwater. Aquaculture is like to be adversely affected. The rise in sea levels is also like to increase the risk of flooding in parts of the lower floodplain with associated impacts upon the community. (DECC, 2008)

⁴ IPCC, 2007: *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R. K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

⁵ Source: CSIRO Sea Level Rise http://www.cmar.csiro.au/sealevel/sl_proj_21st.html

Figure 3-2 Projected Change in Seasonal Rainfall for 2050



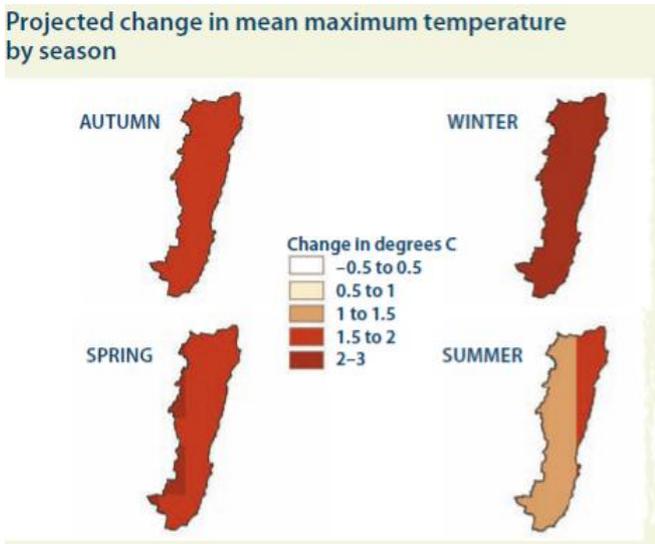
“Summer and autumn rainfall is projected to decrease slightly... Evaporation is projected to increase all seasons. Combined with changes to rainfall, this is projected to make conditions in winter and spring drier.”

In El Niño events, water stress is expected to be more intense due to higher temperatures. During La Niña years storms with heavy down powers are expected to be more frequent.”

Increases in short and intense rainfall events are likely to result in flooding from urban streams and drainage systems (DECC, 2008)

Source: DECC (2008) Summary of Climate Change Impacts, North Coast Region

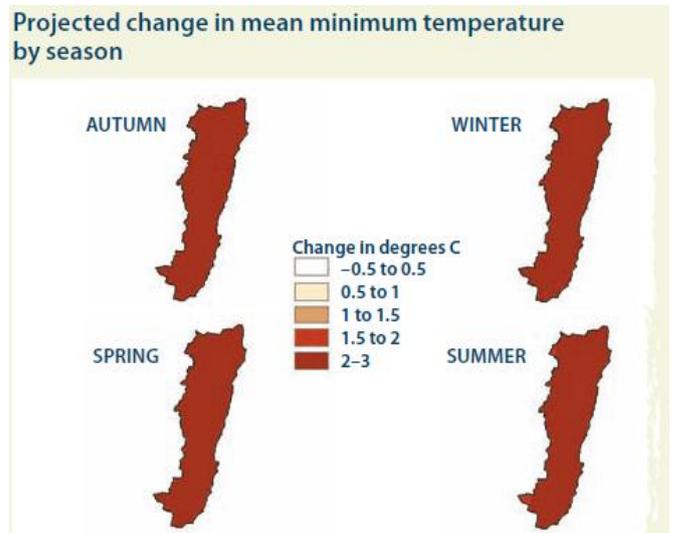
Figure 3-3 Projected Change In Mean Maximum and Minimum Temperature for 2050



“Days are projected to be hotter over all season (1 to 3 °C). The greatest increases are projected for winter (2 to 3 °C) and the smallest increases in summer (1 to 1.5 °C). Nights are also projected to be warmer, with mean minimum temperatures projected to increase by 2 to 3 °C in all seasons”

The frequency of very high or extreme fire-risk days is predicted to increase across NSW”. (DECC, 2008)

Source: DECC (2008) Summary of Climate Change Impacts - North Coast Region





4. Risk Assessment–Results

4.1 Risks Identified

Taking each climate change variable in turn, risks associated with climate change and potential impacts were brainstormed for the scenarios below:

- » Now (2009);
- » 2030; and
- » 2070

There were 22 potential climate change impacts identified for the Byron and Tweed Councils over these time periods.

Although the climate change variables of increased rainfall, temperature changes, increased sea level and severe events were addressed separately, there were incidences where the potential impacts could in fact be a result of a combination of the variables. For example, a combination of increased sea level, storm surge and tidal condition could result in a water level rise that could exceed the design capacity of coastal assets and cause considerable damage. This possibility should be assessed in more detail following subsequent more detailed modelling of the likely combined effects of sea level rise, storm surge and storm events on individual coastal assets. The imminent completion of flood studies by both Councils was noted. Unfortunately these studies were not available during this project.

4.2 Level of Risk

For each of the risks and potential impacts identified, any existing controls were noted and then, taking these controls into account, the existing level of consequence and likelihood were agreed on by the workshop participants. Taking into account the projected changes in climatic variables for 2030 and 2070, the level of consequence and likelihood for each risk were reassessed and agreed on by the participants. Participants were asked to assess which assets and activities are sensitive to climate change and then based upon the judgement of the workshop participants whether climate change is a significant source of risk to the asset and activities. Climate change is not anticipated to introduce new risks but rather increase the severity and consequence of existing risks.

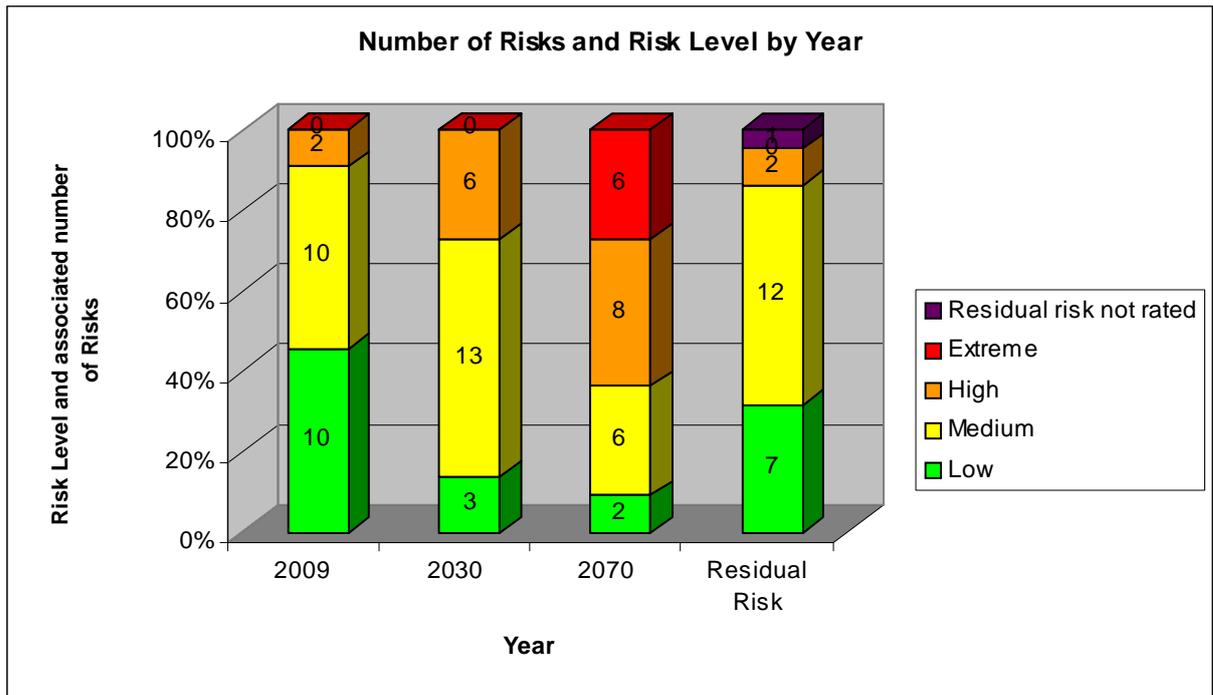
The resultant climate change risk register developed during the workshop is provided in Appendix E In total, there were 22 risks identified.

Table 3 Number of Risks in Each Category

Risk Level	2009	2030	2070	Residual Risk
Low	10	3	2	7
Medium	10	13	6	12
High	2	6	8	2
Extreme	0	0	6	0
Residual risk not rated				1
Total	22	22	22	22

A breakdown of the level of each risk is shown in Figure 4.

Figure 4 Summary of Risk Level's for 2009, 2030, 2070 and Residual Risk



As demonstrated in Figure 4 it is anticipated that there will be a general increase in the level of risk associated with each climate change impact over time. This is expected, as without adaptation planning (i.e. business as usual) the current controls may not be able to adequately manage the consequences of the changed climate.



Table 4 summarises the identified risks over the three timeframes. The graph illustrates the changes in risk levels if current controls and mitigation strategies are not strengthened in accordance with climate change trends.

Table 4 Main Areas of Concern (Eight Priority Areas)

2009	2030	2070
<p>1. The introduction or proliferation of exotic species</p> <p>Increased Temperature <i>(Item 1)</i></p>	<p>3. Loss of current or existing biodiversity</p> <p>Sea level rise <i>(Item 2)</i> *</p> <p>Other risk items related to the area of concern on the Risk Register include:</p> <ul style="list-style-type: none"> - Increased temperature (Item 6) 	<p>6. Increased bushfire events (and intensity)</p> <p>Increased temperature [leading to a loss of property] <i>(Item 9)</i></p> <p>Other risk items related to the area of concern on the Risk Register include:</p> <ul style="list-style-type: none"> - Increased temperature: [leading to loss biodiversity] considered a moderate risk in 2070 (tem 11) - Increased temperature [leading to loss of life and safety issues] considered a moderate risk in 2070 (Item 10)
<p>2. Increased flood level and frequency/flooding</p> <p>Impacts on coastal development</p> <p>Increased Storm Intensity <i>(Item 22)</i></p> <p>Other risk items related to the area of concern on the Risk Register include:</p> <ul style="list-style-type: none"> - Storm Intensity (Item 20) - Sea level rise (Item 8, 19 & 21) * 	<p>4. Effect on freshwater supply</p> <p>Sea level rise <i>(Item 7)</i> *</p> <p>Item specific to Tweed</p>	<p>7. Higher evaporation and longer drought periods</p> <p>Increased temperature <i>(Item 15)</i></p> <p>Decreased Rainfall <i>(Item 25)</i></p> <p>Other risk items related to the area of concern on the Risk Register include:</p> <ul style="list-style-type: none"> - Drought (Item 16) - Decreased rainfall: (Item 4)
	<p>5. Coastal Erosion</p> <p>Sea level rise <i>(Item 23)</i>*</p> <p>Item specific to Byron (Planned retreat)</p>	<p>8. Decline in the local economy leading to a loss of tourism and agricultural productivity</p> <p>More sever weather events from increased rainfall and extended drought periods. <i>(Item 3)</i></p>

Note: Risk 9 - Heat Stress was not considered a high-risk for Byron and Tweed Shire Councils but participants did explore the potential controls during the Adaptation Workshop.

4.3 Current Controls

Climate change risks are unique in terms of their control strategies; the level of risk will almost universally increase if controls are not modified. This is because in most cases the controls are aimed at managing the current level of risk and in the future climate, they may not be suitable for controlling the level of risk posed by the altered climate. A summary of current controls utilised by Byron and Tweed Shire Councils is listed in Table 5 below. The controls identified during the risk assessment and adaptation-planning workshop were predominantly planning/policy, engineering and engagement controls.

It should be noted that the detailed execution of these controls is vital to ensuring the level of risk associated with climate change is reduced to as low as reasonably practicable.



Table 5 Summary of Byron and Tweed Shire Councils' Current Controls

Management Plans & Policies	Community Services And Awareness Programs	State or National Controls	Engineering / Physical Controls
Coastal Zone Management Plan, coastal dune rehabilitation	Pest control education awareness	State biodiversity plans and policy	Coastal dune rehabilitation, set backs, sea walls, sand pumping, set backs, sea walls etc
Weed control which includes joint programs (work on private properties)	Bushfire education	State legislation: - for example Macro Water Sharing Plans, Stormwater Guidelines/Manuals/Programs, Bushfire planning, land Use – Planning-Local Environmental Plan Template (LEP) , Coastal/Flood Guidelines	Integrated water cycle management, water tanks, water recycling, stormwater harvesting
Local Environmental Plans – zoning	Water scarcity community awareness	Federal legislation – Environmental Protection and Biodiversity Conservation (EPBC) Act	Temporary barrier over weir (Tweed)
Development Control Plans - zoning	Community preparedness for storms and floods	State and Federal funding and grants	Hazard reduction burning
Predator and pest eradication program – Cane Toad and Indian Myna Bird Control Program, Mosquito and Biting Midge Program	Demand Management - water	DECC policy, guidelines and manuals e.g. Floodplain	Weed control
Tourism promotion - Increased advertising post severe wet weather	Biodiversity Management Programs	BASIX	Infrastructure design – flood gates systems and levees
Water Management Plan – demand management, water tanks, water recycling, safe yield projections, Macro Water Sharing Plans (under development), restriction levels, Integrated Water Cycle Management, Water Sensitive Urban Design		Building Construction Standards	Operational Management Plans for example temporary barrier over weir, drainage maintenance
Catchment Management, catchment zoning, LEP zoning, Augmentation Management Plans, dam location		Tourism – marketing and campaigns	House raising
Stormwater harvesting and management		Local Government Act provisions	Road Maintenance Program
Infrastructure design – flood gate systems and levies		Catchment Management - Catchment Action Plan (CAPs)	Floodplain management and zoning
Vegetation Management Plans			Tree Management
Operational Management Plans for example temporary barrier over weir, drainage maintenance			Sewer Overflow Abatement Strategy – barriers, sand pumping
Land use planning framework, land tenure			
Voluntary measures - purchase of land by Council or house raising by residents			
Local Government Act provisions			
Asset Management Plans (Tweed complete, Byron in the process of developing an AMP)			
Monitoring			
Research			
Agricultural management			
Asset Protection Zones			
Bushfire Management Plan – Hazard reduction burning fire mapping, ignition management, training, operational readiness			
Road Maintenance Program			
Agricultural management			
Disaster Plan – Emergency Services, road closures			
Floodplain management and zoning			
Tree management			
Sewer Overflow Abatement Strategy – barriers, sand pumping			
Insurance			
Hazard Identification procedures			
Coastline Management Plan with a asset focus			



5. Scoring Adaptive Actions

5.1 Methodology Summary

As detailed in Section 2.3 the Adaptation Workshop was conducted on the risks and controls identified in the risk assessment phase. A detailed methodology for this process can be found in Appendix F and the resultant Climate Change Adaptation Assessment Register is provided in Appendix G.

5.1.1 Prioritisation and Categorisation of Controls

In order to further qualify and analyse the adaptation actions in the workshop, a Multi Criteria Analysis (MCA) approach was employed to score the potential controls in relation to the screening criteria. The screening criteria used included:

- » Cost of implementing control (and Council staff establishment time);
- » Operating cost of control;
- » Dependability;
- » Practicality;
- » Political feasibility;
- » Community acceptance; and
- » Flexibility of implementing control.

For each risk scenario examined in the Adaptation Workshop, the potential controls were categorised based on the following:

- » Control type – Procedure, Engineering, Research, Strategy and Planning (or a combination thereof)
- » Control hierarchy – Elimination, Prevention, Reduction, Mitigation
- » Could control be implemented via existing frameworks
- » Benefits of implementing control (additional benefits that may arise from the control).

Controls were also qualified based on:

- » Applicable to other risks;
- » Concurrent effects;
- » State/Federal/other support required;
- » Timeframe to implement;
- » When to consider/action date;
- » Initiation point (what will have happened necessitating actioning of this control); and
- » Functional area of Council responsible for adaptation action.



These criteria and categories have been used to qualify the adaptation actions because they may enable the Councils to transition from high-level climate change strategy to actually identifying how and when to implement the adaptation actions, thereby developing an (adaptation) action plan.

5.2 Results

5.2.1 Controls for Risks

The focus for the adaptation workshop was on the 'High' and 'Extreme' risks identified in the risk assessment workshop. Due to the limited time available, only a few controls for the identified risks were explored. These controls are shown in Table 6, Table 7, Table 8 and Table 9 below.

All potential controls are in effect action items for Byron and Tweed Shire to integrate into relevant Council plans.

Table 6 Increase in Temperature

Risk 1
The introduction or proliferation of exotic species.
Engagement: Public education (pest species proactive management)
Policy: Pest Species Management Plan
Research: Alliance with key research bodies - in kind contributions
Risk 6
Increased bushfire events (and intensity)
Policy: Bushfire Management Plan
Risk 9
Heat Stress
Policy: Heatwave Management Plan
Engagement: Education

Table 7 Increase in Sea Level Rise in Confluence with Storm Intensity and High Tides

Risk 2
Increased flood level and frequency/ flooding
Policy: Upgrade design standards for infrastructure - better engineering standards
Engineering: Replace infrastructure
Engineering: Other defences (levees, rock revetments, seawalls)
Engagement: Community awareness and education



Policy: Improved planning of development
Risk 3 Loss of current or existing biodiversity
Research & Policy - Identification of at risk habitat and development of management framework
Risk 4 Effect on freshwater supply (Tweed)
Engineering: Weir augmentation before sea level rises 10cm from current level
Risk 5 Coastal erosion (Byron)
Policy - Planned Retreat
Engineering - Planned Retreat

Table 8 Reduction in Rainfall in Combination with Increased Temperature

Risk 7 Higher evaporation and longer drought periods
Policy: Increased scale of rates - user pays increase for infrastructure maintenance and development
Policy: Integrated water cycle management including demand management, water sensitive urban design etc.
Engineering: Integrated Water Cycle Management including demand management, Water Sensitive Urban Design etc.

Table 9 A Combination of Variables Leading to Sever Weather Events such as Increased Rainfall and Extended Drought Periods

Risk 8 Decline in the local economy leading to a loss of tourism and agricultural productivity
Policy: Management Plan for the reduction of economic reliance on tourism e.g. diversification
Policy: Protection of prime agricultural land

5.2.2 Control Categorisation

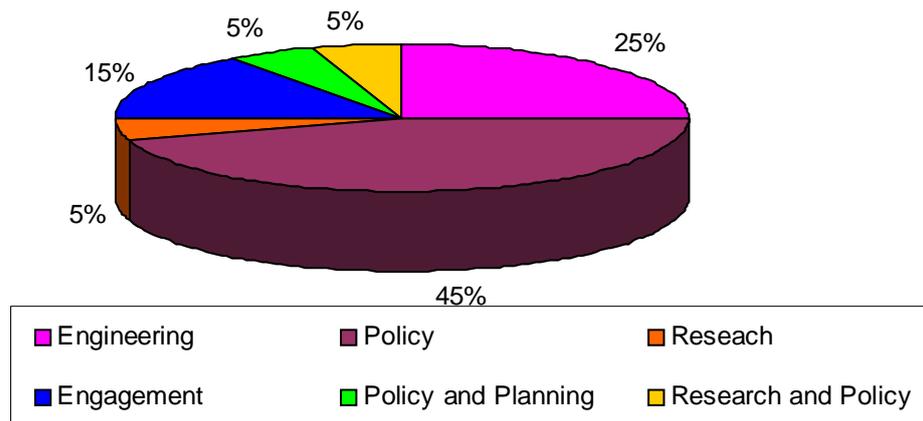
The controls identified were classified into treatment types and control hierarchy as a way of understanding the adequacy of the variety or range of controls.

Treatment types used by councils internationally for adaptation planning generally aim to:

- » To spread or displace the risk (through insurance, risk sharing and diversification);
- » Implementation of engineering solutions;
- » Planning changes;
- » Research to improve understanding on climate change, its local impacts or solutions;
- » Internal procedures and strategies which include provisioning and contingency and disaster planning etc.

The figure below shows the spread of treatment types (and combinations thereof).

Figure 5-1 Number of Controls Per Control Type

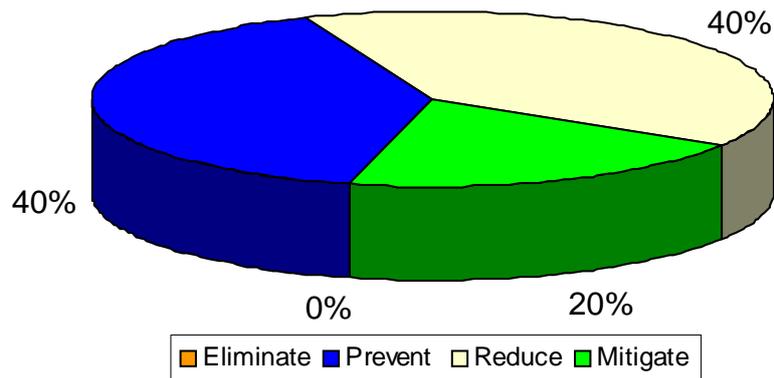


Adaptation actions identified by the Council participants to address climate change risks were largely focused on policy/planning, engineering and engagement. In many case in order to implement these identified controls it is recommended that the Councils initiate and enhance relationships with the Australian and State governments, as well as other bodies such as Universities, CSIRO and the Bureau of Meteorology. The distribution across these categories shows a large proportion of control types were based on policy (45%), engineering (25%), and engagement (15%). This demonstrates the reliance on policy and engineering solutions to help prevent and reduce the impact of climate change on both LGAs.

For each potential control the workshop participants considered the control type in accordance with a control hierarchy from elimination, to prevention and reduction through to mitigation. Figure 5-2 demonstrates the control hierarchy of the risks i.e. how the control will treat the risk (by elimination, prevention, reduction or mitigation). The majority of treatment types identified by the workshop participants were to prevent the risks from occurring in the first instance (40%) and then reducing the identified risks (40%), followed by mitigating the severity (20%). Of the potential controls explored at the

Adaptation Workshop, none were identified for eliminating risk. Ideally a risk management approach should consist of a range of controls across the hierarchy, with a greater focus on elimination or prevention rather than mitigation. Where possible indicative costs for controls were developed.

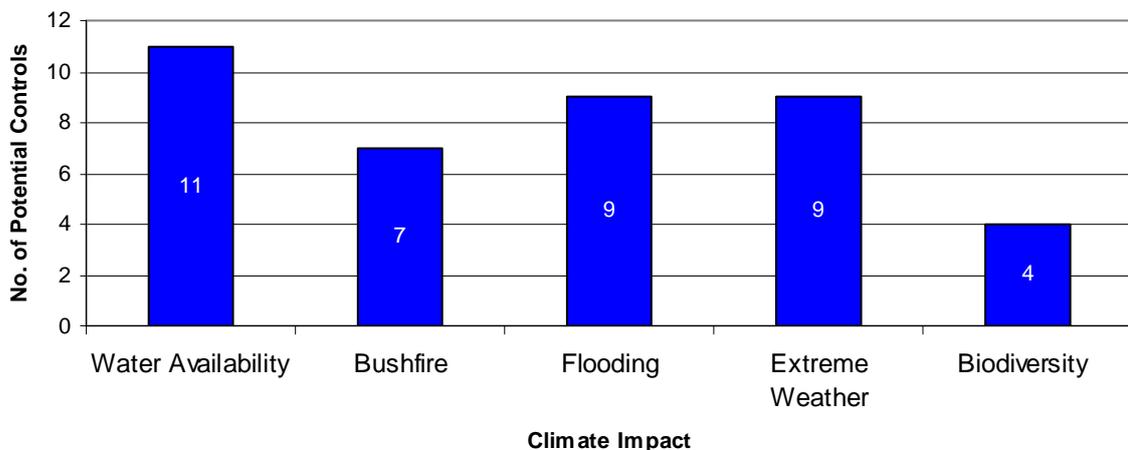
Figure 5-2 Potential Control Hierarchy Distribution



5.3 Controls Linkages

During the workshop, participants assessed the applicability of potential controls to other risks. Figure 5-3 shows the frequency at which the controls affect other identified risks. The majority of the potential controls can therefore have an effect on reducing other climate change risks.

Figure 5-3 Number of Controls with Applicability to Other Climate Change Impacts



When the controls are highly interlinked the success of each individual control is critical to achieving an overall successful outcome. Adopting a systems based approach is therefore appropriate to optimise the controls because there are so many interdependent controls. A systems based approach requires



management activities and engineering solutions to be progressed as linked and coordinated efforts. Auditing each main control can test for interlinking. This has not been done as part of this work but can be achieved by:

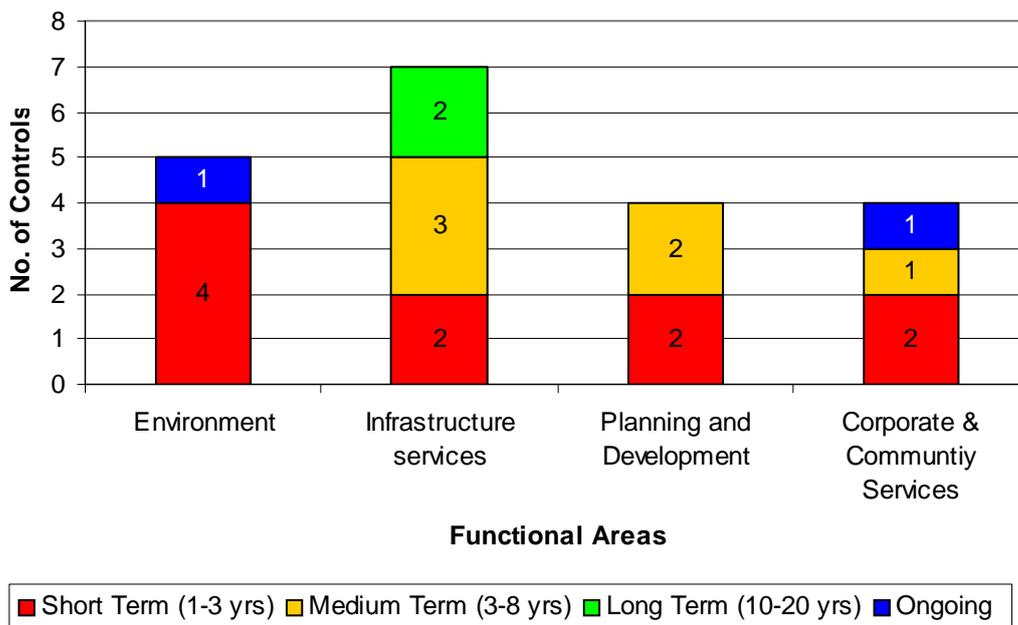
- » Selecting the key control (for each risk) and combining/reducing the number of related controls while ensuring maximum effectiveness is maintained; and
- » Testing and auditing key controls for critical risks to ensure effectiveness is maintained.

In general, for risk scenarios with a higher level of severity such as sea level rise, storm surge and increase storm severity and frequency, there is a requirement for a more diverse range of interdependent control measures.

5.4 Control Implementation

Figure 5-4 shows the relationship between the number of controls by functional area of Byron and Tweed Shire Councils. Figure 5-5 shows the implementation timeframes. The graph demonstrates that the Infrastructure Services (7) and Environment (5) Sections of both Councils have the largest number of controls to implement. Also, the majority of these require action in the short or medium term. The only two controls assessed to require implementation in the long term were the replacement of infrastructure and other defences such as levees, rock revetments and seawalls a result of the combined impact of an increase in the level and frequency of flooding from heavy rainfall, sea level rise and storm surge.

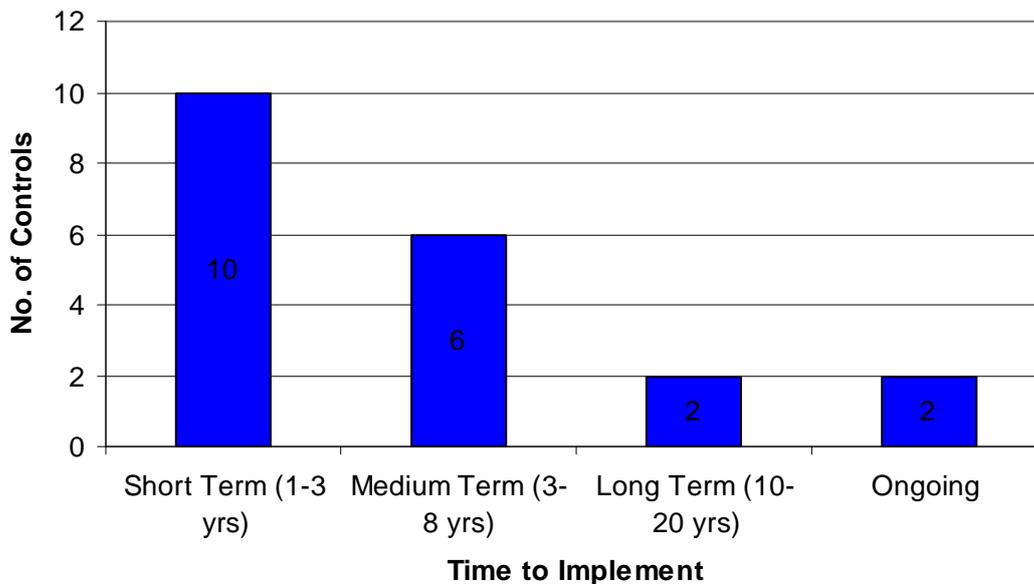
Figure 5-4 Distribution of Controls per Functional Area of Council





A summary of the distribution of the timeframe to implement the controls is shown in the Figure 5-5 below.

Figure 5-5 Timeframe for Implementation



The graph indicates that the majority of the potential adaptation controls are to be implemented in the short term, with eight to be implemented in the medium to long term. Many of the adaptation actions identified involved changes to engineering and procedural practices that should be incorporated as early as possible in the design stage of initiatives and projects. These controls will require implementation in the near future, as any delay in implementation may prove to be costly and unviable.

The controls requiring implementation in the medium term, tended to reflect those needing further detailed planning or research, or controls requiring the support of other tiers of government.

Given the cost of implementing some of the engineering solutions it is recommended that each Council undertake a more detailed analysis, including possibly localised modelling, of some of the identified impacts and adaptation approaches. It is understood that both Council's are finalising flood studies that will provide valuable quantified information to supplement this largely qualitative risk assessment and adaptation planning process. There were also a number of on-going controls, such as public education on pest management, which require the Councils to adapt current programs to reflect the outcomes of this assessment and any future reviews of this work on an on-going basis.

The Table 10 below ranks the potential controls based on the sensitivity score received. The sensitivity score applies an agreed weighting to the potential controls and in doing so provides some guidance on which controls may be more easily implemented than other controls. The Adaptation Workshop participants carried out this weighting exercise therefore assisting Councils in determining an efficient allocation of resources.

The risks highlight in orange received a 'High' Risk Rating for 2030 (see Section 4.2).



5.4.1 Adequacy Assessment

In order to get an in depth understanding of the effectiveness of the controls used for managing climate change risks, consideration should be given to conducting a detailed adequacy assessment of the current control strategies. According to multi-criteria analysis techniques the scores presented in Table 10 below, were checked for robustness to determine if there was a significant shift in the rankings if a different weighting were applied. The analysis found that the deviations in the ranking were minimal with different weightings. This analysis therefore suggests that the assessment is robust and can serve as a guide to relative adaptation priorities, according to effectiveness and ease of implementation.



Table 10 Potential Controls Ranked

Rank	Score	Risk	Adaptation Action / Potential Control	Timeframe to implement	When to consider date/action	Functional Area of Council	Implemented via existing frameworks	\$ Estimates to implement control	Co-Benefits – Sustainability/ Greenhouse	State / Federal / Other Support
1	485	Increased number of bushfire prone days	<i>Bushfire Management Plan</i>	Short Term	2015	Environment	<i>Disaster Plan</i> <i>Bushfire Management Plan</i> <i>Asset Management Plans</i>	Budget: Approx \$15 000 Benefit of incremental revision		RFS Office of Emergency Services
2	463	Increased flood level and frequency of flooding	Upgrade design standards for infrastructure - better engineering standards	Medium Term	Need to start addressing immediately	Infrastructure	Review and update of current standards and policies. State government support will be required. For example, the Flood clause in the Tweed draft LEP is not being accepted by the Department of Planning.	Inland flooding impacts have not yet been comprehensively looked into. Byron and Tweed may be at the forefront at investigating the potential impacts as there are not many example Councils in Australia. Large volume of funds will be required to actually implement on the ground impacting on affordability of development. The implication is for increased Councils rates for the community.		Standards Australia, Australian and State and governments
3	460	The introduction and proliferation of exotic species *	Alliance with key research bodies - in kind contributions	Short Term	After development of shelf projects approach institutions	Environment	Existing contacts with research institutes	Dependent on research and	Sustainability	Funding via institutional support
3	460	Decline in the local economy *	Protection of prime agricultural land	Medium Term	On going	Planning & Development	Existing LEP	Budget: Agricultural Strategy (Tweed - Approx \$30 000) (Byron - already has an Agricultural Strategy but requires updating)	Sustainability	State Planning Dept, Dept of Agriculture, Regional Development Board



Rank	Score	Risk	Adaptation Action / Potential Control	Timeframe to implement	When to consider date/action	Functional Area of Council	Implemented via existing frameworks	\$ Estimates to implement control	Co-Benefits – Sustainability/ Greenhouse	State / Federal / Other Support
5	453	The introduction and proliferation of exotic species *	Public education (pest species proactive management)	Ongoing	2009/10 financial cycle	Environment	Existing community network, Landcare, newsletter (communications group within Council), localised response groups (e.g. cane toad muster group), School education (eg stream watch)		Sustainability	Assistance from Federal & State Environmental education funding
5	453	Heat Stress **	Education	Ongoing	As part of Heatwave Management Plan	Corporate & Community Services	Existing community services network, newsletter (communications group within Council), localised response groups, School education (e.g. cross flow ventilation instead of air conditioning)		Sustainability Greenhouse	Assistance from Federal & State Environmental and Health education funding
7	440	Higher evaporation and longer drought periods **	Integrated Water Cycle Management including demand management, Water Sensitive Urban Design etc.	Short Term	Now	Planning & Development	Currently a process is in place to address the issue. May need to take climate change further into account.	Need better data on climate impacts associated with rainfall and evaporation patterns. Tweed is already aware of the increasing pressure on water supplies as a result of increased population pressure. Concern is that Climate change has not been factored into existing policy.	Sustainability Greenhouse	Seek state support for water policy development. Update existing policy with considerations of climate change.
8	436	Higher evaporation and longer drought periods **	Increased scale of rates - user pays increase for infrastructure maintenance and development of water	Short Term	Currently being implemented by Tweed. When water shortages are deemed an issue.	Infrastructure	Update to existing rates policy		Sustainability	State Government approve rate rise increases
9	430	Increased flood level and frequency of flooding *	Community awareness and education	Short Term	Now	Corporate & Community Services	A communication plan in place although not specific to climate change		Sustainability Greenhouse	Funding from State or Federal



Rank	Score	Risk	Adaptation Action / Potential Control	Timeframe to implement	When to consider date/action	Functional Area of Council	Implemented via existing frameworks	\$ Estimates to implement control	Co-Benefits – Sustainability/ Greenhouse	State / Federal / Other Support
10	426	Heat Stress	<i>Heatwave Management Plan</i>	Short Term	2015	Corporate & Community Services	New plan needs to be made	Budget: Approx \$10 000		RFS, Dept. of Health
11	407	Coastal erosion <i>NB: This risk is specific to Tweed</i>	Planned Retreat	Short Term	Ongoing	Planning & Development	Planning controls - DCP, LEP, Coastal Zone Management Plan, SEPPs			Federal and state support required from minister, DECC, DoP
12	404	Increased flood level and frequency of flooding	Improved planning of development	Medium Term	Currently under consideration	Planning & Development	Updating planning policy for coastal floodplain Moral hazard can be avoided if action is taken. People will begin to act on the information themselves to avoid future impacts i.e. take out insurance. Difficulty lies in delivering the message to raise awareness amongst the community.	Need supporting assessments data, economic costs and benefits, planning to be based on supporting studies. Department of Planning support required.		Required for SEPP, LEPS and DCPs with regards to <i>Coastal Zone Management Plans</i> , community development plans, Consistency with State departments, directions and planning instruments (Flooding, coastal erosion etc).
13	385	Effect on fresh water supply <i>NB: This risk is specific to Tweed</i> *	Weir augmentation before sea level rises 10 cm from current level	Medium Term	Include into 30-year capital plan now.	Infrastructure	Current asset management process for the weirs requires modification to a more permanent solution.	Weir augmentation will be required before sea levels rise a further 0.1 meters from the current level. Currently king tides overtop weir twice a year. As sea levels continue to rise, overtopping of the dam may possibly become a constant event affecting the functionality of the community - \$10 - \$20 million BAU. Capital works program Tweed - around \$102M (mainly water and sewerage). Weir augmentation will avoid having to investigate other viable water supplies.	Sustainability	State or Federal support required for funding and approvals



Rank	Score	Risk	Adaptation Action / Potential Control	Timeframe to implement	When to consider date/action	Functional Area of Council	Implemented via existing frameworks	\$ Estimates to implement control	Co-Benefits – Sustainability/ Greenhouse	State / Federal / Other Support
14	368	The introduction and proliferation of exotic species *	<i>Pest Species Management Plan</i>	Short Term	2010/11 financial cycle	Environment	A new plan will need to be written	Budget: Approx \$10 000 Good management plan needs good principles that follow through to specifics	Sustainability	Possible state and regional support
15	363	Loss of existing biodiversity on the coastal floodplain **	Identification of at risk habitat and development of management framework	Short Term	Research now and planning phase to take effect in 3 years time (2012)	Environment	<i>Biodiversity Strategy</i> (Byron) <i>Biodiversity Program</i> (Tweed) Research Alliances	Budget: Approx \$60 000 Research alliances to take care of the majority of the identification of at-risk habitats Development of the management framework and mapping by Councils	Sustainability Greenhouse	Regional collaboration, National Parks and Wildlife Service
16	331	Higher evaporation and longer drought periods **	Integrated water cycle management including demand management, water sensitive urban design etc.	Medium Term	Now	Infrastructure	Current process in place to address issue. May need to take climate change further into account.	Effluent reuse scheme is on hold for Main Arm Byron is in operation. Links to sustainability and greenhouse gas.	Sustainability	Funding support required from the Australian and State Governments
s17	317	Decline in the local economy	Management Plan for the reduction of economic reliance on tourism e.g. diversification	Medium Term	2009/10 financial cycle	Corporate & Community Services	<i>Tweed Economic Development Strategy Byron EDS</i> (under development) Regional & Local Economic Development Boards Tourism bodies Research and business alliances	Budget: Approx \$100 000 Incremental change of the economic base over a long timeframe is required to spread the cost equitably		<i>Far North Coast Regional Strategy</i> - leverage to get funding, Regional Development Board, Australian Government funding on job creation



Rank	Score	Risk	Adaptation Action / Potential Control	Timeframe to implement	When to consider date/action	Functional Area of Council	Implemented via existing frameworks	\$ Estimates to implement control	Co-Benefits – Sustainability/ Greenhouse	State / Federal / Other Support
18	277	Increased flood level and frequency of flooding	Replace infrastructure	Long Term	Start to incorporate in 3- 5 year program	Infrastructure	Asset Management Plan Currently no requirement for significant funding and replacement plans	Large volume of funds to actually implement on the ground. Impacts on affordability of development. Implications for rates on the community. Tweed - Asset Management Plan is currently being worked on Byron is in the process of developing an Asset Management Plan. Potential damage to infrastructure from flooding alone will be in the order of millions of dollars.		Funding from the Australian and State governments. Technical support from State.
19	267	Increased flood level and frequency of flooding	Other defences (levees, rock revetments, seawalls)	Long Term	5 years for planning approach	Infrastructure	There is an approach based on current risks for flood mitigation and coastal protection. Not in place for climate change. Potentially more controls required.	Need supporting assessments data, economic costs and benefits, planning based on supporting studies. Department of Planning support required. Part 3A is looking into guidelines for defences. Studies are still being carried out to determine what the impacts of Climate Change will be to aid in Coastal Zone Management. Flood pumps are expensive to maintain and currently designed to withstand a 1 in 100 year flooding event only. Pumps will need to be designed to cope with flooding event to the year 2100.		State and Federal funding and technical support and policy support.



Rank	Score	Risk	Adaptation Action / Potential Control	Timeframe to implement	When to consider date/action	Functional Area of Council	Implemented via existing frameworks	\$ Estimates to implement control	Co-Benefits – Sustainability/ Greenhouse	State / Federal / Other Support
20	224	Coastal erosion <i>NB: This risk is specific to Bryon</i>	Planned Retreat	Short Term	Ongoing	Infrastructure	Planning controls - <i>DCP, LEP, Coastal Zone Management Plan, SEPP</i>	<p>The Byron sea wall structure is at immediate risk of failure, exposing the town/ CBD, roads including evacuation routes and impact on infrastructure will need to be taken into account. Estimate cost: Byron – for 1.5km rock wall is greater than \$30 million. Cost not accounted for in any forward work budget.</p> <p>Capital works program for Byron is \$3M (mainly water sewerage)</p> <p>Roads and drainage –Byron \$6-10M</p> <p>Water - Byron - \$1.3M</p> <p>Phase 1 of re-treat: 15 property</p> <p>Phase 2: Estimated to be in the hundred (both private and commercial properties)</p> <p>The scheme is to be voluntary. Compensation has not been considered at this stage.</p>		Federal and State support required from minister, DECC, DoP

* Sustainability co-benefit of potential control

** Sustainability and Greenhouse co-benefit of potential control

Key

Functional Area of Council

-  - Infrastructure
-  - Corporate & Community Services
-  - Environment
-  - Planning & Development

Level of Risk

-  - Extreme
-  - High



6. Discussion

Both Councils have recognised that adaptation is needed now as the climate is already changing. Many of the climatic changes forecast for the Byron and Tweed local region in the next 30–40 years are ‘locked in’ and are the result of past greenhouse gas (GHG) emissions and some climate change is therefore inevitable. Many of each Council’s assets have a design life of 40–100 years, which makes climate change a current, rather than a future issue. In order to increase each Council’s and its community’s resilience to these predicted future changes in climate there is a need to commence taking predicted climatic conditions into account for any new development, planning process or policy. Climate change is a fast-moving policy area, and will increasingly be a requirement of planning and design guidance, for instance, the recently published NSW Government *Draft Sea Level Policy* (2009) guidelines.

This risk assessment and adaptation planning workshops were successful in bringing together a number of staff from different departments in each of the Councils to recognise that climate change has immediate and future impacts on Council assets, operations and services.

The adaptation planning process identified a number of significant opportunities for each Council to rethink its approach and in some cases, such as the future of Byron Town Centre, to create remodeled communities that are more resilient in the face of future climates. Many adaptation strategies identified offer multiple benefits and many are closely aligned to existing actions in each Councils suite of sustainability plans and policies and as such offer the potential to contribute to enhancing quality of life in the Byron and Tweed Shires in the future. Therefore climate change presents opportunities to develop new services and new ways of doing business that respond to the challenges of sustainability and climate change in tandem. As an example, options need to be investigated that realign hard flood defenses but which also improve biodiversity as well as managing flood risks. Adaptation options identified in this plan also have the potential to contribute to greenhouse gas reduction. For instance adaptation actions such as Integrated Water Cycle Management as a strategy to combat higher evaporation and longer droughts under future climatic conditions also improve climate change resilience, reduce greenhouse gas emissions and contribute to more sustainable communities.

This adaptation planning process identified a forward plan for each Council of policymaking, planning, capital works, monitoring and research and education. These actions relate to Council business planning processes as well as work with the Australian and State Governments and other bodies. Where possible indicative resource needs have been identified, in cases such as drainage and coastal works these are considerable and it is recommended that each Council needs to undertake a more detailed analysis, including possibly localised modelling, of some of the identified impacts and adaptation approaches in order to build the business case for this investment.

Opportunities for community education to assist in engaging the community in each Councils future climate change adaptation work have also been identified; priority areas for enhanced community education include pest management, heat stress and sea level rise/flooding. Priority areas for monitoring and research included proliferation of exotic species and biodiversity at risk from climate change.

Overall the analysis of controls identified how well current Council Business Plans address climate change risk. In particular it is recommended that each Council reviews their key strategic documents and plans such as the Byron Shire Council ‘*Management Plan*’, ‘*Settlement Strategies*’, ‘*Local Environmental Plan*’ and ‘*Coastal Zone Management Plan*’ and for Tweed Shire Council it’s ‘*7 Year Infrastructure and Services Plan*’, ‘*Urban Stormwater Management Plan*’, ‘*Economic Development Strategy*’, ‘*Coastline Management Plan*’ and ‘*Local Environmental Plan*’ in light of the identified climate change risks and adaptation actions. There is a need to integrate the identified adaptations actions into



all of these key Council planning frameworks.

It is also important for the Councils to commit to review this exercise, and undertake a further risk assessment in the future in order to consider any further risks and adaptation controls (for operation) in light of future developments in technology, knowledge and research. Ongoing reviews of risks are required as more clarity and certainty regarding climate change effects emerge.

Approaches to address the high priority ('High' and 'Extreme') risks included:

- » New and heighten engineering controls (eg review and update of current standards and policies such as the Flood clause in the Tweed draft LEP which have not yet been accepted by the Department of Planning).
- » New engineering works (eg coastal defences such as levees, rock revetments, seawalls and for Tweed Shire Council Bray Park Wier augmentation before sea level rises 10 cm from current level)
- » Potential controls and actions for the Council operations (eg a new Heatwave Management Plan and updating planning policy for the coastal zone)
- » Further research into the applicability and severity of climate change risks (eg better data needed on climate impacts associated with rainfall and evaporation patterns);
- » Land use planning (eg Byron's Planned Retreat including changes to DCP, LEP, Coastal Zone Management Plan, SEPPs);
- » Strategic planning (eg new management plan or revisions to economic development plan for the reduction of economic reliance on tourism e.g. diversification) and,
- » Education (eg use of existing community services network, newsletters and establishing a communications group within Council on heat stress and increase flooding).

These are detailed in Table 10.

6.1 New and Heighten Engineering Controls

The need for new and heighten engineering controls were identified during the climate change risk assessment and adaptation workshops to manage in particular future flooding. An initial approach is to build on the existing controls and then to identify additional control measures. In this way, it is possible to utilise the current momentum in the management of risks and continuously improve control measures. Many of these new controls require implementation of climate change considerations into existing modelling or planning eg asset management plans, water sensitive urban design, flood mitigation and coastal protection. If climate change is not integrated as soon as practicable into these then it is most likely to result in greater costs into the future. These are examples of preventive and mitigating controls. For example, controls to reduce the impact of sea level increase if delayed could at later stage lead to very costly options. More detailed study, such as sea level and storm surge modelling to better determine the exact likelihood and severity of potential impacts, is recommended given the potential expense of these engineering design changes.

6.2 New Engineering Works

Many risks relating to sea level rise and increased severe events identified the need for augmentation of existing coastal and inland infrastructure to prevent and mitigate the risk of increased flooding and inundation. It was identified that the scale of required works may need a large increase in the allocated funds and the implications for Councils budget was noted. These actions should be informed by more detailed localised impact modelling (such as sea level rise and storm surge). This may require the



involvement of climate change specialists as well as design and engineering personnel.

6.3 Potential Controls And Actions For Council Operations

Numerous control strategies were identified during the climate change risk assessment and adaptation workshops that require adjustment to Council operations. For example, the introduction of new or revised operating procedures to the *Bushfire Management Plan* and changes to biodiversity programs to respond respectively to increased number of bushfire prone days and loss of biodiversity on the floodplains.

6.4 Research and Monitoring

A number of controls and actions which were identified during the climate change risk assessment and adaptation workshops involved further research and monitoring the impacts of climate change to the local area. These controls can be implemented in the short term or on a continued on an on-going basis. The outcomes of these controls can aid in the identification and implementation of further potential controls. Depending on the timeframe the research and monitoring does not need to be done solely by Council, as this can be ineffective in terms of results and costs. It is recommended that support from the Australian and State Governments, as well as alliances with bodies such as CSIRO and Universities, for research and monitoring be sought. Research was needed in the identification of at-risk habitats in the coastal floodplain.

6.5 Land Use Planning

Many high priority risks require amendment to each Council's planning schemes to improve resilience to sea level rise, storm surge, flooding and extreme events, eg. Council's *DCPs*, *LEPs*, *Coastal Zone Management Plans*, *SEPPs*. The need for further supporting assessments - data, modelling and costs and benefits analysis to support these changes was noted. The support of the NSW Department of Planning would also be required.

6.6 Strategic Planning

During the workshops it was made evident by the workshop participants that climate change was not consistently applied across all Council planning. As it currently stands, there is no explicit allowance for future climate change conditions and risks in these key plans. Council needs to instigate the systematic consideration of climate change into all planning processes into the future. In particular, as stated above, it is recommended that each Council reviews key strategic documents and plans such as the Byron Shire Council '*Management Plan*', '*Settlement Strategies*', '*Local Environmental Plan*' and '*Coastal Zone Management Plan*' and for Tweed Shire Council it's '*7 Year Infrastructure and Services Plan*', '*Urban Stormwater Management Plan*', '*Economic Development Strategy*', '*Coastline Management Plan*' and '*Local Environmental Plan*' in light of the identified climate change risks and adaptation actions. It is recommended that plans be reviewed and upgraded to:

- » Consider all items in light of climate change;
- » Integrate identified and prioritised adaptation actions into these strategic plans;
- » Conduct a gap analysis, i.e. what aspects of the plan will have climate change impacts that have not been addressed; and
- » Make recommendations as to how these items are to be managed through the allocation of resources and budget into the future.

The priority for the next phase of this project is to integrate the potential adaptation controls into the



Council strategic planning and processes.

6.7 Education and Community Awareness

For heat stress and proliferation of exotic species educational control strategies were suggested. These could include utilising existing community services network, creating new newsletters, establishing a new communications group within Council, establishing localised response groups and conducting school education. These adaptation responses would only be effective with widespread community awareness and engagement. It was identified that each Council does not presently have any climate change awareness programs.

6.8 Other Issues

6.8.1 Costs, Resources and Time

Numerous potential adaptation controls were identified and it will take time and resources to implement all of these actions. In order to assist the development of the adaptation plan and implementation of the actions, it is suggested that a budget be developed for each Council in order to assist in determining what can be effectively managed within available resources.

A number of potential controls showed a reliance on external funding to meet these increased funding requirements. The majority of controls also require short-term implementation. This may pose significant resourcing and budgeting challenges. It is therefore important to optimise co-ordination with the other tiers of government. There is also a need to acquire a better understanding of potential impacts (through research and modelling) in order to better define the key adaptation actions, especially coastal and flooding works, further emphasising the importance of the Research and Monitoring Control outlined above (6.4).

6.9 State and Federal Frameworks, Policies and Support

A number of potential adaptation actions require support from the Australian and State Governments, other local agencies, or collaboration with surrounding Councils. Where this support is required, it is recommended that Council develop a plan for communication, or enhancing existing communications and focussing a part of them on climate change risk and adaptation, between Council and these organisations in order to drive implementation of the required actions.

A coordinated approach from all tiers of government, and strong leadership with conviction about managing climate change is required for effective change management of this issue in the Byron and Tweed Shire Councils. The approach will need to be dynamic and flexible because it will need to adapt as new climate change information comes to hand.

While working to develop policy or regulatory changes can commence immediately or is already underway, implementation and then an actual change driven by policy may not be realised or functioning until 10-15 years time or more. Taking fire risks as an example, although new guidelines may be enacted to reduce the impact of fires on new buildings, existing buildings will continue to be at higher risk. Therefore, opportunities to complement changes in policy or planning regulations, such as retrofitting should be applied to existing buildings where possible.



6.10 Other Potential Controls to Consider

There is a range of controls for climate change risks that have been identified in similar work across Australia, some of which could be considered for the Byron and Tweed Shire Councils in the future. Some of these are used by Byron and Tweed Shire Councils now but may not have been explicitly reviewed at the workshop due to time limitations. Some of these are also in the guidelines for managing climate change.

6.10.1 General

Alliance	With universities/CSIRO etc to assist with ecological research
Monitoring	Monitoring of local climate change sensitive variables (i.e. Environmental, Flora and Fauna)
Plan	Media management plan
Plan	Improved contingency and disaster planning
Plan	Enhanced communication plans
Research	Improve knowledge of the probability of frequency and magnitude of changes to extreme climate events and other climate variables under climate change
Research	Improve modelling of regionally based climate change impacts
Stakeholders	Targeted awareness campaign (specify groups and issues)
Strategy	Factor climate change into criteria for designation of species or ecosystems requiring increased protection

6.10.2 Increased stress on local vegetation

Strategy	Factor climate change into criteria for designation of species or ecosystems requiring increased protection
Design	Measures to retain water in landscape e.g. detention basins, recharge areas, water sensitive urban design

6.10.3 Extreme Weather – economic hardship, and health of individuals

Grants	Australian Tourism Development Program (ATDP)
Grants	Caring for our Country
Grants	Eco Living grants program
Monitoring	Community audit
Plan	Encourage: review plans of adjoining Councils
Plan	Current Council core value/objectives for area, vision for region

6.10.4 Bushfire

Design	Amend building design standards
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Equipment	Emergency genset
Management	Firebreaks and management program
Monitoring	Monitor insurance provisions of residents & business owners
Policy	Harvest ban over 35°C
Stakeholders	Targeted awareness campaign (specify groups and issues)
Strategy	Migration of people away from high risk areas

6.11 Monitoring and Review Process

The recommendations arising from this Report will be subject to periodic review and update by Council to assist with future planning and decision making within Council.



7. Recommendations

The intent of the adaptation planning is to develop strategies for better managing risks and build resilience into Council planning, operations and management by developing adaptive actions.

7.1 Next Steps

- » It is recommended that both Councils conduct in depth assessments as identified in this project, such as a cost benefit analysis and/or a detailed adequacy assessment of existing controls. This should include more detailed, localised impact studies, particularly of potential sea level rise, storm surge and severe events to inform the identified flooding, coastal zone management and land use planning adaptation measures;
- » Use an integrated approach to climate change risk assessment that highlights the multiple benefits in terms of contribution to each Councils' sustainability and greenhouse gas reduction plans and policies;
- » Review strategic plans in light of the identified climate change risks and integrate potential controls and adaptation actions;
- » Develop a plan that explicitly addresses the implementation of the controls including resources, funding and timeframes required;
- » Develop a long-term position for each Council on climate change, this should include an assessment of the overlay of a number of compounding potential climate change impacts on the LGAs, this should build on the more detailed climate change risk assessments;
- » Further develop the collection and evaluation of climate change forecasts and local measurements, for the purposes of strategic planning and ongoing adaptation of operational procedures;
- » Develop a monitoring program of the local environmental variables identified in this project that are sensitive to climate change;
- » Identify environmental, social and economic thresholds and therefore associated initiation points for associated adaptation controls, potentially working with local universities to collect this information;
- » Review the identified controls in light of future research, knowledge and technology, and;
- » Ensure ongoing climate change risk assessment at key points is incorporated into all strategic planning and operational and other management plans.

7.2 Use of This Report

This report has been prepared as a component of the Local Adaptation Planning Program (LAPP) for the Byron and Tweed Councils and is for the sole purpose to provide adaptation action recommendations associated with climate change for Byron Shire Council and Tweed Shire Council.

This report is not for use by any related or third party or for any other project. The information and recommendations are to be read and considered as a whole and the content is not to be used selectively as this may misrepresent the content of the report and provide erroneous project or decision outcomes.

Byron and Tweed Shire Council representatives largely provided the information utilised in this climate change risk assessment and the outputs of the Risk Assessment Phase checked by key Council staff.

The analysis, recommendations and summaries presented in this report are based on information



provided by Byron and Tweed Shire Councils, *ABS, CSIRO, IPCC, the Australian Government Department of Climate Change (DCC), New South Wales Department of Environment and Climate Change (DECC) and other similarly recognised government bodies*. This information has not been independently verified. Assumptions and recommendations which need further testing are noted in the text of the report.

The data and process used as the basis for conducting the climate change risk and adaptation assessment was approved by Byron and Tweed Shire Councils and was based on the AGO Guidelines as per the requirements of LAPP.

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Appendix A

Abbreviations



AGO	Australian Greenhouse Office
AS	Australian Standard
BoM	Bureau of Meteorology
CO2	Carbon dioxide
CZMP	Coastal Zone Management Plan
CSIRO	Australian Commonwealth Scientific and Industrial Research Organisation
DCC	Australian Government Department of Climate Change (Formerly AGO)
DCP	Development Control Plan
DECC	Department of Environment and Climate Change
DPI	Department of Planning and Infrastructure
EPBC	Environmental Protection and Biodiversity Conservation
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
LEP	Local Environmental Plan
MCA	Multiple Criteria Analysis
RL	Relative Level
SEPP	State Environmental Protection Plan
SRES	Special Report on Emission Scenarios
TEU	Twenty Foot Equivalent Unit
WSUD	Water Sensitive Urban Design



Appendix B

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Appendix C
Workshop Attendance Lists



Byron and Tweed Climate Change Risk Assessment Workshop

12 February 2009, Byron Shire Council

Workshop Participants

Table 11 Workshop Participants

Name	Position	Council / Company	Mobile / email
James Flockton	Flood & Drainage Engineer	BSC	James.flockton@byron.nsw.gov.au
Ben Fitzgibbon	Coastal & Estuary Officer	BSC	Ben.Fitzgibbon@byron.nsw.gov.au
Shayn French	Manager CP & NR	BSC	Shayne.French@byron.nsw.gov.au
Graeme Williams	Sustainability Officer	BSC	Graeme.Williams@byron.nsw.gov.au
Danny Rose	Planning and Infrastructure	TSC	drose@tweed.nsw.gov.au
Stuart Russell	Strategic Planner	TSC	srussell@tweed.nsw.gov.au
Peter Pennycuick	Water and Sewerage Engineers	TSC	peterp@tweed.nsw.gov.au
Rachel Nicholson	Work Experience	TSC	Rachel.Nicholson2@student.griffith.edu.au
Mark Kingston	Biodiversity Programme Leader	TSC	mkingston@tweed.nsw.gov.au
Dan Walton	Sustainability Programme Leader	TSC	danw@tweed.nsw.gov.au
Iain Lonsdale	Coordinator Planning Reforms	TSC	ilonsdale@tweed.nsw.gov.au
Lawrence McCoy	Community Safety Officer, WSWRFS	Rural Fire Service	Lawrence.mccoy@rfs.nsw.gov.au
Sandy Pimm	Specialist Planner/Ecologist	TSC	spimm@tweed.nsw.gov.au
Lisa Wrightson	Team Leader Community Planning	BSC	Lisa.wrightson@byron.nsw.gov.au
Peter Ganser	Building & Recreational Assets Coordinator	TSC	pganser@tweed.gov.au 02 6670 2725
Stella Whittaker	Service Line Leader, Sustainability	GHD	stella.whittaker@ghd.com.au
Mike Erskine	Principle Risk	GHD	mike.erskine@ghd.com.au
Ashani Basnayake	Sustainability Consultant	GHD	ashani.basnayake@ghd.com.au



Byron and Tweed Climate Change Adaptation Workshop

23 April 2009, Byron Civic Hall

Workshop Participants

Adaptation workshop attendees

Name	Position	Council / Company	Mobile / email
James Flockton	Flood & Drainage Engineer	BSC	James.flockton@byron.nsw.gov.au
Ben Fitzgibbon	Coastal & Estuary Officer	BSC	Ben.Fitzgibbon@byron.nsw.gov.au
Graeme Williams	Sustainability Officer	BSC	Graeme.Williams@byron.nsw.gov.au
Danny Rose	Planning and Infrastructure	TSC	drose@tweed.nsw.gov.au
Peter Pennycuick	Water and Sewerage Engineers	TSC	peterp@tweed.nsw.gov.au
Mark Kingston	Biodiversity Programme Leader	TSC	mkingston@tweed.nsw.gov.au
Dan Walton	Sustainability Programme Leader	TSC	danw@tweed.nsw.gov.au
Sandy Pimm	Specialist Planner/Ecologist	TSC	spimm@tweed.nsw.gov.au
Stella Whittaker	Service Line Leader, Sustainability	GHD	stella.whittaker@ghd.com.au
Mike Erskine	Principle Risk	GHD	mike.erskin@ghd.com.au
David McLean	Senior Environmental Scientist	GHD	david.mclean@ghd.com.au
Ashani Basnayake	Sustainability Consultant	GHD	ashani.basnayake@ghd.com.au



Appendix D
Risk Workshop Methodology

B Risk Workshop Methodology

Risk is commonly referred to as a combination of the likelihood and the consequence of an occurrence. Publications by the AGO (2006) suggest that climate change is not expected to create new risks, but potentially change the frequency and intensity of existing risks and hazards. There are a range of uncertainties around global climate scenarios and modelling resulting in varying degrees of confidence.

The proposed risk assessment methodology recommended by the AGO is adapted from AS 4360: 2004, the Australian Standard for Risk Management. A simplified summary of the methodology is represented in Figure B.1.

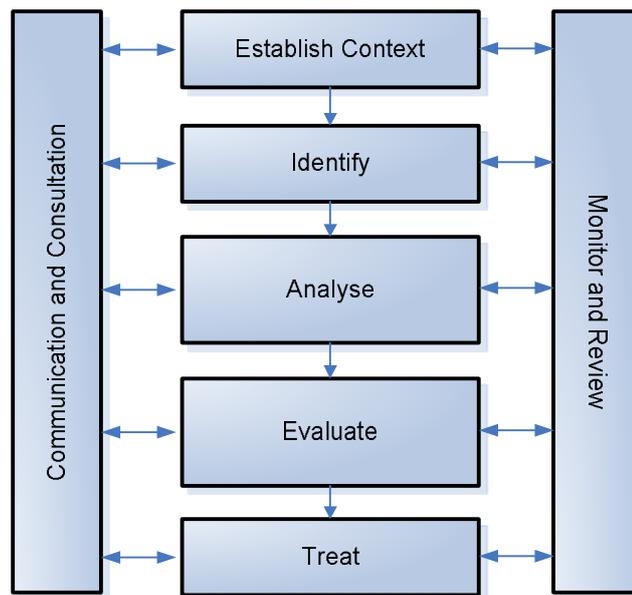


Figure B.1 Risk Assessment Methodology

The main elements are described in the following subsections.

Establish Context

In order to maximise the efficiency of the workshop, a context setting document was prepared prior to the workshop and sent to all relevant parties. The purpose of this document was to:

- » Establish the agenda for the workshop;
- » Introduce global and local climate change projections, trends and effects to the workshop participants;
- » Introduce the Risk Assessment methodology to the workshop participants;
- » Provide copies of the Risk Matrices to the workshop participants for familiarisation; and
- » Provide background information relevant to the climate change scenarios that were to be discussed in the workshop;

A summary of the context document is also included in this report.



Identify

The hazards and risks associated with climate change relating to design, construction, operations and maintenance were identified.

This was done by taking each climate change variable in turn and discussing associated risks until the main issues were felt to have been exposed.

Analyse

Once the risks and their causes were identified, the likelihood of the risks manifesting themselves and their consequence were measured. The assessment tables in Section 4 were used to determine the likelihood and consequence levels.

For each risk:

- » Existing controls already in place to mitigate the risk were identified;
- » Consequences arising from the risks were identified and controls for each of the scenarios under consideration were determined using the adopted consequence scale;
- » The likelihood of the consequence given the controls for each of the scenarios under consideration was determined using the adopted likelihood scale; and
- » An initial priority was assigned to each scenario based on the likelihood and consequence of the risk. The adopted risk matrix was used to achieve this.

Evaluate

The estimated level of risk was compared against the Risk Determination Matrix and ALARP levels determined by Byron/Tweed Shire Councils to evaluate the effectiveness of the controls

After all relevant climate change variables had been considered; all the risks were assembled into a single set and reviewed as a whole.

Any risks found to have been over or under-rated were manually altered to illustrate the agreed priority. The outcome was a list of risks with all the information recorded in the identification and analysis stage.

Treat

Based upon the findings of the workshop, a planning exercise known as the Adaptation Approach will be carried out as a second workshop to identify methods or controls to mitigate risks that were deemed as High in the first workshop.

This approach will establish the method by which these new controls or methods can be implemented and integrated into Council operation and existing systems.

Monitor and Review

Ongoing review is essential to ensure that the management plan remains relevant. As the project progresses, drawings and project documentation will be verified at regular intervals to make sure that control measures and special requirements are constructed and documented as required.

Evaluation Framework

The evaluation framework to be used for the Byron/Tweed Climate Change Risk Assessment is consistent with Australian Standards risk management framework (*AS4360:2004 – Risk Management*) described in Section 3 of this report.

The Climate Change Risk Register comprises an excel spreadsheet that was used during the workshop



and has been developed based on the Australian Standard (*AS4360:2004 - Risk Management*) and the Australian Government Department of Climate Change (formerly AGO) risk management framework. The Climate Change Risk Register enables an immediate calculation of risk level and was provided as a deliverable of the exercise and for the ongoing management of the identified climate change risks.

In order to evaluate the level of risk associated with each identified scenario during the workshop, the following likelihood descriptors (Table B.1), consequence scales (Table B.2) and risk matrix (Figure B.2) will be used. These are based on the Australian Government Department of Climate Change (formerly AGO) Climate Change Impacts and Risk Management Guidelines (2006). The risk level descriptors are further explained in Table B.3.

Table B.1 Likelihood Scale

Rating	Recurrent Risks	Single Events
Almost Certain	Could occur several times per year	More likely than not - Probability greater than 50%
Likely	May arise about once per year	As likely as not - 50/50 chance
Possible	May arise once in ten years	Less likely than not but still appreciable - Probability less than 50% but still quite high
Unlikely	May arise once in 10 years to 25 years	Unlikely but not negligible - Probability low but noticeably greater than zero
Rare	Unlikely to occur during the next 25 years	Negligible - Probability very small, close to zero



Table B.2 Consequence Scales

	Operational Safety	Environment & Sustainability	Equipment Damage (fiscal loss)	Operational Impact
Catastrophic	Large numbers of serious injuries or loss of lives	Major widespread loss of environmental amenity and progressive irrecoverable environmental damage	>\$2M	Operations permanently cease No practical alternative available
Major	Isolated instances of serious injuries or loss of lives	Severe loss of environmental amenity and danger of continuing environmental damage	\$1M - \$2M	Operations cease or severely impacted thereafter. Alternatives available
Moderate	Small number of injuries	Isolated but significant instances of environmental damage that might be reversed with intensive efforts	\$500,000 - \$1M	Operations impacted Only specific sized vessels able to use port
Minor	Serious near misses or minor injuries	Minor instances of environmental damage that could be reversed	\$50,000 - \$500,000	Negligible impact on operations
Insignificant	Appearance of threat but no actual harm	No environmental damage	<\$50,000	No impact on operations



		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
Likelihood	Almost Certain	Medium	Medium	High	Extreme	Extreme
	Likely	Low	Medium	High	High	Extreme
	Possible	Low	Medium	Medium	High	High
	Unlikely	Low	Low	Medium	Medium	Medium
	Rare	Low	Low	Low	Low	Medium

Figure B.2 Risk Matrix

Table B.3 Risk Level Descriptors

Risk Level	Response
Extreme	Risks demand urgent attention at the most senior level and cannot be simply accepted as part of routine operations without executive sanction.
High	Risks are the most severe that can be accepted as part of routine operations without executive sanction but they will be the responsibility of the most senior operational management and reported upon at the executive level.
Medium	Risks can be expected to form part of routine operations but they will be explicitly assigned to relevant managers for action, maintained under review and reported upon at senior management level.
Low	Risks will be maintained under review but it is expected that existing controls will be sufficient and no further action will be required to treat them unless they become more severe.



Appendix E
Risk Register



No	GHG Emissions Scenario	Climate Change Variables	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk									Residual Risk			Comments	
							Now			2030			2070			Potential Controls	Consequence	Likelihood		Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
1	High	Increased temperature	The introduction or proliferation of exotic species	Environment	<ul style="list-style-type: none"> Byron - Cane toad control programs Tweed/Byron - Indian Myna Weed control - some joint programs - eg work on private property Community education programs and monitoring Cane Toad muster & fences Biodiversity plans Policy plans and programs State biodiversity plans Zoning - DCPs and other policies Local policies Federal Policies - EPBC Act Funding and grants both State and Federal 	<ul style="list-style-type: none"> Impacts associated with pollution of air, land and water Competition and predation of native flora and fauna Confluence with other risk scenarios such as sea level rise Loss of biodiversity- eg cane toad and red belly black snake reduction Destruction of habitat eg proliferation of weeds - morning glory displaces natives. Fauna - Indian mynas The loss of existing biodiversity 	Moderate	Likely	High	Moderate	Likely	High	Moderate	Almost Certain	High	<ul style="list-style-type: none"> Increased funding for existing controls to be expanded in scale Possible technological controls 	Moderate	Possible	Medium	<ul style="list-style-type: none"> Insufficient knowledge to know what will occur in 2070 Need to break down to specific areas of flora and fauna Need to look at the effectiveness of various programs and grants Majority of current exotic species control programs are limited in their effectiveness. Eg toads and mynas populations are still increasing No research evidence to back up increase in temperature impacts. Evidence is anecdotal to date for example will the varacity of exotic/invasive species be more prevalent in winter due to increased temperatures Difficult to provide a blanket control across a variety of flora and fauna. For example invasive trees and vines will react differently. ACTION: Will need further analysis to determine the individual risks in order to apply appropriate controls. Research needs to be more precise. Research into existing native species required. For example, Beech forest may be sensitive to a 1.5C increase Comment made that if there was a similar level of funding to tackle invasive species as has been assigned for new parks (\$30 million) then an impact could be made.
2	High	Sea Level Rise	Loss of current or existing biodiversity	Environment	<ul style="list-style-type: none"> Coastal Zone Management Plan (estuary and coastal and floodplain) - protect/retreat strategy maintain current dune structure via engineering works ie rock walls, barriers Flood gates systems and levees Legislative controls - coastal vegetation, endangered communities Land zoning, buffers as coastline retreats Development control plans Funding - State - for planning (biodiversity planning) 	<ul style="list-style-type: none"> Loss of coastal ecosystems, dunes Loss of estuarine environment Migration of salt marsh Loss of flood plain vegetation Habitat clearing Fragmentation Habitat modification Disturbances 	Insignificant	Possible	Low	Moderate	Likely	High	Catastrophic	Almost Certain	Extreme	<ul style="list-style-type: none"> Ensure connectivity of corridors (biomes links) Translocation Development controls - buffer Floodplain defences Seawalls Technology Comprehensive mapping - for planning purposes Biodiversity banking/gene banking Ranking of areas, selection of key areas 	Moderate	Likely	High	<ul style="list-style-type: none"> Residual Risk Rated against 2030 . Acting now may reduce costs later for the community Should tease out coastal and floodplain later on in detail. Insufficient data on flood plain response to sea level rise to date. Possibly will need study Initial assessment appears lot of money for little improvement, further offline study required for validation Separate habitat from biodiversity as separate lines in the matrix A holistic approach will need to be taken into biodiversity planning. Alignment of all levels, i.e. National, State and Local - control, planning & programs, research both existing and p Fine level of profiling of ecosystems and species on the floodplain will be required to app ACTION: A study maybe be required of the health of ecosystem on the floodplain. Determine if flora and fauna can cope with the rate of change. Need for environmental bu Review the risk rating for this CC variable currently classified as catastrophic even with Pt
3	High	More severe weather events from increased rainfall and extended drought periods.	Decline in the local economy	Property & Finance	<ul style="list-style-type: none"> Increased advertising post severe wet weather 	<ul style="list-style-type: none"> Loss of income from tourism & agricultural productivity. 	Insignificant	Possible	Low	Minor	Possible	Medium	Moderate	Likely	High	<ul style="list-style-type: none"> Management Plan for the reduction of economic reliance on tourism e.g diversification Diversification of crops and cropping regimes Protection of prime agricultural land Education (agricultural practices and community food literacy) Sustainable Agricultural Strategy Regional Food Trail eg speciality restaurants, farmers markets, wine trail 	Minor	Possible	Medium	
4	High	Decreased rainfall	Drought	Property & Finance	<ul style="list-style-type: none"> Water storages and water supply Use of recycled water Rainwater tanks 	<ul style="list-style-type: none"> Change in the location of infrastructure Loss of property amenity and function 	Insignificant	Unlikely	Low	Minor	Possible	Medium	Minor	Possible	Medium	<ul style="list-style-type: none"> Integrated water cycle management including demand management, water sensitive urbane design etc. 	Minor	Possible	Medium	<ul style="list-style-type: none"> Need to review risk once better climate data for area is available.
5	High	Sea Level Rise	Increased groundwater level leading to intrusion of pipe works	Property & Finance	<ul style="list-style-type: none"> Coastal Zone Management Plan (Estuary and coastal and floodplain) - protect/retreat strategy maintain current dune structure via engineering works ie rock walls, barriers Flood gates systems and levees Infrastructure design 	<ul style="list-style-type: none"> Inability of infrastructure to function 	Insignificant	Unlikely	Low	Minor	Possible	Medium	Moderate	Possible	Medium	<ul style="list-style-type: none"> Mapping of at risk infrastructure across the area. Identify areas requiring capital works. Implementing a planning policy for new infrastructure. 	Minor	Unlikely	Low	<ul style="list-style-type: none"> Rising groundwater levels are compounding the sea level rise and storm surge issue.



No	GHG Emissions Scenario	Climate Change Variables	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk									Residual Risk			Comments	
							Now			2030			2070			Potential Controls	Consequence	Likelihood		Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
6	High	Increased temperature	Habitat displacement	Environment	Vegetation management plans across the shire, SEPPs, EEC, LEP zones	Isolation (fragmentation) and reduced resilience due to climate change	Insignificant	Unlikely	Low	Minor	Possible	Medium	Moderate	Likely	High	Identification of at risk habitat Improving connectivity Translocation of species.	Minor	Possible	Medium	Taken for 2030 Timeframe
7	High	Sea Level Rise	Effect on freshwater supply	Property & Finance	Operation management system - temporary barrier over the weir	Seawater incursion as it overtops current weir height	Minor	Almost Certain	Medium	Moderate	Almost Certain	High	Major	Almost Certain	Extreme	Weir augmentation before sea level rises 10cm from current level	Minor	Unlikely	Low	This is a risk that is specific to the Tweed Shire Legal arguments over the weir in Tweed which has implications for farmers but can be resolved with a relatively simple engineering solution. (Will need further clarification) There has been a loss of property now. Please clarify to what extent - how many properties/area. Risk of sea level rise contaminating fresh water supply, especially a concern for Tweed. Current occurs twice a year with King Tides. Weir augmentation will be required before sea levels rise a further 0.1 meters from current level. Note that as sea levels continue to rise, this may possibly become a constant event affecting the functionality of the community (\$10-\$20 million BAU).
8	High	Sea Level Rise	Impacts on coastal development	Property & Finance	DCPs Levies Floodgates Flood pumps Landuse planning framework Drainage maintenance Zoning Voluntary purchase of land Voluntary house raising Local Government Act DECC policy and guidelines and manual (floodplain) Coastline Management Plan with an Asset focus Flood studies Asset Management Plans (Tweed in place, Byron progressing) Monitoring Grant funding Research Agricultural management -how land is managed, crop type See Items 19, 20, 21, 22, 23	Property damage Devaluation of land Council liability Loss of property Loss of development potential Class Actions Community outrage Loss of agricultural yield Impact on SES Increased cost to develop Loss of income Loss of taxation revenue Insurance - increased property insurance Councils own insurance rating - higher premiums Damage to infrastructure Disruption to utilities Cost to government for natural disaster response	Insignificant	Almost Certain	Medium	Minor	Almost Certain	Medium	Major	Almost Certain	Extreme	Potential rate increase (Climate Change levy) Specific state funded allocation Planned retreat Coastal buffers Levies Other defences Compulsory purchasing Back zoning DCPs LEP state system changed Community awareness and education Major upgrade of emergency response Relocation of critical infrastructure Insurance clarification See Items 19, 20, 21, 22, 23	Minor	Almost Certain	Medium	
9	High	Increased temperature	Increased bushfire events (and intensity)	Property & Finance	Asset protection zones Hazard reduction burning Bushfire Management Plans Fire mapping See Items 10 & 11 below	Increased bushfire events leading to loss of property (infrastructure and community assets) Increased insurance premiums Reduction in community services Increased resource requirements for bushfire management See Items 10 & 11 below	Minor	Likely	Medium	Minor	Almost Certain	Medium	Moderate	Almost Certain	High	Increased bushfire management and resources Fuel reduction strategies Sighting of new infrastructure See Items 10 & 11 below	Minor	Possible	Medium	ACTION: Check existing bushfire controls in the Bushfire Management Plan (repeated against items 8,9,10) ACTION: Need to determine what the specific risks and consequences will be at a given location. The suggestion is to divide the area into 9 precincts (eg separate line items perhaps NB each precinct may again need to be categorised by the 3 risk categories i.e. environment, property and health) and analyse on a case by case basis to more tailor the potential controls. Cannot provide a blanket control to determine residual risk level. - Rural Fire Service will need to be consulted.(repeated against items 8,9,10) ACTION: Check figures for the number of total fire bans / yr now and into the future. Currently there are 4/yr but said to increase 10 fold.(repeated against items 8,9,10) Taken for the 2030 timeframe
10	High	Increased temperature	Increased bushfire events (and intensity)	Human Life and Health	Ignition management Hazard reduction Community education Preparedness - operational readiness Training Bushfire Management Plan Development controls See Items 9 & 11	Increased bushfire events leading to loss of life Safety issues See Items 9 & 11	Insignificant	Unlikely	Low	Minor	Unlikely	Low	Moderate	Possible	Medium	Increased bushfire management Fuel reduction strategies Increased resources Sighting of new infrastructure Community education Improved health services (managing responses to bushfire injuries) See Items 9 & 11	Minor	Unlikely	Low	Split into 8 or 9 precincts and analyse case by case ACTION: Check existing bushfire controls in the Bushfire Management Plan (repeated against items 8,9,10) ACTION: Need to determine what the specific risks and consequences will be at a given location. The suggestion is to divide the area into 9 precincts (eg separate line items perhaps NB each precinct may again need to be categorised by the 3 risk categories i.e. environment, property and health) and analyse on a case by case basis to more tailor the potential controls. Cannot provide a blanket control to determine residual risk level. - Rural Fire Service will need to be consulted.(repeated against items 8,9,10) ACTION: Check figures for the number of total fire bans / yr now and into the future. Currently there are 4/yr but said to increase 10 fold.(repeated against items 8,9,10)



No	GHG Emissions Scenario	Climate Change Variables	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk									Residual Risk			Comments	
							Now			2030			2070			Potential Controls	Consequence	Likelihood		Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
11	High	Increased temperature	Increased bushfire events	Environment	<ul style="list-style-type: none"> Ignition management Hazard reduction Community education Preparedness - operational readiness Training Bushfire Management Plan Development controls See Items 9 & 10 above 	Increased bushfire events leading to loss biodiversity See Items 9 & 10 above	Minor	Possible	Medium	Moderate	Possible	Medium	Moderate	Possible	Medium	<ul style="list-style-type: none"> Increased bushfire management Fuel reduction strategies Increased resources Sighting of new infrastructure Community education Improved health services (managing responses to bushfire injuries) WIRES Cool burns See Items 9 & 10 above 	Moderate	Possible	Medium	ACTION: Check existing bushfire controls in the Bushfire Management Plan (repeated against items 8,9,10) ACTION: Need to determine what the specific risks and consequences will be at a given location. The suggestion is to divide the area into 9 precincts (eg separate line items perhaps NB each precinct may again need to be categorised by the 3 risk categories i.e. environment, property and health) and analyse on a case by case basis to more tailor the potential controls. Cannot provide a blanket control to determine residual risk level. - Rural Fire Service will need to be consulted. (repeated against items 8,9,10) ACTION: Check figures for the number of total fire bans / yr now and into the future. Currently there are 4/yr but said to increase 10 fold. (repeated against items 8,9,10) Is there a greater focus on property and people and to reduce risk from fire? increased fire management may have a negative impact on the environment if the management regimes don't incorporate site specific environmental considerations.
12	High	Increased temperature	Decreased water flows into dam or catchments	Human Life and Health	<ul style="list-style-type: none"> Dam locations Demand Management Strategies Safe yield projections 	Inability to service suburban water demands Drop in water quality Algal blooms	Minor	Likely	Medium	Moderate	Possible	Medium	Minor	Possible	Medium	<ul style="list-style-type: none"> Development of alternative water supplies Water supply augmentation Increased resources for demand management. 	Minor	Possible	Medium	ACTION: What are the figures for water use reduction as a result of Council programs? Fresh water supply is an issue faced mainly by Tweed (action repeated item 15 - Higher Evaporation and longer drought periods below)
13	High	Increased temperature	Decreased water flows into dam or catchments	Environment	To be analysed	To be analysed			0			0			0				0	Risk to be rated
14	High	Increased temperature	Spread of mosquito Borne diseases	Human Life and Health	<ul style="list-style-type: none"> Mosquito and biting midge control plan 	Increased hospitalisation Sick leave (loss of livelihood)	Insignificant	Unlikely	Low	Minor	Possible	Medium	Minor	Possible	Medium	<ul style="list-style-type: none"> Increase services for mosquito control and mosquito borne disease treatment. Building codes changed to better manage mosquitos. 	Minor	Unlikely	Low	ACTION: What are the potential vector Borne diseases that may arise? Eg speed of mosquitos further south as temperature rises There is like to be an increase between 2030 and 2070 although not significant enough to change ranking. Decentralised water may increase risks.
15	High	Increased temperature	Higher evaporation and longer drought periods	Property & Finance	<ul style="list-style-type: none"> Macro Water Sharing Plans (under development) Restriction levels Demand Management Strategy Integrated Water Cycle Management Strategy Catchment Zoning - LEP zoning Catchment Management Plans Augment Management Plans Asset Management Plans Community awareness State government BASIX Water Sensitive Urban Design User pays/step pricing Stormwater harvesting management Wastewater reuse 	Reduction of yield of water supply Water shortage Impact on community Water quality Reduced irrigation rights	Minor	Possible	Medium	Minor	Possible	Medium	Major	Possible	High	<ul style="list-style-type: none"> Sewer mining Better climate change data over the next 5 to 10 years Decentralising water supply Increased scale of rates - user pays increase Greywater reuse Dry toilets Dual reticulation Retrofitting depending on economics Potable reuse Landscape design Change in cropping regime (drought hardy species and GM) 	Minor	Unlikely	Low	Risk issue lies mainly based on Tweed issue. Tweed and Byron have different triggers. Two different water supplies. Byron water supply is safe till 2100- Rouse implications. Tweed will need augmentation around 2015 and further augmentation further down the track eg land purchase for a future dam site. Hoped that demand management to delay augmentation. ACTION: What are the figures for water use reduction as a result of Council programs? (action repeated in item 12 - Decreased water flows into dams or catchments above). ACTION: Check figures - 7% factored in using CC scenario to determine yield back in 2006 but did not account for 2070 climate change scenario? Tweed did not have an issue during the last drought period. Challenge will be to match population growth. The lumpy wet and dry seasons may improve the supply issues but this will need further analysis. ACTION: Better regional and season climate change data on rainfall in particular should be plugged into modelling when available. This could change the risk rating and should be included as a potential control (action repeated in item 12 - Decreased water flows into
16	High	Increased temperature	Increased evaporation and drought	Human Life and Health	<ul style="list-style-type: none"> Dam locations Demand management strategies Safe yield projections Heat stroke and health risk 	Heat stress and health related impacts	Insignificant	Rare	Low	Insignificant	Unlikely	Low	Minor	Unlikely	Low	<ul style="list-style-type: none"> Sewer mining Better climate change data over the next 5 to 10 years Decentralising water supply Increased scale of rates - user pays increase Greywater reuse Dry toilets Dual reticulation Retrofitting depending on economics Potable reuse Landscape design Change in cropping regime (drought hardy species and GM) 			0	Residual Risk to be rated



No	GHG Emissions Scenario	Climate Change Variables	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk									Residual Risk			Comments	
							Now			2030			2070			Potential Controls	Consequence	Likelihood		Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
17	High	Increased temperature	Infrastructure services - Degradation of roads	Property & Finance	Road maintenance program	Expansion of pipes Road degradation Wash out of roads from flood and storm events			0			0			0			0	Risk to be rated	
18	High	Increased temperature	Heat stress	Human Life and Health	Air conditioners Swimming Rehydration Building codes Outdoor staff amended work hours	Heat related stress and injury Death Vulnerable elderly and children Loss of motivation Increased conflict amongst people	Insignificant	Unlikely	Low	Insignificant	Possible	Low	Minor	Likely	Medium	Recalander Tie free - clothing policy Heatwave Management Plan Education Managing public opinion OHS New technology Reduced maintenance requirements - less mowed areas Insulated housing for all existing and future development Migration	Insignificant	Possible	Low	ACTION: High humidity coupled with high temperature worsens heat stress. Check area health data for heat related injuries and death. More vulnerable include the elderly of whom there is higher and growing proportion of the population. Recent data suggests that there is a 0.5 increase in deaths per day based on recent events. High humidity and high temperature creates metabolic stress impacting mainly on the elderly. ACTION: Likely that there will be 1 heatwave in every year under future climatic conditions - check from which year this is predicted to be.
19	High	Sea Level Rise	Increased flood level and frequency	Human Life and Health	DCPs Levies Floodgates Flood pumps Landuse planning framework Drainage maintenance Zoning Voluntary purchase of land Voluntary house raising Local Government Act DECC policy and guidelines and manual (floodplain) Coastline Management Plan with an Asset focus Flood studies Asset Management Plans (Tweed in place, Bryon progressing) Monitoring Grant funding Research Agricultural management - how land is managed, crop type See Items 8, 20, 21, 22, 23	Property damage Devaluation of land Council liability Loss of property Loss of development potential Class Actions Community outrage Loss of agricultural yield Impact on SES Increased cost to develop Loss of income Insurance - increased property insurance Councils own insurance rating - higher premiums Damage to infrastructure Disruption to utilities Cost to government for natural disaster recovery	Insignificant	Unlikely	Low	Moderate	Likely	High	Major	Almost Certain	Extreme	Potential rate increase (Climate Change levy) Specific state funded allocation Planned retreat Coastal buffers Levies Other defences Compulsory purchasing Back zoning DCPs LEP state system changed Community awareness and education Major upgrade of emergency response Relocation of critical infrastructure Insurance clarification Improved stormwater design standards and drainage See Items 8, 20, 21, 22, 23	Moderate	Possible	Medium	There have been 2 major floods in 15 years. Change from the pattern of annual flood events in the 1980s (this comment will further clarification by the sustainability officers) The 1 in 100 year floods are currently effecting hundreds of properties ACTION: Use Byron Tweed inundation mapping to calculate numbers of properties against the storm surge/sea level impacts. Cross check results with risk rating.
20	High	Increased storm intensity	Increased flood level and frequency	Property & Finance	Disaster Plan Emergency Services Stormwater and drainage Building construction standards Community preparedness Flood plain zoning and Sewer overflow abatement strategy Detention basins Bridges and culverts Road closure programs Tree management Floodplain management Dam construction - management of catchments Dam spillways Road maintenance Personal insurance See Items 8, 19, 21, 22, 23	Property damage Devaluation of land Council liability Loss of property Loss of development potential Class Actions Community outrage Loss of agricultural yield Impact on SES Increased cost to develop Loss of income Loss of taxation revenue Insurance See Items 8, 19, 21, 22, 23	Minor	Possible	Medium	Minor	Likely	Medium	Moderate	Almost Certain	High	Adjusting drainage and engineering controls. Improved planning of infrastructure Improved design standards of at risk infrastructure See Items 8, 19, 21, 22, 23	Minor	Likely	Medium	Minor improvement in how infrastructure will cope



No	GHG Emissions Scenario	Climate Change Variables	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk						Residual Risk			Comments				
							Now			2030			2070				Potential Controls	Consequence	Likelihood	Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
21	High	Sea Level Rise	Flooding	Property & Finance	DCPs Levies Floodgates Flood pumps Landuse planning framework Drainage maintenance Zoning Voluntary purchase of land Voluntary house raising Local Government Act DECC policy and guidelines and manual (floodplain) Coastline Management Plan with an Asset focus Flood studies Asset Management Plans (Tweed in place, Byron progressing) Monitoring Grant funding Research Agricultural management - how land is managed, crop type See Items 8, 19, 20, 22, 23	Property damage Devaluation of land Council liability Loss of property Loss of development potential Class Actions Community outrage Loss of agricultural yield Impact on SES Increased cost to develop Loss of income Loss of taxation revenue Insurance - increased property insurance Councils own insurance rating - higher premiums Damage to infrastructure Disruption to utilities Cost to government for natural disaster recovery	Moderate	Possible	Medium	Moderate	Possible	Medium	Major	Almost Certain	Extreme	Potential rate increase (Climate Change levy) Specific state funded allocation Planned retreat Coastal buffers Levies Other defences Compulsory purchasing Back zoning DCPs LEP state system changed Community awareness and education Major upgrade of emergency response Relocation of critical infrastructure Insurance clarification See Items 8, 19, 20, 22, 23	Minor	Possible	Medium	List of assets at future sea level, flooding risk Salt water intrusion - study into which assets are at risk. Get a register followed up with further analysis Councils are carrying out studies to quantify impacts of flooding - check inundation mapping Sea level rise will lead to a big impact on salt marshes. Salt marshes may be able to migrate further inland. On the other hand, migration may be restricted by existing and/or proposed development (environmental buffers). ACTION: Asset Management and question of how effective it will be. Will potential impacts of the various climate change variables be a consideration over the life of each asset? ACTION: Asset Register - check for AHD data (flood risk, tidal range, current and future sea level, flood plain) infrastructure on the coast and in floodplain for eg. sewage pumping, stormwater, roads, public buildings. Currently no assessment on the infrastructure impacts available. ACTION: Register of mapping infrastructure at risk. Salt water incursion due to sea level rise will have major impacts on infrastructure. Rising groundwater levels are compounding the sea level rise and storm surge issue. Has to be managed. Agriculture on the floodplain is very vulnerable.
22	High	Increased storm intensity	Increased flood level and frequency	Human Life and Health	Disaster Plan Emergency Services Communications Stormwater and drainage Building construction standards Community preparedness Flood plain zoning Sewer overflow abatement strategy Detention basins Mosquitoes control programs Bridges and culverts Road closure programs Tree management Floodplain management Dam construction - management of catchments Dam spillways Road maintenance Water sharing Personal insurance See Items 8, 19, 20, 21, 22	Increased injury and death during events Isolation and reduced access Localising disease Property damage Sewage overflows Sewerage infiltration Stock and crop damage Contamination of drinking water Loss of income Stress and mental health Vulnerable communities worst hit - caravan parks, aged, agricultural community, Slips on roads See Items 8, 19, 20, 21, 22	Major	Possible	High	Major	Possible	High	Major	Likely	High	Upgrade design standards for infrastructure - better engineering standards Replace infrastructure Potential rate increase (Climate Change levy) Specific state funded allocation Planned retreat Coastal buffers Levies Other defences Compulsory purchasing Back zoning DCPs LEP state system changed Community awareness and education Major upgrade of emergency response Relocation of critical infrastructure Insurance clarification See Items 8, 19, 20, 21, 22	Major	Possible	High	Depends on convergence with sea level rise, rainfall and secondary impacts such as flooding could exacerbate this problem ACTION: Currently isolated incidences with loss of life - check number of deaths due to severe storm events People may voluntarily relocate
23	High	Sea Level Rise	Coastal Erosion	Property & Finance	DCPs LEPs REPs Coastal Management Plan Barriers Sand pumping State SEPP Land tenure - difference between public and private Coastal dune rehabilitation Set backs Landuse Building and construction codes Hazard definitions Hazard identification Defences Submerged offshore reefs Seawalls - 1 retained to protect Byron, the rest to be removed Brunswick Head Training Walls (risk of failure) See Items 8, 19, 20, 21, 22	Potential town flooding for Brunswick Heads and Byron Risk to development and utilities development Immediate risk to persons residing in coastal development Loss of infrastructure - particularly roads which are important evacuation routes Coastal inundation Impacts on utilities See items 8, 19, 20, 21, 22	Minor	Possible	Medium	Moderate	Likely	High	Major	Almost Certain	Extreme	Potential rate increase (Climate Change levy) Specific state funded allocation Planned retreat Coastal buffers Levies Other defences Compulsory purchasing Back zoning DCPs LEP state system changed Community awareness and education Major upgrade of emergency response Relocation of critical infrastructure Insurance clarification See Items 8, 19, 20, 21, 22	Moderate	Rare	Low	Convergence of all of the variables There are currently several sea walls. 1 will be retained in Byron Bay and the other will go. Tweed are planning to build one new sea wall at Brunswick Heads (lands). The Byron sea wall structure is at immediate risk of failure, exposing the town's CBD, roads including evacuation routes and impact on infrastructure will need to be taken into account. Estimate cost: Byron - approx \$15 000/metre, total cost between \$3 - \$9 Million to upgrade. Cost not accounted for in any forward work budget - earmarked as future projects. Capital works program for Byron is \$3M (mainly water sewerage) Tweed - around \$102M (mainly water and sewerage). ACTION: Have available all capital and discretionary annual spending figures, especially for the Adaptation preparation meeting. Roads and drainage - Byron - \$6-10M Water - Byron - \$1.3M Can manage down with retreat BUT at a cost. Please clarify with figures as per recent flood study. Currently the 1 in 100 year floods are affecting hundreds of properties. Coastal recession has only been seen to kick in in the last two years. Only just beginning to There has been an increase in sea level of 17cm since 1970. Are we still able to assess as Noted that the coastline has not moved back to the 1990 equivalent Increased storm activity leading to storm surges and negative IPO ACTION: Need to clarify sea level rise estimates for 2030. GHD to double check estimates
24	High	Increased temperature	Impact on Parks	To be analysed	To be analysed	To be analysed			0			0						0	Risk to be rated	



No	GHG Emissions Scenario	Climate Change Variables	Risk	Risk Category	Current Controls	Specific Consequences / Vulnerability	Current Risk									Residual Risk			Comments	
							Now			2030			2070			Potential Controls	Consequence	Likelihood		Risk Level
							Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level	Consequence	Likelihood	Risk Level					
25	High	Decreased rainfall	Drought	Environment	Regional macro water sharing plans and environmental flows.	loss of habitat, change in ecosystem function and diversity	Insignificant	Unlikely	Low	Minor	Possible	Medium	Moderate	Likely	High	Increased weed control etc to reduce pressure on habitat and environmental flows for riparian areas	Minor	Possible	Medium	



Appendix F
Adaptation Methodology



Methodology

The methodology adopted for the Byron Shire Council and Tweed Shire Council Climate Change Adaptation workshop was consistent with the requirements set out in the AGO's *Climate Change Impacts & Risk Management: A Guide for Business and Government*.

Usually during an adaptation workshop the priority risks associated with climate change are focussed on. However, time permitted for all identified risks and potential controls to be assessed for adaptation.

F.1 Control Categorisation

For each risk scenario examined in the adaptation workshop, the potential controls were categorised based on the following:

- » Control type – Planning, Research, Engineering, Strategy and Procedure.
- » Control hierarchy – Elimination, Prevention, Reduction and Mitigation.
- » Could control be implemented via existing frameworks.
- » Benefits of implementing control (additional benefits or concerns that may arise from the control).

F.2 Control Ratings (Multi Criteria Assessment)

The methodology adopted for the workshop used elements from Multiple Criteria Decision Analysis (MCDA) and the Delphi Technique of prioritisation (Cline, 2000). By combining relevant elements of these techniques, a sound, robust and repeatable methodology was constructed to ensure that all participants were able to provide input into, and have ownership of the outcome.

Criteria Identification

In order to develop an understanding of the issues that may impact the performance of the potential controls, a criteria identification exercise was completed. This process enabled the identification of key issues that were considered to be of importance to the continued functionality of the controls. The following table defines the screening criteria.

Table F.1 Criteria

Criterion	Description
Cost of implementing control	Capital costs associated with the implementation of any control. Both Councils have a limited budget, however they can apply for further funds from the State Government.
Project/Policy establishment time	Takes into consideration the time commitment of Council staff measured as a cost.
Operating cost of control	This reflects ongoing maintenance and operating costs. This includes time commitment and resources.
Dependability	Reliability of the control over a long period of time.
Practicality	How practical each control is in both implementation and operation, and how well it will perform under normal circumstances. Is it an industry-accepted approach?



Criterion	Description
Political Feasibility	Both Councils assessed the feasibility of each control in terms of the alignment with Local, the Australian and State Governments policies and priorities.
Community Acceptance	Community acceptance of the control. Council understands the importance of the support of the community.
Flexibility of Implementing control	The control should have the ability to adapt to new climate change knowledge, and allow for add ons and changes to be made in the future as well as the ability of it to be implemented in a number of ways.

Following the identification of the critical elements, a weighting and rating exercise was completed based on the MCDA technique.

Multiple Criteria Decision Analysis

The principle aim of MCDA is to help decision makers learn about the problem situation, about their own and others' values and judgements, and through organisation, synthesis and appropriate presentation of information, guide them in identifying a preferred course of action.

Adopted Value Analysis Methodology

To facilitate the decision making process for the adaptation control selection, a simplified version of MCDA was used to aid in providing a value analysis of the proposed options.

Prioritisation

The prioritisation process was completed in a workshop format of open discussions. Following are the general steps towards prioritisation, implemented during this workshop:

- » An overview of each potential control was provided;
- » Ratings were provided for each of the potential controls against the criteria;
- » The potential control rankings were weighted and results assessed, and informed opinion was received for each;
- » Weighted scores were normalised and comparisons made;
- » Results were tested for robustness; and
- » Adjustments were made as necessary.

Weightings and Ratings

The initial step involved the allocation of a weighting to each of the criteria. Participants in the adaptation workshop were asked how important they consider the listed criteria and to allocate a value from the described weightings as illustrated in the table below. The weightings were defined on continuum.

Table F.2 Criterion Weighting Continuum

0	1	2	3	4	5	6	7	8	9	10
Trivial		Of minor importance		Important		Moderately important		Very important		Extremely important



The weightings of the criteria used in the adaptation workshop are provided in the table below.

Table F.3 Criteria Weightings

Criteria	Weighting
Cost of implementing the control	10
Project/Policy establishment time	5
Operating cost of control	6
Dependability	10
Practicality	8
Political feasibility	5
Community acceptance	6
Flexibility of implementing the control	3

The Workshop participants were then required to rate how well they think the potential controls would perform against the specified criteria. Again, a continuum scale was used for this rating, as provided in the following table.

Table F.4 Option Rating Continuum

0	1	2	3	4	5	6	7	8	9	10
Very poor		Poor		Satisfactory		Good		Very good		Excellent

Robustness Testing

In order to test validity of the weightings and ratings applied in the workshop, the weighting applied to each of the following criteria was artificially inflated to 20 (separately) and the resulting option rating was re-evaluated:

- » Cost of implementing control and establishment time;
- » Community acceptance;
- » Flexibility;
- » Operating Cost; and
- » Dependability.

By conducting a robustness test in this manner ensured there were no weightings that had a disproportionate impact on the overall rating. It also gave an indication as to whether a particular grouping of criteria resulted in a variation of the preferred option, and helps to test for unforeseen circumstances in the future that may not have been considered at the time of the assessment.



F.3 Residual Risk

Taking into consideration the combined effect of the adaptation controls, the risk level was re-evaluated for each of the risk scenarios in order to estimate the impact of the controls on the 2030 risk level. The residual risk level was estimated using the AGO risk management framework, as described in Appendix D.

F.4 Control Implications

The impacts of the potential controls were identified in regards to whether the control would be applicable to other risks identified in the risk assessment workshop including:

- » Reduced water availability;
- » Bushfire;
- » Flooding;
- » Extreme weather (temperature, wind, storm etc.).

Any additional effects that may occur due to the implementation of the potential controls were also identified. Support requirements from other bodies such as Local and the Australian Government, IMO etc. were also identified.

F.5 Control Implementation

In order to determine the timing requirements for the potential controls, a number of factors were considered including:

- » The timeframe required to implement the control (short, medium or long term implementation regimes);
- » When to implement the control (i.e. date);
- » Initiation point (what is required to occur in order to have the potential control implemented);
- » The functional area of council that will be in control of the implementation; and
- » Business case requirements and any additional follow on actions required to implement the potential control.



Appendix G
Adaptation Register

<p>Loss of existing biodiversity on the coastal floodplain</p> <p>(Item 2 - Sea Level Rise)</p> <p>(Item 6 - Increased Temperature)</p> <p>Risk Rating Current: Low 2030: High 2070: Extreme Residual: High</p>	<p>Loss of coastal ecosystems, dunes</p> <p>Loss of estuarine environment</p> <p>Migration of salt marsh</p> <p>Loss of flood plain vegetation</p> <p>Habitat clearing</p> <p>Fragmentation</p> <p>Habitat modification</p> <p>Disturbances</p> <p>Isolation (fragmentation) and reduced resilience due to climate change</p>	<p>Identification of at risk habitat and development of management framework</p>	<p>Research/Policy</p>	<p>Reduce</p>	<p>Biodiversity Strategy (Byron)</p> <p>Biodiversity Program (Tweed)</p> <p>Research Alliances</p>	<p>Resilience of the local economy (eg tourism)</p>	<p>363</p>	<p>Moderate</p>	<p>Likely</p>	<p>High</p>	<p>Moderate</p>	<p>Likely</p>	<p>High</p>	<p>Research first</p> <p>Articulate business case (Cost/Benefit Analysis)</p> <p>Present to Council</p>	<p>x</p>	<p>x</p>	<p>Displacement of habitat may result in the displacement of some other land use in another location (knock on effect)</p>	<p>Regional collaboration</p> <p>National Parks and Wildlife</p>	<p>Short Term</p>	<p>Research now and planning phase to take effect in 3 years time (2012)</p>	<p>Outcomes of field monitoring and research</p>	<p>Environment</p>	<p>Functional Areas: NRM, Planning and Regulation</p> <p>Champion: NRM</p> <p>Budget: Approx \$60 000</p> <p>Research alliances to take care of the majority of the identification of at-risk habitats</p> <p>Development of the management framework and mapping by Councils</p>		
<p>Effect on fresh water supply</p> <p>(Sea Level Rise - Item 7)</p> <p>NB: This risk is specific to Tweed</p> <p>Risk Rating Current: Medium 2030: High 2070: Extreme Residual: Low</p>	<p>Seawater incursion as it overtops current weir height</p>	<p>Weir augmentation before sea level rises 10cm from current level</p>	<p>Engineering</p>	<p>Mitigate</p>	<p>Current asset management process for the weirs require modification to a more permanent solution.</p>	<p>Reduction in treatment costs.</p> <p>Ability to meet drinking water standards without increased treatment. Reduces the need for infrastructure relocation.</p>	<p>385</p>	<p>Moderate</p>	<p>Almost Certain</p>	<p>High</p>	<p>Minor</p>	<p>Unlikely</p>	<p>Low</p>	<p>Finding a funding source.</p> <p>Cost benefit analysis.</p>	<p>x</p>	<p>x</p>	<p>Effects on flooding upstream resulting in downstream impacts</p>	<p>State or Federal support required for funding and approvals</p>	<p>Medium Term</p>	<p>Included into 30 year capital plan now.</p>	<p>10cm rise relative to 2009.</p>	<p>Infrastructure</p>			
<p>Coastal erosion</p> <p>(Sea Level Rise Item 23 - Coastal Erosion)</p> <p>NB: This risk is specific to Bryon</p> <p>Risk Rating Current: Medium 2030: High 2070: Extreme Residual: Low</p>	<p>Potential town flooding for Brunswick Heads and Byron</p> <p>Risk to development and utilities development</p> <p>Immediate risk to persons residing in coastal development</p> <p>Loss of infrastructure - particularly roads which are important evacuation routes</p> <p>Coastal inundation impacts on utilities</p>	<p>Planned Retreat</p>	<p>Policy</p>	<p>Prevent</p>	<p>Yes by planning controls - DCPs, LEP,CZMP, SEPPs</p>	<p>Reduction in the need for infrastructure (defence).</p> <p>Reduces the need for maintenance of infrastructure as it is relocated.</p> <p>Reduces impacts to development.</p>	<p>407</p>	<p>Moderate</p>	<p>Likely</p>	<p>High</p>	<p>Moderate</p>	<p>Rare</p>	<p>Low</p>	<p>Community consultation and ministerial support.</p> <p>Continued council endorsement</p>	<p>x</p>	<p>x</p>	<p>Environmental benefits, policy assurance</p> <p>Community safety</p> <p>Liability insurance and reduction in infrastructure costs.</p> <p>Spreading of costs across the community.</p>	<p>Federal and state support required from minister, DECC, Department of Planning</p>	<p>Short Term</p>	<p>Ongoing</p>	<p>Gazette of coastal management plan.</p>	<p>Planning & Development</p>			
<td> <p>State support</p> <p>Community acceptance</p> </td> <td> <p>x</p> </td> <td> <p>Environmental benefits, policy assurance</p> <p>Community safety</p> <p>Liability insurance and reduction in infrastructure costs.</p> <p>Spreading of costs across the community.</p> </td> <td> <p>Federal and State support required from Minister, DECC, Department of Planning</p> </td> <td> <p>Short Term</p> </td> <td> <p>Ongoing</p> </td> <td> <p>Gazette of Coastal Zone Management Plan.</p> </td> <td> <p>Infrastructure</p> </td>	<p>State support</p> <p>Community acceptance</p>	<p>x</p>	<p>Environmental benefits, policy assurance</p> <p>Community safety</p> <p>Liability insurance and reduction in infrastructure costs.</p> <p>Spreading of costs across the community.</p>	<p>Federal and State support required from Minister, DECC, Department of Planning</p>	<p>Short Term</p>	<p>Ongoing</p>	<p>Gazette of Coastal Zone Management Plan.</p>							<p>Infrastructure</p>											
<p>Increased number of bushfire prone days</p> <p>(Increased Temperature - Item 9, 10 & 11)</p> <p>Risk Rating Current: Medium 2030:Medium 2070: High Residual: Medium</p>	<p>Increased bushfire events leading to loss of property (infrastructure and community assets)</p> <p>Increased insurance premiums</p> <p>Reduction in community services</p> <p>Increased resource requirements for bushfire management</p> <p>Increased bushfire events leading to loss of biodiversity</p> <p>Increased bushfire events leading to loss of life</p> <p>Safety issues</p>	<p>Bushfire Management Plan</p>	<p>Policy</p>	<p>Reduce</p>	<p>Disaster Plan</p> <p>Bushfire Management Plan</p> <p>Asset Management Plans</p>	<p>Already exists, benefit of incremental revision</p>	<p>485</p>	<p>Moderate</p>	<p>Possible</p>	<p>Medium</p>	<p>Moderate</p>	<p>Possible</p>	<p>Medium</p>	<p>Service Level Agreement between Councils and RFS adopted by the Councils</p>	<p>x</p>	<p>x</p>	<p>x</p>	<p>x</p>	<p>Compromise between biodiversity protection and fire management</p>	<p>RFS</p> <p>Office of Emergency Services</p>	<p>Short Term</p>	<p>2015</p>	<p>Severe fire</p> <p>Outcome of the Victorian Bushfire Enquiry</p>	<p>Environment</p>	<p>Functional Areas: NRM, Environment and Health, Asset Management</p> <p>Champion: NRM</p> <p>Budget: Approx \$15 000</p> <p>Benefit of incremental revision</p>

<p>Higher evaporation and longer drought periods</p> <p>(Increased Temperature - Item 15, 16)</p> <p>Decreased Rainfall - Item 4, 25)</p> <p>Risk Rating Current: Medium 2030:Medium 2070: High Residual: Low</p>	<p>Loss of habitat, change in ecosystem function and diversity</p> <p>Macro water sharing plans (under development)</p> <p>Restriction levels</p> <p>Demand management strategy</p>	<p>Increased scale of rates - user pays increase for infrastructure maintenance and development of water</p>	<p>Policy</p>	<p>Reduce</p>	<p>Update to existing rates policy</p>	<p>Option to raise revenue for council</p>	<p>436</p>	<p>Minor</p>	<p>Possible</p>	<p>Medium</p>	<p>Minor</p>	<p>Possible</p>	<p>Medium</p>	<p>Justification for revenue expenditure including plans with transparent spending of resources.</p>	<p>x</p>	<p>May change community use of water supply and other infrastructure</p>	<p>State government approve rate rise increases</p>	<p>Short Term</p>	<p>Currently being implemented by Tweed. When water shortages are deemed an issue.</p>	<p>Implementation of completed infrastructure management plans for water supply.</p>	<p>Infrastructure</p>	<p>Adjustment to changes in infrastructure due to climate change policies and demand management. Byron needs to check if this is currently implemented as per this potential control</p>	
	<p>Integrated Water Cycle Management Strategy</p> <p>Catchment zoning - LEP zoning</p> <p>Catchment Management Plans</p> <p>Augment Management Plans</p> <p>Asset Management Plans</p> <p>Community awareness</p> <p>BASIX, WSUD</p> <p>User pays/step pricing</p>	<p>Integrated water cycle management including demand management, water sensitive urbane design etc.</p>	<p>Policy</p>	<p>Reduce</p>	<p>Currently there is a process in place to address the issue. May need to take Climate Change further into account.</p>	<p>Large financial benefits on extension of life of dam. Better use of what we have and reductions of capacity for new infrastructure. Improved amenity for urbane design.</p>	<p>440</p>							<p>Policy direction and budget.</p> <p>Standard council process.</p> <p>Community consultation</p>	<p>x</p>	<p>x</p>	<p>More efficient use of existing water supply. Increase community awareness</p>	<p>Seek state support for water policy development. Update existing policy with considerations of climate change.</p>	<p>Short Term</p>	<p>Now</p>	<p>New development change to water yield.</p>	<p>Planning & Development</p>	<p>Need better data on climate impacts associated with rainfall and evaporation patterns.</p>
	<p>Stormwater harvesting management</p> <p>Wastewater reuse</p> <p>Heat stress and health related impacts</p> <p>Change in the location of infrastructure</p> <p>Loss of property amenity and function</p>	<p>Integrated water cycle management including demand management, water sensitive urbane design etc.</p>	<p>Engineering</p>	<p>Mitigate</p>	<p>Currently there is a process in place to address the issue. May need to take climate change further into account.</p>	<p>Large financial benefits on extension of life of dam. Better use of what we have and reductions of capacity for new infrastructure. Improved amenity for urbane design.</p>	<p>331</p>							<p>Cost benefit analysis, policy direction and budget.</p> <p>Standard council process.</p> <p>Community consultation.</p> <p>More targeted regional data on climate change.</p>	<p>x</p>	<p>x</p>	<p>Reduced water supply for other purposes. Increased population Availability of budget Sustainability and greenhouse gas Environmental benefits Better water quality.</p>	<p>Funding support required from the State and Federal government</p>	<p>Medium Term</p>	<p>Now</p>	<p>Completion of policy and funding.</p>	<p>Infrastructure</p>	<p>Effluent reuse scheme is on hold. Main arm of Byron is in operation. Links to sustainability and greenhouse gas.</p>

<p>Decline in the local economy</p> <p>(Increased temperature and wetter summers and dryer winters - extreme event) - Item 3)</p> <p>Risk Rating Current: Medium 2030: Medium 2070: High Residual: Low</p>	<p>Loss of income from tourism</p> <p>Loss agricultural productivity and income</p>	<p>Management Plan for the reduction of economic reliance on tourism e.g. diversification</p>	<p>Policy</p>	<p>Mitigate</p>	<p>Tweed Economic Development Strategy</p> <p>Byron EDS (under development)</p> <p>Regional & Local Economic Development Boards</p> <p>Tourism bodies</p> <p>Research and Business Alliances</p>	<p>Economic security of region</p> <p>Employment, secondary flow on effects to community well being</p>	<p>317</p>	<p>Minor</p>	<p>Possible</p>	<p>Medium</p>	<p>Minor</p>	<p>Possible</p>	<p>Medium</p>	<p>Tweed EDS already identifies economic diversification as a high priority</p> <p>Byron EDS under development</p> <p>Economic feasibility studies</p>						<p>NA</p>	<p>Far North Coast Regional Strategy - leverage to get funding</p> <p>Regional Development Board</p> <p>Australian Government funding on job creation</p>	<p>Medium Term</p>	<p>2009/10</p>	<p>Identified as a priority action in the relevant economic development strategy (has occurred)</p>	<p>Corporate & Community Services</p>	<p>Functional Areas: Economic Development (Unit/Corporation), Tourism Boards, Chamber of Commerce</p> <p>Champion : Economic Development (Unit/Corporation)</p> <p>Budget: Approx \$100 000</p> <p>Incremental change of the economic base over a long timeframe is required to spread the cost equitably</p>	
		<p>Protection of prime agricultural land</p>	<p>Policy / Planning</p>	<p>Prevent</p>	<p>Existing LEP</p>	<p>Retention of income and wealth</p> <p>Employment</p> <p>Food security</p>	<p>460</p>							<p>Augment LEP through exhibition process</p> <p>Interpretation and enforcement of LEP</p>	<p>x</p>	<p>x</p>	<p>x</p>	<p>x</p>	<p>x</p>	<p>Loss of development benefit</p> <p>Reduction of housing availability & affordability</p>	<p>State Planning Department</p> <p>Department of Agriculture</p> <p>Regional Development Board</p>	<p>Medium Term</p>	<p>On going</p>	<p>State Directive or LEP amendment</p>	<p>Planning & Development</p>	<p>Functional Areas: Planning and Development, NRM</p> <p>Champion: Planning & Development</p> <p>Budget: Agricultural Strategy (Tweed - Approx \$30 000)</p> <p>(Byron - already has an Agricultural Strategy but requires updating)</p>	
<p>Heat Stress</p> <p>(Increased Temperature - Item 18)</p> <p>Risk Rating Current: Low 2030: Low 2070: Medium Residual: Low</p>	<p>Heat related stress and injury</p> <p>Death of the vulnerable - elderly and children</p> <p>Loss of motivation</p> <p>Increased conflict amongst people</p>	<p>Heatwave Management Plan</p>	<p>Policy</p>	<p>Reduce</p>	<p>New plan needs to be made</p>	<p>Reduction in work hours lost (healthier workforce)</p>	<p>426</p>	<p>Insignificant</p>	<p>Possible</p>	<p>Low</p>	<p>Insignificant</p>	<p>Possible</p>	<p>Low</p>	<p>Council approval for approach and budget support required</p>						<p>x</p>	<p>Linkages to other heat wave related activity potentially around bushfires</p>	<p>RFS, Health Dept</p>	<p>Short Term</p>	<p>2015</p>	<p>Increase in people presenting at hospitals</p>	<p>Corporate & Community Services</p>	<p>Possibility of lowering risk rating</p> <p>Research with local health community</p> <p>Should apply organisation wide</p> <p>Champion: Community Services</p> <p>Budget: Approx \$10 000</p>
		<p>Education</p>	<p>Engagement</p>	<p>Prevent</p>	<p>Existing community services network,</p> <p>Newsletter (communications group within Council)</p> <p>Localised response groups</p> <p>School education (e.g cross flow ventilation instead of air conditioning)</p>	<p>Less stress on the public health sector and Council services</p>	<p>453</p>							<p>Report to Council - opportunity to apply for a grant</p> <p>Planned and proactive media releases</p>						<p>Behavioural change</p> <p>Engagement on wider environmental and health issues</p> <p>Research alliance in the health area</p>	<p>Assistance from Federal & State environment, health or education funding</p>	<p>Ongoing</p>	<p>Development of the Heatwave Management Plan</p>	<p>Grant funding</p> <p>Exhibition of Heatwave Management Plan</p>	<p>Corporate & Community Services</p>	<p>Functional Area: Community Services, Public Relations and Media, Environment and Health</p> <p>Champion: Community Services</p>	



GHD

10 Bond Street Sydney NSW 2000

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T: 2 9239 7100 F: 2 9239 7199 E: sydmail@ghd.com.au

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