Final KIAMA MUNICIPAL COUNCIL Climate Change Risk Assessment

ASSESSMENT OF CLIMATE CHANGE RISKS TO KIAMA MUNICIPAL COUNCIL

- FINAL
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Department of Climate Change

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Contents

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Executive Summary

This report documents the first stage of the Climate Change Risk Assessment and Adaptation Project, which is being undertaken for Kiama Municipal Council. Kiama, Wollongong and Shellharbour Councils each received a Local Adaptation Pathways Program Grants from the Department of Climate Change (DCC) to undertake the project, which is being administered by the Southern Councils Group (SCG).

The risk assessment focussed on two climate change scenarios, 2050 and 2070 which were chosen in consultation with SCG. The predicted changes in climate variables were determined using the most up to date information on climate change for the Illawarra region, which included the CSIRO, (2007) *Climate Change in Australia* and DECC (2008) *Summary of climate change impacts – Illawarra region*.

The risk assessment framework was designed to identify, assess and evaluate risks across four functional areas of Council; planning and development, corporate and community services, infrastructure and infrastructure services and environment. Uncertainty is an inherent feature of climate change and the risk assessment provides a valuable tool for understanding and managing uncertainty. Decisions about consequence, likelihood and risk rank are driven by perception and the process drew on the opinion and experience of Council staff and key stakeholders through a workshop setting to ensure perceptions of risk were as informed as possible.

A final register of all risks was prepared following the workshop. Risks ranked as 'high' or 'extreme' are selected as those which need addressing by Council. Adaptation options for these risks will be investigated in the second stage of the project, to formulate an Adaptation Action Plan.

Key findings

Table 1a and 1b summarises the extreme and high risks for Kiama Municipal Council with respect to planning and development. Extreme and high risks for are shown in **Table 2a and 2b** for environment, corporate and community services (**Table 3a and 3b**) and infrastructure (**Table 4a and 4b**). Extreme risks are unacceptably high and action should be taken to address these as a matter of priority. High risks are less urgent, but action is still required to reduce the risk to as low as possible.

EXTREME RISKS	2050	2070
Decreased tourism due to loss of beaches and Holiday Parks	✓	✓
Increased water demand for farming practices	✓	✓
Pasture growth impacts	✓	✓
Loss and Damage of crops/livestock through extreme events.	✓	✓
Species suitability eg Increase in heat stress for livestock, crop type etc	✓	✓
Limited urban expansion, limits economic development and access to jobs	✓	✓
Building design - impacts including building design, materials, stormwater, ossm, water and energy supply (resilience)	✓	✓
Future location and present viability of Council assets from impacts of sea level rise, bushfire and flood risk	✓	✓
Increased power failures (new and existing developments due to inadequate substation capacity)	✓	✓
Threatened Water Supply for urban expansion	✓	✓
Increased competition for land to retain the water ie. New dams	✓	✓
Increased reliance on offsite water (water capture and re-use on farms)	✓	✓
Changes in building heights due to sea level rise and inundation	✓	✓
Extreme Weather (fires), Rainfall/flood - need to redesign or replace key assets	✓	✓
Subdivision location may be restricted due to increased risk of flooding/bush fire/sea level rise		✓
Loss of revenue from cancellation of events, and inability to use Council assets and buildings.		✓
Business closure and job loss due to business interruption from blackouts, storm damage, sea level inundation and flooding		✓

- **Table 1a Extreme risks to planning and development, 2050 and 2070 scenario**

HIGH RISKS	2050	2070
Inability to increase land for urban and industrial subdivision expansion (see Land Use Planning)	✓	✓
Loss of land through erosion, salinity, inundation, flooding and bushfire	✓	
Increased runoff and sedimentation into watercourses	✓	
Subdivision location may be restricted due to increased risk of flooding/bush fire/sea level rise	✓	
Change in land use (urban/rural/industrial)	✓	✓
Increase in bushfires, sea level rise and floods, limits locations for planned infrastructure services	✓	✓
Changing demands on energy use - fire rating, water capture/reuse, energy efficiency, subdivision layout	✓	✓
Acquisition of lands and provision of capital funding for Council asset replacement due to threat from sea level rise, flooding, bushfire		✓
Loss of productive agricultural lands due to pressure of urban expansion.		✓

- **Table 1b High risks to planning and development, 2050 and 2070 scenario**

EXTREME RISKS	2050	2070
Increased Fire Risk for vegetation	✓	✓
Habitat loss due to drying of swamps and wetlands	✓	✓
Saline intrusion of aquifers	✓	✓
Loss of Habitat –due to sea level rise and flood events impacting on salt marsh and mangrove migration Impacts on EECs Fishing, Oyster Leases	✓	✓
Increased soil salinity due to sea level rise	✓	✓
Onsite sewer management systems overflow and systems failure due to inundation, and high rainfall.	✓	✓
Increased green waste from hazard reduction clearing due to bushfire risk	✓	✓
Increased coastal erosion of beaches and foreshores and inundation		✓
Inundation of acid sulphate soils and impact on estuaries and rivers		✓

- **Table 2a Extreme risks to environment, 2050 and 2070 scenario**

HIGH RISKS	2050	2070
Increase in number of weeds	✓	✓
Increase stagnation of water bodies leading to increase in algal blooms,	✓	✓
High rainfall events leading to pollution and fish kills	✓	✓
Increased coastal erosion of beaches and foreshores and inundation	✓	
Leaching and inundation of contaminated sites	✓	✓
Biodiversity impacts-Increased disease outbreaks in fauna and flora and changes in species and extinctions.		✓

- **Table 2b High risks to environment, 2050 and 2070 scenario**

EXTREME RISKS	2050	2070
Increased potential for injury, death, damage, or delays resulting from falling trees. Loss of amenity from tree loss.	✓	✓
Increased potential for mental stress, associated with events such as flash flooding, sea level inundation, heat stress, bushfires	✓	✓
Respiratory illness due to bushfire related poor air quality	✓	✓
Increase in cost of insurance premiums, availability and potential liability claims	✓	✓
Increased risk of natural disasters increased pressure on emergency services and social services, including financial and provision of services and resources.	✓	✓
Sea level rise puts the entire tourism industry at risk - elimination of all beaches.	✓	✓
Extreme heat results in loss of power to traffic control systems.	✓	✓
Increased violence/anti-social behaviour and conflict leading to increased public nuisance and hospital admissions.		✓

- **Table 3a Extreme risks to corporate and community services, 2050 and 2070 scenario**

HIGH RISKS	2050	2070
Reduced public amenity and health risks in waterways due to insufficient environmental flows or flooding	✓	✓
Increase in temperatures/rainfall and inundation - increase in disease vectors eg. Mosquito bred diseases.	✓	✓
The elderly at more risk of death or illness related to temperature spikes.	✓	✓
Increased violence/anti-social behaviour and conflict leading to increased public nuisance and hospital admissions.	✓	
Increase in the number of people requiring health care services, therefore increase in staff requirements and costs and reduction in our resources.	✓	✓
Increase in power failures leading to loss of refrigeration and causing food borne disease	✓	✓
Increased stress on volunteer base for SES & RFS requiring increase in voluntary resources to assist	✓	✓
Increased risk of heat stress at public events (eg. Kiama show),	✓	✓
Loss of roads and impacts on bus and private transport, due to lack of alternatives available in flood, bushfire events. Includes emergency access routes.	✓	✓
Communication breakdown- phone, fax, email, mobile phone	✓	✓
Declining public health or injury due to inability to access sporting fields and recreation areas due to restricted or suspended usage from drought, sea level rise or flooding impacts		✓
Heat stress related illness amongst outdoor staff		✓

- **Table 3b High risks to corporate and community services, 2050 and 2070 scenario**

EXTREME RISKS	2050	2070
Increased rainfall, intensity affects capacity, life of stormwater assets, and increases operational, maintenance costs.	✓	✓
Inundation of STPs and pumping stations, overload, and reduction in system capacity leading to increased maintenance costs, upgrade costs, decreased asset life	✓	✓
Supply Demand Balance -continued pressure on urban water supply security and quality	✓	✓
Increased damage to pavement, pot holing, seal deterioration, scouring table drains/shoulders	✓	
Increased capital expenditure maintenance and reparation costs for damaged, replacement of buildings, general clean up etc	✓	✓
Increased maintenance, refurbishment and replacement of marine structures, rockpools and bridges due to higher water levels and increased flood return	✓	✓
Sea level rise may result in submerged stormwater outlets. Increased capital cost for upgrade of stormwater system.		✓

- **Table 4a Extreme risks to infrastructure and infrastructure services, 2050 and 2070 scenario**

HIGH RISKS	2050	2070
Increased damage to pavement, pot holing, seal deterioration, scouring table drains/shoulders		✓
Sea level rise may result in submerged stormwater outlets. Increased capital cost for upgrade of stormwater system.	✓	
Changes in climate variables - inability to irrigate recreational areas and /or parks, inundation issues from flood and overall field surface maintenance.	✓	✓
Hotter weather causing increased energy demand from system at capacity leading to blackouts, line sparking.	✓	✓

- **Table 4b Extreme risks to infrastructure and infrastructure services, 2050 and 2070 scenario**

Extreme risks

Planning and Development

Kiama Local Government area has a substantial agricultural economy comprising pasture and a wide variety of crops. Potential changes in the climate through warmer temperatures and variable rainfall will impact the agricultural economy and current practices. This may also lead to an increase in food prices due to competition for agricultural land. The Illawarra Strategy is focused on encouraging economic development in the area and expects an increase in population of up to 50,000 people. The potential increase of flood risk and sea level rise will cause increased competition for developable land and locating infrastructure.

Environment

The Illawarra region is known for areas of outstanding natural beauty including forested escarpments, the Minnamurra rainforest and expansive wetlands on the low lying floodplain. Impacts of sea level rise in the region can cause substantial habitat loss through saltwater intrusion leading to a change in biodiversity, particularly through the extinction of existing species.

An increase in temperature by 2050 and 2070 poses a heightened risk of bushfires in the region, which will also impact the ability of species to recover.

Corporate and Community Services

An increase in natural disasters including bush fires and floods will put considerable pressure on emergency services. This will increase the demand on volunteers in organisations such as the SES and RFS. With an increase in bush fires, flooding and sea level rise there is likely to be an increase in insurance premiums. Residents may also find insurance companies refuse to insure properties which are at high coastal or inland flood risk. An increased number of hot days will put pressure on power supplies which are critical to emergency services for disaster management.

Infrastructure and Infrastructure Services

Increased rainfall intensity threatens the capacity of stormwater assets including detention basins, pipes and channels. The existing controls include design standards which are effective in managing current assets, however there will be a need to update these to manage increased rainfall intensities in the future. Increased rainfall intensities also increase the risk of pavement damage, pot holing and scour which are currently controlled using asset management plans.

Potential inundation of Sewage Treatment Plants would lead to increased maintenance costs and upgrade costs.

High risks

Planning and Development

Changing demands on energy use due to climate change impacts will require revisions to be made in the way urban developments are planned, including energy efficiency, water capture/re-use and subdivision layout.

Areas which are increasingly at risk from bushfires and/or flooding reduce the availability of land for development. This may impact on the planned infrastructure to support growth areas from existing development. Changes in rainfall intensities may also result in more land being required for water capture, for example for new dams or detention ponds.

Environment

Warmer temperatures and changes in flow regimes of rivers will create conditions conducive to increased weed infestation on public and private lands and in waterways. This will also threaten the stability of flora and fauna species.

Community and Corporate Services

An increase in temperature will increase the likelihood of airborne disease being spread by mosquitoes. Increased temperatures will cause an increase in heat related illnesses which is a particular risk for the elderly residents in the community. There will be flow on impacts in increased costs for health service provision and a need to recruit more health professionals to cope with rising demand.

More frequent and severe inundation of surrounding land may cause on-site sewerage systems to become overloaded leading to increased contamination of water supplies which in turn could have adverse impacts on public health.

Kiama has a high level of tourist activity with many visitors to the region over the summer months. The annual Kiama show held in January each year experienced temperatures of over 40 celcius in 2009. More frequent hot days puts the public attending these events at greater risk of experiencing heat related illnesses.

The rail and road services connecting Kiama to the south and north are a key commuting route and link the Local Government Area to the cities of Wollongong and Sydney. Any loss of use of these transport services would cause considerable disruption for the local community relying on them to commute to work, school and emergency situations.

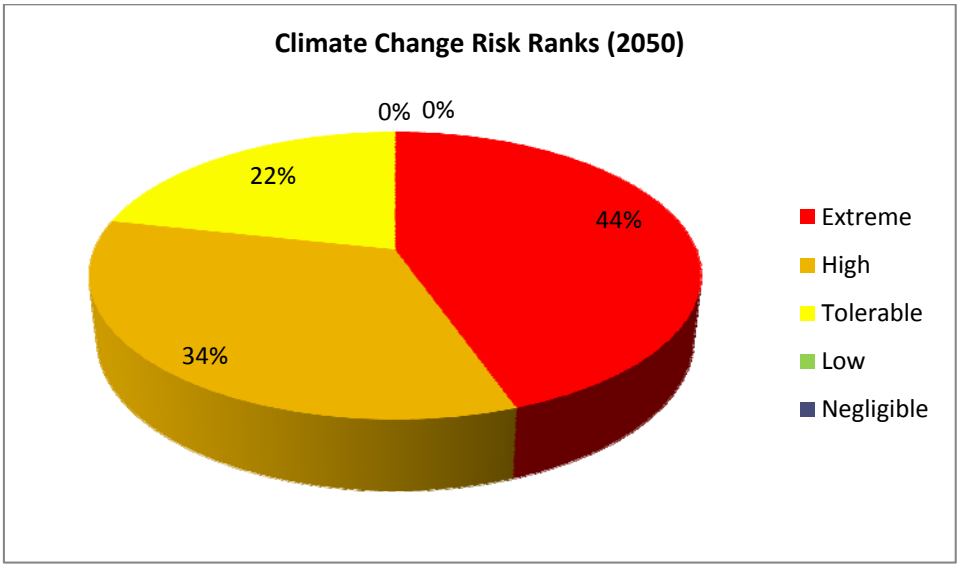
Infrastructure and Infrastructure Services

A threat to water supply security has impacts on the availability of water for irrigation. This poses risks to parks and reserves as well as sporting grounds used for recreational activities. Higher temperatures are likely to increase contaminants found in the water supply requiring treatment.

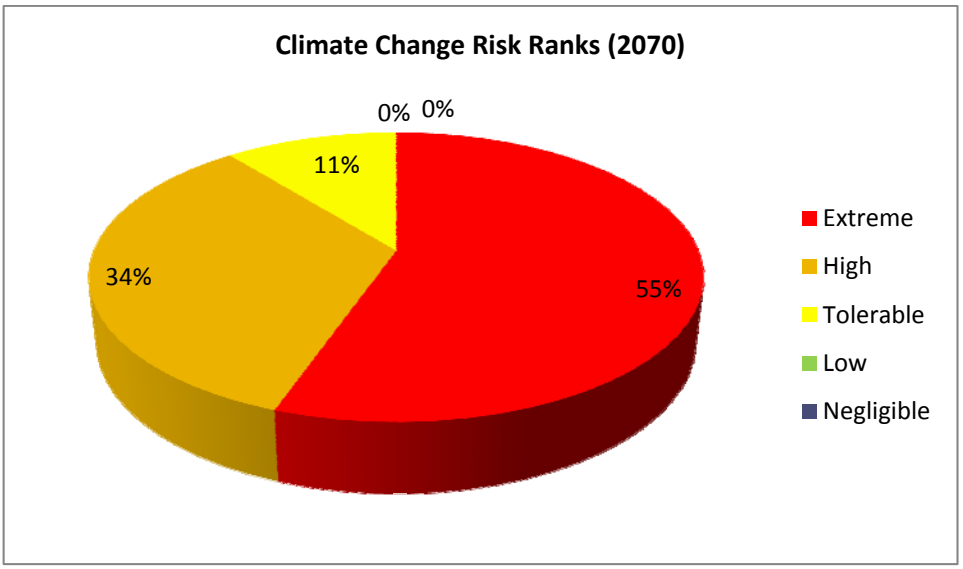
Water treatment plants are highly effective in managing contaminants but if the concentrations of contaminants increase as a result of climate change greater treatment will be required at an additional cost.

Distribution of climate change risks

The risk assessment process identified and analysed 74 risks to Kiama Municipal Council planning and development, corporate and community services, infrastructure and environment. Of the total identified, 22% of climate change risks in 2050 and 11% of risks in 2070 were considered as low, moderate or tolerable to Kiama Municipal Council after current control measures are taken into account. Thus, the majority of risks to Kiama Council (approximately 80-90%) are classified as extreme or high. There is some shift in risk ranking between the 2050 and 2070, however, based on the assumption that some control measures would be developed in that timeframe to mitigate impacts. In the majority of cases, risk ranking remained the same or increased due to the uncertainty of climate change and any adaptive measures which may/may not be available in the elapsed period.



- **Figure 2 Distribution of climate change risks in 2050**



- **Figure 3 Distribution of climate change risks in 2070**

Summary

Throughout the assessment common themes were identified across the functional areas of Council which would be at risk from climate change For example, the issue of budget allocations and funding to address some of the impacts identified was a common theme. The combined effects of increased temperatures, occurrence of extreme weather events and sea level rise present considerable risks to the natural and built environment and to human health and safety. While cumulative impacts of climate change possibly represent the extremes in climate change risk they nonetheless present challenges beyond those of the individual risks associated with a change in individual climate variables and will require a coordinated response across the Illawarra region.

1. The project

1.1. Objective

The objective of this project is to identify and assess the key risks that climate change poses to the achievement of local government objectives in the municipality of Kiama Council, and identify appropriate risk management and adaptation strategies. The project is being administered by the Southern Councils Group (which in this project context includes only Kiama, Wollongong and Shellharbour Councils). The project is being undertaken in two phases.

1) Risk Assessment – this phase involved risk assessment workshops with key Council staff and contractors with responsibility for planning and development, corporate and community services, infrastructure and environment.
2) Adaptation Strategy – this phase will involve developing strategies for addressing extreme and high level risks identified through the risk assessment.

The project is examining the impacts of climate change on key functional areas of Council, including planning and development, corporate and community services, infrastructure and infrastructure services and environment within the Council region. In undertaking this task, the impact of climate change on a number of assets have been identified.

This report provides the outcomes of the first phase of the project.

1.2. Method

The risk assessment was carried out in accordance with the Australian Greenhouse Office[1] (2006), *Climate Change Impacts and Risk Management: A Guide for Business and Government*. **Figure 4** illustrates the stages which have been completed to date and where they are documented within this report.

- **Figure 4 Steps in project methodology**

[1] The AGO no longer exists as a Government body and all functions for administering the LAPP program now reside with the Department of Climate Change

2. Risk Context Establishment

2.1. Organisational Objectives

Kiama Municipal Council has the following objectives which have been considered in the development of the risk assessment framework:

- Encourage economic growth supported by adequate provision of infrastructure and services
- Protect and promote a sustainable environment
- Strengthen the position of urban centres to attract new development
- Protect the cultural, European and aboriginal heritage of the local area
- Promote community wellbeing and cohesion
- Provide good governance and sound financial management

2.2. Stakeholders

A number of Stakeholders were identified within Council (internal) and outside Council (external), including Government departments, emergency services, NSW Police etc. Details of Stakeholders and consultation are provided in **Chapter 8**.

2.3. Risk Assessment Criteria

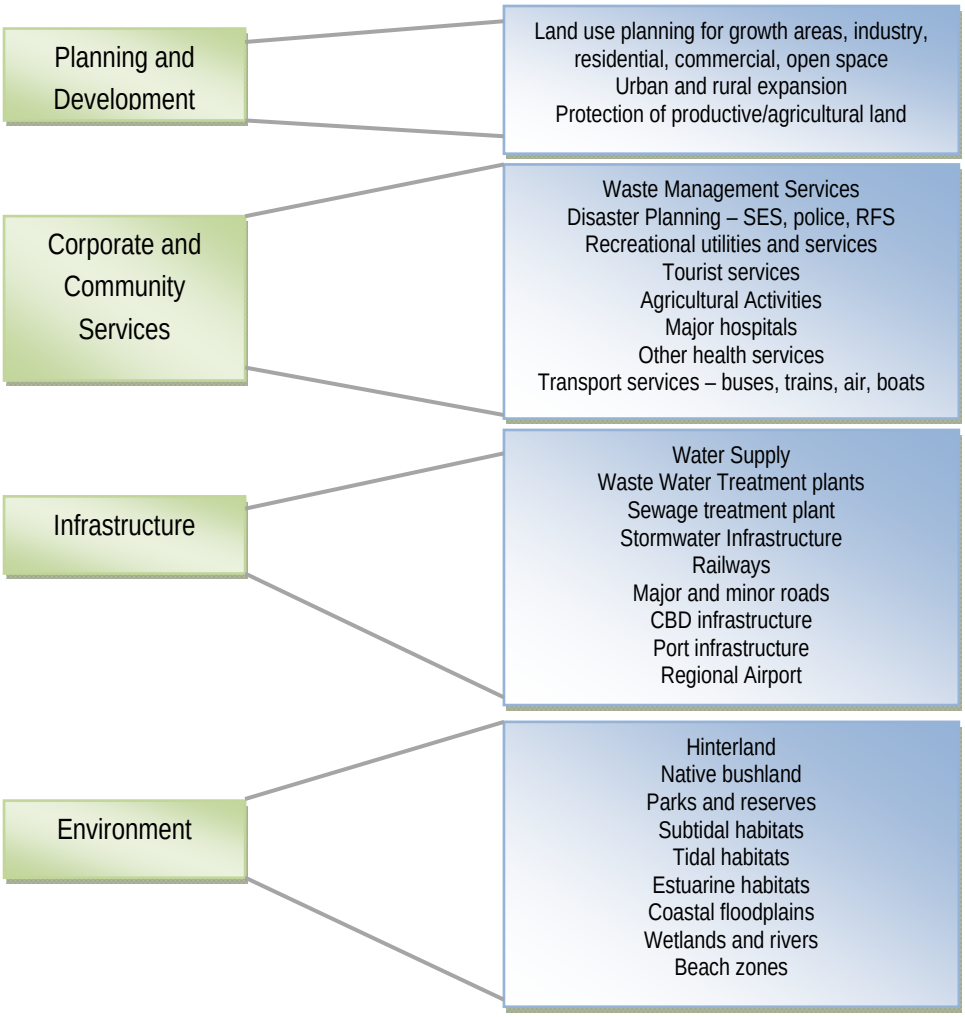
In order to understand the consequence of a risk posed by climate change a number of success criteria were identified. Success criteria are a summary of the Council's long term objectives and define what the community most desires to be protected from climate change. Six success criteria have been chosen for this project;

1) Public Safety
2) Asset Damage
3) Environment and Sustainability
4) Local Economy and Growth
5) Health, Community and Lifestyle
6) Public Administration.

The success criteria have been established in line with the Guidelines provided in Climate *Change Impacts and Risk Management – A Guide for Business and Government* and modified to meet the needs of Kiama Municipal Council. For details see **Attachment 3**.

2.4. Key Elements

The risk assessment framework was structured around the four key Council functional areas (**Figure 5**). A number of assets were identified using GIS data and information provided by Councils. These assets were mapped across the LGA and used as a visual aid during the risk assessment workshops.



- **Figure 5 Council Functional areas**

2.5. Climate Change Scenarios

The project is considering changes in climate from its current state (**Attachment 1: Historical Climate**) to 2050 and 2070 based on the climate scenarios provided in **Attachment 2: Climate change scenarios**.

The scenario assumes high-global warming to 2050, which is consistent with current emissions trends. The selection of two scenarios was made in consultation with the Southern Councils Group, based on advice from Department of Climate Change (DCC) that scenarios which are at least 25 years in advance should be considered and scenarios which provide a long term adaptation plan for Kiama Council.

3. Risk – Identification, Analysis and Evaluation

The three steps of the risk assessment process were carried out on consecutively by Council staff and external stakeholders. Workshop delegates we asked to form small groups and to focus on one key functional area. Each group was provided with a worksheet to complete the risk identification, analysis and evaluation.

3.1. Risk Identification

A list of risks was developed by each working group using the climate information provided and the asset maps produced for the workshop. Delegates were also invited to annotate the maps to include areas or assets which may be at risk.

3.2. Risk Analysis

Prior to the workshop, delegates received briefing notes detailing the consequence and likelihood scales to be used to analyse each identified risk. The scales were developed for the sole purpose of this project and are applicable to a Local Government setting. The scales adopted are included in Attachment 3: SCG Risk Analysis Criteria.

These scales are defined by the Council and are not necessarily transferrable to another jurisdiction as the risk context for each council or jurisdiction will differ.

3.3. Risk Evaluation

The likelihood and consequence rating are combined to determine a rank for each risk. This enables a priority to be assigned to each risk. The priority levels area Extreme, High, Tolerable, Low or Negligible.

3.4. Uncertainties

Uncertainty is an inherent feature of climate change. Our climate is shifting into a state that we have no experience of, and therefore limited reference points from which to make judgements and decisions. Risk assessment is a valuable tool for understanding and managing uncertainty. Although it is possible to identify the hazards with a reasonable degree of certainty, the immediate and consequential impacts and the likelihood that they will occur are uncertain. This is particularly true of impacts on natural systems, which are less well understood than man-made infrastructure or systems.

Decisions about consequence, likelihood and risk are inherently driven by perception. The risk assessment process drew on the opinion of experienced professionals in relevant fields so that the perceptions of risk were as informed as possible. The absence of quantitative analysis should

not be confused with a lack of rigour. When managing uncertainty, it is better to be approximately right that precisely wrong.

The impacts of climate change will be increased or reduced over time by other contextual factors such as population and demographic changes, social and behavioural change, capacity for adaptation and future availability of insurance.

The outcomes of both the internal and external workshop were combined and a register of risks is provided in the chapters which follow.

4. Register of risks to planning and development

Key Element	Impact	Assumptions (Target sites if applicable)	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Economic Development -Council	Loss of revenue from cancellation of events, and inability to use Council assets and buildings.	Filming, Kiama Show and Markets, Hall and Public Reserve Hire	Govt funding to run programs and events.	5%-33%	Econ	Min	L	Tolerable	Mod	AC	Extreme
	Decreased tourism due to loss of beaches and Holiday Parks		Tourism levy	5%-33%	Econ	Maj	L	Extreme	Cat	AC	Extreme
	Inability to increase land for urban and industrial subdivision expansion (see Land Use Planning)		LEP, DCP, Bushfire Hazard mapping, Flood hazard mapping but not Council wide	66%-95%	Econ	Mod	L	High	Mod	L	High
	Acquisition of lands and provision of capital funding for Council asset replacement due to threat from sea level rise, flooding, bushfire	Legal implications for Councils not clear	Council's 10 year financial plan.	0	Econ	Min	L	Tolerable	Mod	L	High
Economic Development - Agriculture dairy, beef and wine industries	Increased water demand for farming practices	Jerrara and Fountaindale Dams, Minnamurra River. Aquifers	DWE guidelines, CMA. Dairy farm effluent reuse-Gerringong Gerroa Sewerage Scheme. Reuse	33%	Econ/Env	Maj	L	Extreme	Maj	L	Extreme

Key Element	Impact	Assumptions (Target sites if applicable)	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
			study for dairy farms –Jamberoo Valley								
	Pasture growth impacts		DPI guidelines		Econ/Env	Mod	AC	Extreme	Mod	AC	Extreme
	Loss and Damage of crops/livestock through extreme events.		Private insurance	Depend on individuals	Econ	Maj	L	Extreme	Cat	L	Extreme
	Loss of land through erosion, salinity, inundation, flooding and bushfire		Bushfire hazard mapping, some flood mapping. DPI, DWE and DECC guidelines. CMA, CVA works,bushcare. Groundwater availability and vulnerability mapping	50%	Econ/Env	Mod	L	High	Maj	AC	Extreme
	Species suitability eg Increase in heat stress for livestock, crop type etc		DPI, CSIROEducation/ Awareness Programs	33% - 66%	Env	Maj	AC	Extreme	Maj	AC	Extreme
Economic Development -Business	Limited urban expansion, limits economic development and access to jobs	Jobs/access to services	LEPs, DCPs, BASIX, BCA, Australian Standards (Coastal and Floodplain Management	33% - 66%	Econ	Maj	L	Extreme	Maj	L	Extreme

Key Element	Impact	Assumptions (Target sites if applicable)	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
			Plans), SEPPs, RFS modelling								
Economic Development -Business	Business closure and job loss due to business interruption from blackouts, storm damage, sea level inundation and flooding		LEP, DCP, LEMC, Displans, Bushfire Hazard mapping, limited Flood Risk mapping. SES flood plan. Integral. Sydney Water	33% - 66%	Econ/Social	Mod	P	Tolerable	Maj	L	Extreme
Land Use Planning -Building Design	Building Design- Future liability and reputation damage due to construction of dwellings unsuitable for projected climate change impacts including building design, materials, stormwater, ossm, water and energy supply (resilience)	Across LGA	LEP, DCP, Building Codes of Australia and Australian Standards, SES Shellharbour City and Kiama Local Flood Plan (draft 2008) 2007 Sea Level impact study Kiama Surf Club catchment area 0.4m SL rise. 1999 GHD Flood study report Gerringong Gerroa Sewerage Scheme.	33% - 66%	PoI	Maj	L	Extreme	Maj	L	Extreme

Key Element	Impact	Assumptions (Target sites if applicable)	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
			GIS mapping layer for Bushfire zones.								
Land Use Planning -Sediment Control	Increased runoff and sedimention into watercourses	Minnamurra River estuary	Completed WSUD, DCP Estuary Management Plans. Community education. Enviropods. Stormwater management plans. DECC grants	33% - 66%	Env	Mod	L	High	Maj	AC	Extreme
Land use Planning -Council Asset location	Future location and present viability of Council assets from impacts of sea level rise, bushfire and flood risk	Across LGA Eg Kiama Harbour, Holiday Parks,	LEP,DCP, Asset Management Plans. Asset mapping. Bushfire hazard mapping, Limited flood mapping. Budget	5%-33%	Econ/Assets	Maj	L	Extreme	Cat	AC	Extreme
Land use Planning -Utility dependency	Increased power failures (new and existing developments due to inadequate substation capacity)	Holiday Parks, Blue Haven, Council admin, and works and waste depots, libraries etc	DCP, Sydney Water, Integral risk management plans?	5% - 33%	Assets	Maj	L	Extreme	Maj	L	Extreme

Key Element	Impact	Assumptions (Target sites if applicable)	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Land use Planning	Subdivision location may be restricted due to increased risk of flooding/bush fire/sea level rise		Regional Strategies (DCP) NSW RFS modelling and planning for Bushfire protection SES Shellharbour/Kiama Local Flood Plan	33% - 66%	PoI	Maj	P	High	Maj	L	Extreme
Land use Planning	Change in land use (urban/rural/industrial)		Floodplain manuals (PMF and Climate Change) Bushfire hazard mapping	66% - 95%	PoI	Mod	L	High	Mod	L	High
Land use Planning -Water Supply	Threatened Water Supply for urban expansion	2070 scenario	LEP, Sydney Water Plans?	5% - 33%	Assets	Maj	L	Extreme	Maj	L	Extreme
Land use Planning -Agriculture	Loss of productive agricultural lands due to pressure of urban expansion.	Jamberoo Valley, Gerringong,	LEP, DCP, Planning studies. Budget	66%	Social/Env Econ	Mod	P	Tolerable	Ma	L	High
Land use Planning -Water supply	Increased competition for land to retain the water ie. New dams Increased reliance on offsite water (water capture and re-use on farms)	No new dams ie. Nowhere to put them, Uncertainty over variability of rain and access to water Dam size (State),	Water restrictions from time to time, LEPs - catchment area protections, SEPPs - catchment area protection DEW guidelines.	5% - 33%	All	Maj	AC	Extreme	Maj	AC	Extreme
Land use Planning	Increase in bushfires, sea level rise and		Bushfire hazard mapping, Limited	50%	PoI	Mod	L	High	Mod	L	High

Key Element	Impact	Assumptions (Target sites if applicable)	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
	floods, limits locations for planned infrastructure services		flood risk mapping. Utility Service Strategy								
Urban Development	Changes in building heights due to sea level rise and inundation	Flooding events	Australian Standards	5% - 33%	PoI	Mod	AC	Extreme	Mod	AC	Extreme
Urban Development	Extreme Weather (fires), Rainfall/flood - need to redesign or replace key assets	Across LGA	Budgets, Servicing Plans, LEPs, RFS modelling	33% - 66%	Assets	Maj	L	Extreme	Maj	L	Extreme
Urban Development	Changing demands on energy use - fire rating, water capture/reuse, energy efficiency, subdivision layout		LEPs, DCPs, BASIX, BCA, AUS Standards, RFS modelling, Insurance, Coastal MPS, Floodplain MPS, Design Best Practice, Budgets	5% - 33%	All	Maj	P	High	Maj	P	High

5. Register of risks to environment

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Environment and Natural Resources	Increased Fire Risk for vegetation		Bushfire hazard mapping	33%-66%	Env	Cat	L	Extreme	Cat	L	Extreme
Environment and Natural Resources	Increased number and species of pests	Public and private lands	Rural protection board. Funding and support from council - mapping. State government budget . Landcare groups	33%-66%	Env	Mod	P	Tolerable	Mod	P	Tolerable
Environment and Natural Resources	Habitat loss due to drying of swamps and wetlands	Minnamurra River, Crooked River, Jamberoo Valley	Habitat mapping. Development Control, LEP and State Government Budget DEW extraction guidelines	66% - 95%	Env	Cat	AC	Extreme	Cat	AC	Extreme
Environment and Natural Resources	Increase in number of weeds	Public and private lands	Land care groups support. Council funds - education and control, Budget	66% - 95%	Env	Mod	L	High	Mod	L	High
Environment and Natural Resources	Increase stagnation of water bodies leading to increase in algal blooms,	Jerrara and Fountaindale Dams, estuaries etc	Sydney Water, Council education and water sampling, DECC, DOH, Streamwatch, CARS	33% -66%	Env/Safety	Mod	P	High	Mod	L	High
Environment and Natural Resources	High rainfall events leading to pollution and fish kills	Rivers estuaries, beaches	DECC, DPI, Fisheries, Council sampling, Contaminated sites register, POEO act,	70%	Safety/Env	Mod	P	High	Mod	P	High

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
			Enviropods, Stormwater management plans etc								
Environment and Natural Resources	Increased coastal erosion of beaches and foreshores and inundation	Rivers estuaries, beaches	LEP, DCP, Council development control. Landcare groups	5%-33%	Env	Maj	L	High	Cat	L	Extreme
Environment and Natural Resources	Saline intrusion of aquifers	Coastal sand and alluvial aquifers at Minnamurra etc	Council development control , DWE guidelines. DECC groundwater mapping	33%	Env	Maj	L	Extreme	Cat	L	Extreme
Environment and Natural Resources	Loss of Habitat –due to sea level rise and flood events impacting on salt marsh and mangrove migration Impacts on EECs Fishing, Oyster Leases	Minnamurra Estuary, Crooked River Estuary, Werri Lagoon	LEP, DCP, Minnamurra Estuary Management Plan. Mapping (as constraints), State Legislation Protection	5% - 33%	Env	Maj	L	Extreme	Maj	L	Extreme
Environment and Natural Resources	Increased soil salinity due to sea level rise		DECC protocols?	5% - 33%	Env	Maj	L	Extreme	Maj	L	Extreme
Environment and Natural Resources	Inundation of acid sulphate soils and impact on estuaries and rivers		Acid Sulphate mapping, LEP, DCP	33%	Env	Mod	P	Tolerable	Maj	L	Extreme

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Environment and Natural Resources	Leaching and inundation of contaminated sites	Works Depot, Gerroa and Minnamurra Tips	LEP,DCP DECC Contaminated Site Register	66%-80%	Safety/Env	Mod	L	High	Mod	L	High
Environment and Natural Resources	Onsite sewer management systems overflow and systems failure due to inundation, and high rainfall.	Rural Non sewered areas	Local Government Act approvals. OSSMs policy and register.Has category regime. Streamwatch sampling, Council Water Monitoring. POEO.	33%-66%	Safety/Env	Maj	L	Extreme	Maj	AC	Extreme
Environment and Natural Resources	Increased green waste from hazard reduction clearing due to bushfire risk		Bushfire hazard mapping. Burning Off Policy. Council Management Plan. RFS Policy.Budget	70%	Safety/Env	Mod	AC	Extreme	Mod	AC	Extreme
Environment and Natural Resources	Biodiversity impacts- Increased disease outbreaks in fauna and flora and changes in species and extinctions.		Vegetation Mapping, State Government, Council Biodiversity Strategy. Mills report. DA information ECC, CMA, DPI newsletters, CSIRO and UOW research	5%-33%	Env	Mod	P	Tolerable	Mod	L	High

6. Register of risks to community and corporate services

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Community Health	Increased potential for injury, death, damage, or delays resulting from falling trees. Loss of amenity from tree loss.	Council and private property.	Strategic Asset Management Policy, CARS, KMC Tree Preservation. KMC tree guidelines. Council Landscape plans	5%-33%	Safety/ Env	AC	C	Extreme	C	AC	Extreme
Community Health	Increased potential for mental stress, associated with events such as flash flooding, sea level inundation, heat stress, bushfires		SESIAHS and Division of General Practice- not known	Not Known	Safety/Social	Maj	AC	Extreme	Maj	AC	Extreme
Community Health	Increased temperature and usage leading to declining quality of water, leading to public health issues in Council owned pools.	Pools at caravan parks, Leisure Centre	CARS, Monthly water monitoring by EHOs. Twice daily water balance monitoring by parks/pool staff	66%-80%	Safety	Min	P	Tolerable	Min	P	Tolerable
Community Health	Declining public health or injury due to inability to access sporting fields and recreation areas due to restricted or suspended usage from drought, sea level rise or flooding impacts	All recreational facilities	Community Land Management Plans, Kiama Sports Council. CARS. Budget	90%	Safety/Social	Min	L	Tolerable	Min	AC	High
Community -Public Amenity	Loss of public amenity due to decreasing quality of public		Reuse schemes. Shade audits.	66%-95%	Social	Min	L	Tolerable	Min	L	Tolerable

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
	recreational facilities such as garden, playgrounds etc		Management Plan. Budget								
Community Health	Reduced public amenity and health risks in waterways due to insufficient environmental flows or flooding	Minnamurra River, Crooked River, Werri Lagoon	DWE extraction guidelines. Beachwatch and Streamwatch monitoring. Estuary management plans.	33%	Social/Env Eco	Mod	L	High	Mod	L	High
Community Health	Respiratory illness due to bushfire related poor air quality		KMC Burning Off Policy. DECC Health Alert Line. NSW DOH – not known.	5%-33%	Safety/Social	Maj	L	Extreme	Maj	L	Extreme
Staff health	Heat stress related illness amongst outdoor staff		Human Resources. OH & S policy and training	70%	Safety	Min	L	Tolerable	Mod	L	High
Community Health	Increase in temperatures/rainfall and inundation - increase in disease vectors eg. Mosquito bred diseases.	Low lying areas. Estuarine and dams	NSW Health Education programs and alerts. Mapping of regional Ross River Fever mosquito breeding grounds.	50%	Assets	Maj	P	High	Maj	P	High
Community Health	The elderly at more risk of death or illness related to temperature spikes.	Blue Haven nursing home and retirement village, Community Centres,etc Community transport	Air conditioning of some Council buildings.	5% - 33%	Safety	Mod	L	High	Mod	L	High

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Community Health/Crime	Increased violence/anti-social behaviour and conflict leading to increased public nuisance and hospital admissions.	Lack of permanent police presence in Kiama. Water restrictions and theft.	Commercial Centre Management Committee. Alcohol and Liquor accord. Alcohol free zones. Sydney Water restrictions and policing. BASIX. Community education	60%	Safety/Social	Mod	L	High	Mod	Ac	Extreme
Community Health	Increase in the number of people requiring health care services, therefore increase in staff requirements and costs and reduction in our resources.	GP to patient ratio already overstressed. Kiama Hospital is a rehab and aged care facility.	SESIAHS and Division of GPs – not known	Not known	Safety/Social	Mod	L	High	Mod	L	High
Community Health	Increase in power failures leading to loss of refrigeration and causing food borne disease	Council and commercial facilities.	CARS. NSW Food Authority Guidelines. EHO inspections are 3 visits pa, high risk premises up to 6 visits pa. Budget	50%	Safety	Mod	L	High	Mod	L	High
Corporate -Risk	Increase in cost of insurance premiums, availability and potential liability claims	All Council operations	Insurance policies. Risk assessments. SAMP	66% - 95%	PoI	Maj	AC	Extreme	Maj	AC	Extreme
Disaster Management	Increased risk of natural disasters increased pressure on emergency services and social services, including	All LGA	Council supports local SES with supply of building and vehicles and admin support-	33%-66%	PoI	Cat	L	Extreme	Cat	L	Extreme

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
	financial and provision of services and resources.		Council has input into their planning and operations. State and Federal funding. DISplans. LEMC								
Disaster Management	Increased stress on volunteer base for SES & RFS requiring increase in voluntary resources to assist	Kiama Council has I SES and 3? RFS volunteers on staff. Kiama SES Unit has 50 active volunteers (10 of which are Police, Ambos, NSW Fire Brigade etc)	Council budget, council policy (HR - eg. Staff volunteers). SES and RFS recruitment.	5%-33%	Pol	Mod	L	High	Mod	L	High
Disaster Management	Increased collaboration amongst all emergency services.		LEMC meetings	66%-95%	Pol	Min	L	Tolerable	Min	L	Tolerable
Recreation Services	Increased expenditure due to the increase in visitation eg. Cleaning, waste, energy , water costs and usage	Tourist and Council facilities	Budget allocations and Management plan	33% - 66%	Econ	Min	P	Tolerable	Min	P	Tolerable
Recreation Services	Sea level rise puts the entire tourism industry at risk - elimination of all beaches.	Kendalls, Werri and Seven Mile Beaches Holiday Parks	None	0	Econ/Env Social/Assets	Maj	Ac	Extreme	Cat	Ac	Extreme
Recreation Services	Increased pressure on Tourist facilities/accommodation		DCP, LEP, SGC	66% - 95%	Assets	Mod	P	Tolerable	Mod	P	Tolerable

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Recreation Services	Increased risk of heat stress at public events (eg. Kiama show),		Shade audits undertaken. CARS. Budget	66%	Social/Safety	Mod	L	High	Mod	L	High
Transport services	Flooding and inundation of railway lines, power loss, and heat stress causing delays or stoppages in services and level crossing	South Coast/ Illawarra Line. Gerringong and Minnamurra level crossings.	RailCorp. Integral	Not known	Econ/Social Safety	Mod	U	Tolerable	Mod	U	Tolerable
Transport services	Extreme heat results in loss of power to traffic control systems.	Across LGA	Integral plans- not known. Disaster Management/Other Plans	33% - 66%	Assets/Public Safety	Maj	L	Extreme	Maj	L	Extreme
Transport services	Loss of roads and impacts on bus and private transport, due to lack of alternatives available in flood, bushfire events. Includes emergency access routes.		Gerringong bypass proposal (RTA) Emergency Plans, LEMC	66% - 95%	Social/Safety	Maj	P	High	Maj	P	High
Communications	Communication breakdown- phone, fax, email, mobile phone	Council and Private	Council's Business Continuity Plan. Telstra/Optus other providers not known	66% - 95%	Safety/Econ Social	Maj	P	High	Maj	P	High

7. Register of risks to infrastructure and infrastructure services

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Stormwater	Increased rainfall, intensity affects capacity, life of stormwater assets, and increases operational, maintenance costs.		Design standards (will change depending on rainfall). Annual budget allocation for operationa/ maintenance, asset replacement/ upgrade.	66% - 95%	Assets	Mod	AC	Extreme	Maj	AC	Extreme
Stormwater	Sea level rise may result in submerged stormwater outlets. Increased capital cost for upgrade of stormwater system.	Selected locations	DCP and subdivision development codes, Asset Management Plans, Customer Requests, Emergency Management Plans	5% - 33%	Safety/Assets	Mod	L	High	Maj	AC	Extreme
Wastewater	Inundation of STPs and pumping stations, overload, and reduction in system capacity leading to increased maintenance	Flood events, sea level rise and increased storm events affecting STPs at Bombo and Gerroa. Pumping stations located in Gerringong/Gerroa	Sydney Water. Notification of overflows by Sydney Water. CARS. Beachwatch monitoring.		Assets	Maj	L	Extreme	Maj	L	Extreme

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
	costs, upgrade costs, decreased asset life	and Kiama									
Water Supply	Supply Demand Balance - continued pressure on urban water supply security and quality	Entire water supply for LGA dependent on Sydney Water Supply.	Refer to Sydney Water and SCA.		Assets	Mod	AC	Extreme	Mod	AC	Extreme
Public Utilities -Sporting Facilities	Changes in climate variables - inability to irrigate recreational areas and /or parks, inundation issues from flood and overall field surface maintenance.	All Council Sporting Fields	Sydney Water restrictions. Sporting organisation risk assessments, drainage systems. Re-use schemes, resurfacing fields. Budget/Grants	33%-66%	Assets	Mod	L	High	Mod	L	High
Public Utilities -Roads	Increased damage to pavement, pot holing, seal deterioration, scouring table drains/shoulders	All Council Roads and RTA highways	DCP and subdivision development codes, Asset Management Plans, Customer Action Requests, Emergency Management Plans. RTA owned roads.	66%-95%	Safety/Assets	Maj	L	Extreme	Mod	L	High

Key Element	Impact	Assumptions	Existing Controls	Effectiveness of controls	Consequence Scale Used	2050			2070		
						C	L	Risk Ranking	C	L	Risk Ranking
Public Utilities -Buildings and Assets	Increased capital expenditure maintenance and reparation costs for damaged, replacement of buildings, general clean up etc	Impacts on Council Buildings from flooding, sea level rise, storm event inundation, bushfires.	KMC Asset Management Plans. CARS. 10 year financial Budget allocation	66%-95%	Assets	Maj	AC	Extreme	Maj	AC	Extreme
Public Utilities -Marine Assets	Increased maintenance, refurbishment and replacement of marine structures, rockpools and bridges due to higher water levels and increased flood return	Kiama Harbour, Minnamurra Boat Ramps, Boat Harbour, Gerringong, Rockpools at Kiama, Boat Harbour, Gerringong, Werri Beach	KMC Asset Management Plans. Budget allocation	33%-66%	Assets/Public Safety/Social	Maj	AC	Extreme	Cat	Ac	Extreme
Public Utilities -Dams	Dam failure due to extreme rainfall.	Jerrara and Fountaindale Dams	Developing a Dam Safety Emergency Plan to go to SES and LEMC	66%-95%	Public Safety/Assets	Mod	U	Tolerable	Mod	U	Tolerable
Public Utilities -Electricity	Hotter weather causing increased energy demand from system at capacity leading to blackouts, line sparking.	Council facilities eg Bluehaven, Admin, Holiday Parks, libraries and also private facilities such as nursing homes etc	Emergency plans for Council Facilities. Backup power for Council Admin, Bluehaven	33%-66%	Public Safety/Assets	Mod	L	High	Mod	L	High

8. Communication and Consultation

8.1. Communications Plan

Following the project inception, a communications plan was developed for the purpose of ensuring that the development of the risk assessment and adaption plans takes into consideration the views of key stakeholders. Five objectives of the communications plan were identified as follows;

1) Identify key internal and external stakeholders responsible for managing climate change risks
2) Communicate key messages on climate change projections for the LGA to the stakeholders
3) Explain how climate change may affect Council assets and functions (through the use of workshop visual aids)
4) Provide opportunities for stakeholders to participate in the risk assessment and adaptation planning
5) Record stakeholder comments and include in the preparation of the risk assessment and adaptation reports

8.2. Internal and External Stakeholders

In consultation with SCG, it was agreed that stakeholders would include representatives from Council (internal) and other organisations (external). The staff who attended the Kiama Council Risk Assessment Workshop are listed below.

Council Functional Area	Workshop Delegate
Planning and Development	Andrew Knowlson
	Chris Fuller
Environment	Sue Pritchard
	Clive Bailey
Infrastructure and Infrastructure Services	Rick Boyle
	Bryan Whittaker
	Ken Adcock
Corporate and Community Services	Chris Quigley
	Clare Rogers
	Marianne Hazell

A list of external delegates is provided below. As external stakeholders have interests across all three Councils, one workshop was held to capture their contributions to the risk assessment. This was considered to be the most efficient way of gathering information and discussing risks among a broad range of stakeholders.

Organisation	Workshop Delegate
Kiama Council	Bryan Whittaker
Shellharbour Council	Simon Illife
Wollongong Council	John Bubb
	Marina Porteous
	Jo Ferguson
SES –Region and Wollongong City Unit	Dianne Gordon
	Peter Higgins
SES- Kiama Unit	David Leigh,
SES-Shellharbour Unit	Richard Hart,
SES-Wollongong Unit	Warren Helson
Police	Danny Sharkey
	Ken McDonald Deputy LEOCON Wollongong
Rural Fire Service	Maree Larkin
SESIAH	Curtis Gregory
	Franca Facci
Health Department	Glenis Lloyd
NSW Maritime	Craig Whitmore
Surf Life Saving	Murray McMillan
	Gerald Davies SLSI
Department of Primary Industry	Liz Yeatman
DECC	Tony Hodgins
	Mark Conlon
	Phil Watson
RTA	Mark Clark
Dept of Planning	Graham Towers
	Katrina Zantiotis-Linton
Dept of Lands	Mark Edwards
Port Kembla Authority	Jim Robinson
SCG	Pat Knight

Kiama	Sue Pritchard
Shellharbour	Andrew Williams
Wollongong	Damian Gibbins

The following organisations were invited to the workshop but were unable to attend;

- NSW Ambulance
- NSW Fire Brigade
- Australian Volunteer Coastguard
- National Parks and Wildlife Services
- Lake Illawarra Authority
- RailCorp
- Sydney Water

8.3. Ongoing Communication with/from Stakeholders

The following steps have been taken to ensure Stakeholders remained informed of the project progress and outcomes

- Delegate briefing notes were circulated to all participants prior to their attendance at the workshop.
- At completion of the workshop, all delegates were invited to fill in a feedback/evaluation form to allow SKM to further understand
- Worksheets completed at the workshop were circulated to Council Project Officers for review.

8.4. Communication following finalisation

The outcomes of the project will be reported to Council, for review of its alignment with planning directions. Following this process, the actions will be incorporated into future Management Plans.

9. References

Australian Greenhouse Office (2006). *Climate Change Impacts and Risk Management: A Guide for Business and Government.*

Chiew, F.H.S., Piechota, T.C., Dracup, J.A. and McMahon, T.A. (1998), *El Nino Southern Oscillation and Australian rainfall, streamflow and drought - links and potential for forecasting*, Journal of Hydrology, 204, 138-149.

CSIRO (2005). *Potential Impacts of Climate Change on the Kiama Local Government Area*

CSIRO (2007). *Climate Change in Australia*.

Kiem, A.S., Franks, S.W. and Kuczera, G. (2003), *Multi-decadal variability of flood risk*. Geophysical Research Letters*,* 30(2), 1035, 10.1029/2002GL015992.

Kiem, A.S. and Franks, S.W. (2004), *Multi-decadal variability of drought risk - Eastern Australia*. Hydrological Processes*,* 18(11), 2039-2050.

Local Emergency Management Committees of Wollongong, Shellharbour and Kiama (2008). *Emergency Risk Management Report.*

Local Government Association of Queensland (2007). *Adapting to Climate Change – A Queensland Local Government Guide.*

NSW Government Department of Environment and Climate Change (2008). *Summary of climate change impacts – Illawarra region.*

NSW Government Department of Planning (2007). *Illawarra Regional Strategy 2006 – 31.*

Power, S., Casey, T., Folland, C., Colman, A. and Mehta, V. (1999), *Inter-decadal modulation of the impact of ENSO on Australia,* Climate Dynamics*,* 15(5), 319-324.

Ropelewski, C.F. and Halpert, M.S. (1996), *Quantifying Southern Oscillation - precipitation relationships*, Journal of Climate*,* 9, 1043-1059.

Verdon, D.C., Wyatt, A.M., Kiem, A.S. and Franks, S.W. (2004b), *Multi-decadal variability of rainfall and streamflow - Eastern Australia*. Water Resources Research, 40(10), W10201, doi:10.1029/2004WR003234

http://www.bom.gov.au/climate/averages/

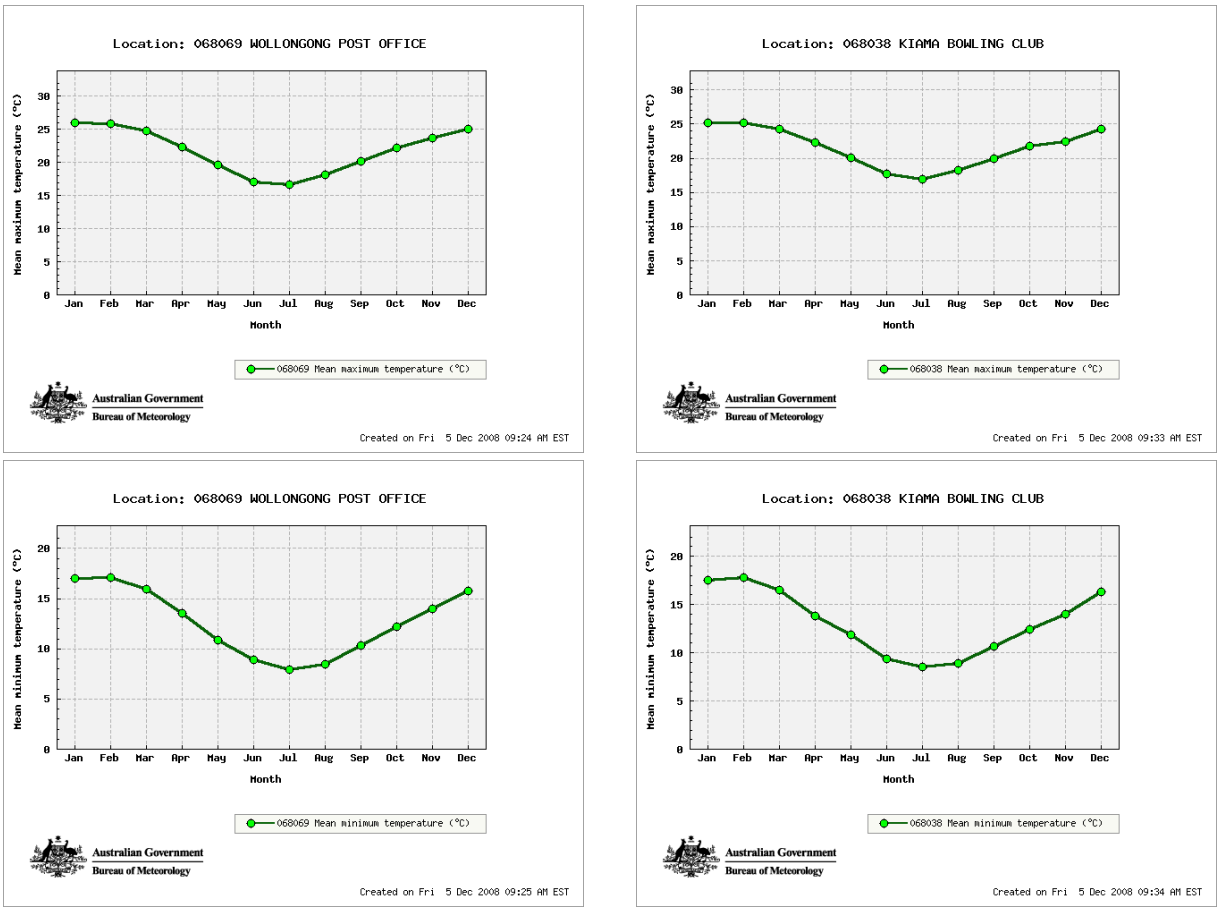
http://www.ema.gov.au

Attachment 1: Historical Climate

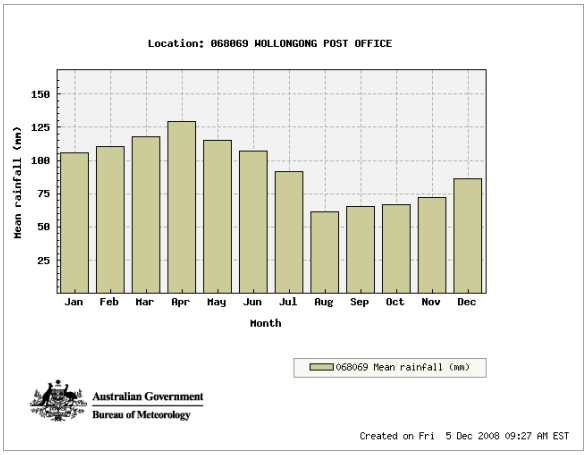
Assessment of historical climate variability - Southern Councils region

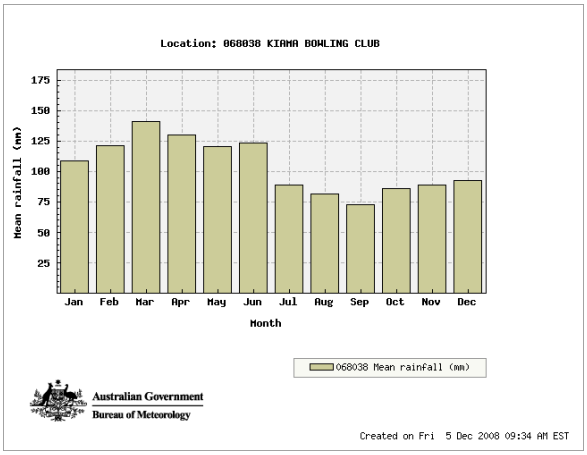
Average climate

The Illawarra region is mostly cool temperate, with an average annual rainfall of approximately 1100 mm, uniformly distributed throughout the year with a slight summer-autumn dominance. Average and minimum temperatures vary across the region and are influenced by the proximity of the coast. Monthly average temperature and rainfall for Wollongong and Kiama are shown in **Figure 1- 1** and **Figure 1- 2**.



- **Figure 1- 1 Monthly average temperature (max and min) for the Wollongong and Kiama region**

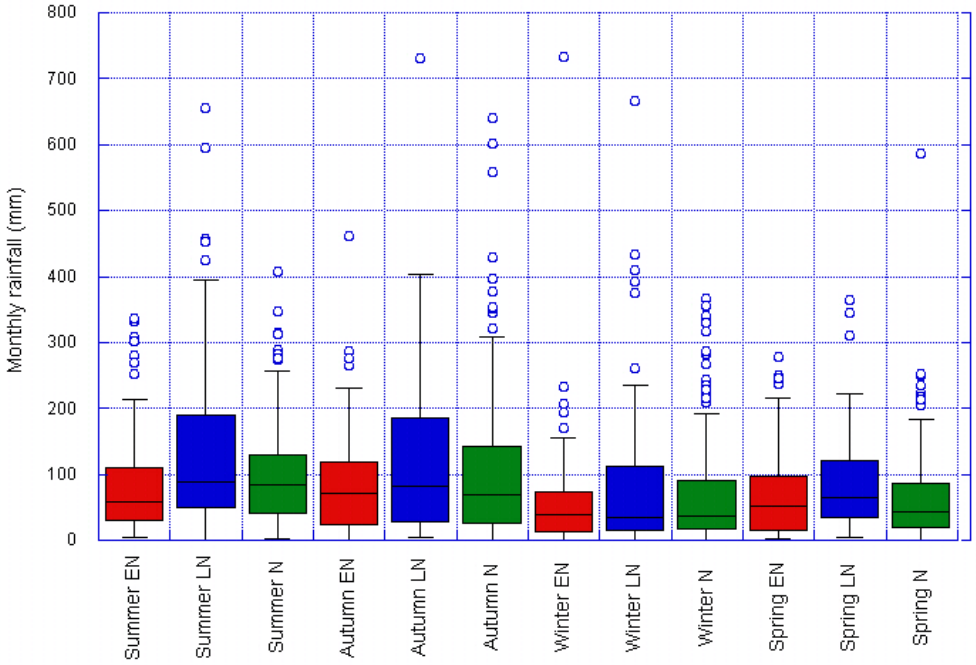




- **Figure 1- 2 Monthly average rainfall for the Wollongong and Kiama region.**

Climate variability

The Illawarra region is strongly influenced by a number of large-scale climate modes, including the El Niño/Southern Oscillation (ENSO), resulting in high interannual variability in the region. **Figure 1- 3** demonstrates the strong impact of ENSO on rainfall, using the Dapto rain gauge (68022) as an example. Note there are three phases of ENSO; El Niño, La Niña and Neutral.

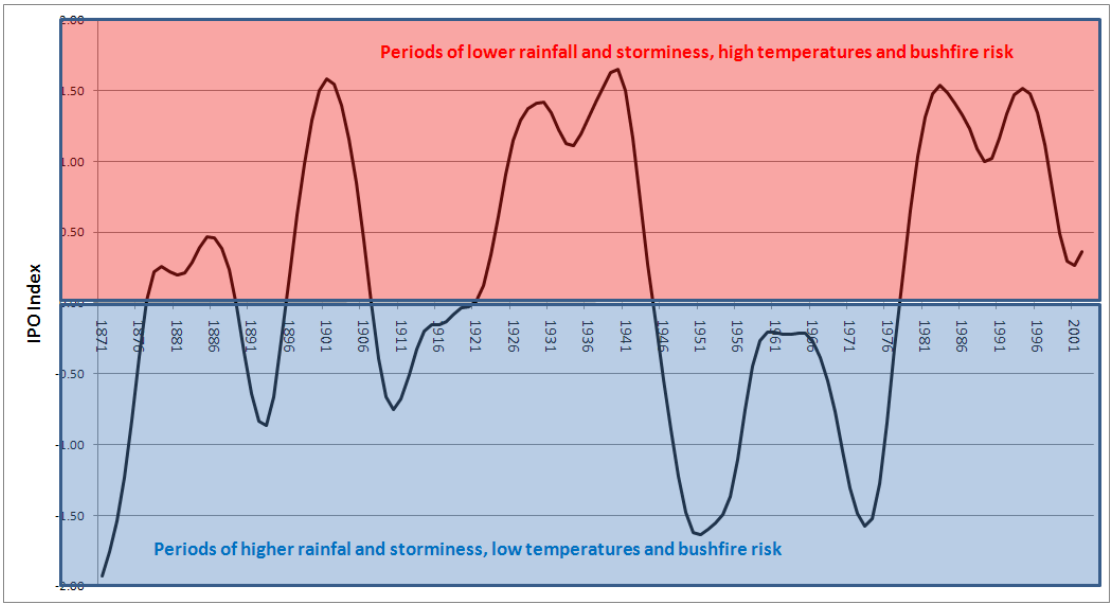


- **Figure 1- 3 Impact of ENSO on rainfall (EN=El Niño, LN=La Niña, N=Neutral)**

Figure 1- 3 demonstrates that rainfall is much higher during the La Niña phase of ENSO compared to the El Niño phase. The average rainfall received during a La Nina event is 40 to 50% greater than during an El Niño event. In addition, extreme events tend to occur less frequently during the

El Niño phase. ENSO is also known to influence the occurrence of events such as bushfires, storms and heatwaves.

Eastern Australia has also experienced a number of shifts in climate during its history, resulting in periods of high rainfall and storminess and low temperatures and bushfire risk, followed by the reverse conditions. These 'shifts' have tended to occur every 20 to 30 years and are associated with changes in the Inter-decadal Pacific Oscillation (IPO). The impacts of these changes on the coastline are also well documented, with beach erosion and realignment often occurring during the 'switch' between the two phases. For example, between 24 May and 18 June 1974, three periods of erosive wave conditions dramatically changed the character of many beaches along the central and southern New South Wales Coast. Inside Jervis Bay, normally inactive beaches lost up to 25m of their dune systems. Outside the bay, on southeasterly facing Cudmirrah Beach, surveyed rates of dune retreat increased northwards from 2m to 40m, exposing a previously buried boulder beach, bedrock cliff and rock platform. This period represents a time when the IPO was transitioning from a negative phase into a positive phase. The timeseries of the IPO and the relative impacts are illustrated in **Figure 1- 4**.



- **Figure 1- 4 Timeseries of the IPO, highlighting periods of elevated or suppressed rainfall, storminess, temperature and bushfire risk.**

History of extreme events

The Illawarra region has experienced regular floods, bushfires and severe storm events since settlement of the region. The following tables summarise some of the extreme events that have been documented in the region (note this list does not include all events, merely a summary of the most notable). The location of the event as well as a summary of the damage caused is outlined in each table. This information will be used when considering current and future climate risks in the region. **Table 1- 1** lists various major flood events, **Table 1- 2** highlights bushfire events

that have affected the region and **Table 1- 3** outlines some of the severe storm events the region has experienced.

- **Table 1- 1 History of severe floods (source - http://www.ema.gov.au)**

Date	Region affected	Damage	ENSO class
Jan 1860	Wollongong	The severity of the floods caused deaths and great damage and led to the rebuilding of Nowra as it was originally located in a low-lying area near the Shoalhaven River.	*La Niña*
Apr 1950	Wollongong	Concrete causeway on West Dapto Rd were destroyed. 17 people evacuated from homes in Dapto district when floods lapped into rooms of cottages.	*La Niña*
Jun 1950	Coastal NSW	The highest known flood levels to date occurred in a number of major river systems, with most rivers in eastern, particularly coastal, NSW affected and heavy damage in many areas. There were 26 deaths and heavy property and agricultural losses.	*La Niña*
Feb 1955	Eastern NSW	Extreme floods caused great loss of life and property when almost every river system in NSW flooded.	*La Niña*
Oct 1959	Wollongong	Hundreds of people stranded at Kembla Grange as Highway flooded up to 2.5m for 1.2km. Hundreds of acres of farmland damaged at Dapto and Kembla Grange. All roads from Dapto to Wongawilli flooded. Fowlers Rd and Cleveland Rd damaged.	*Neutral*
Apr 1963	NSW (in particular Wollongong)	A man from Milton, on the NSW South Coast, drowned when he was swept by surging waters off a road into a ditch near the town. The tragedy followed as the Princes Highway was cut at Milton stranding truck & car drivers.	*Neutral*
Mar 1975	Wollongong	Semi-trailer driver trapped on West Dapto Rd. 'Water swept through 20 houses in Burringbar Ave Dapto which has never previously experienced flooding'	*La Niña*
Feb 1984	Wollongong	A record 797mm rain fell at Wongawilli in 24 hours. Over 100 properties in the Dapto and Brownsville areas were damaged. Severe damage occurred at Kembla Grange industrial estate. Dozens of people had to be rescued by boat or helicopter.	*La Niña*
Apr 1988 flood +landslide	Wollongong	Landslide which resulted from a combination of human interference & 2 weeks of heavy rainfall had fatal consequences. A 20m high railway embankment collapsed after earth & rock ballast used to fill an old mine dam became saturated & caused severe under mining & subsidence.	*La Niña*
Feb 1992	NSW	A spate of violent storms caused a series of flash floods across Sydney & NSW causing large-scale damage & severe disruption. The SES & volunteer bushfire brigades were called on to remove fallen trees from roads. The Princes Highway was cut in several places at various times over the fortnight of flooding.	*Neutral*
Sep 1993 – Berry flash Flood	Wollongong	NSW - Berry/south coast - Flash flood	*Neutral*
Aug 1998	Illawarra/ Wollongong	Rainfall intensities at several pluviometers exceeding 120 mm hr^{-1} over a duration of one hour, with up to 249 mm falling in 3.5 hours during the main storm burst. Widespread erosion	*La Niña*

		occurred particularly where urban development had encroached on natural water courses. Debris/ hyperconcentrated flows originating from both anthropogenic and natural sediment sources caused damage to urban areas. 	
Feb 2008	Illawarra/Shoalhaven	More than 200 millimetres fell in the region, on the New South Wales south coast, resulting in the closure of many roads and the rescue of two young men caught in a causeway at Kiama. In all, the SES received 290 calls for help in the region.	*La Niña*

- **Table 1- 2 History of severe bushfires (source - Council of Australian Governments, National Inquiry on Bushfire Mitigation and Management 2004)**

Date	location	No. deaths	Ha burnt	losses	ENSO class
1964–1965	Snowy Mountains, Southern Tablelands, Nowra, Sydney	5	530 000	Houses, farms, forests	*Neutral **
1968-1969	South Coast , much of the coastal and nearby range areas of the state	14	> 2 000 000	161 buildings (80 houses)	*El Niño*
1979–1980	Mudgee, Warringah and Sutherland Shires, majority of council areas, Goulburn and South Coast	13	>1 000 000	14 houses	*Neutral **
1982–1983	Blue Mountains, Sutherland and southern NSW	3	60 000	$12 million of pines	*El Niño*
1993–1994	North Coast, Hunter, South Coast, Blue Mountains, Baulkham Hills, Sutherland, most of Royal National Park, Blue Mountains, Warringah–Pittwater	4	>800 000 (>800 fires)	206 houses destroyed, 80other premises destroyed	*El Niño*
1997–1998	Hunter, Blue Mountains, Shoalhaven, Menai, Coonabarabran, Padstow Heights, South Windsor – Bligh Park	3	>500 000 (250 fires)	10 houses destroyed	*El Niño*
2002–2003	81 local government areas in Greater Sydney, Hunter, North Coast, Northern Tablelands, Northern Rivers, northwest slopes, north-west plains, Central Tablelands, Southern Tablelands, Illawarra, South Coast	3	1 464 000 (459 fires)	86 houses destroyed; 3400 stock; 151 days of severe fire activity	*El Niño*

** note preceding year was an El Nino*

- **Table 1- 3 Selected severe storm events (source – P Hellman PhD Thesis, Southern Cross University 2007 & http://www.ema.gov.au)**

Date	Type of Event	Location	Summary of Damage
Jul 1866	Very severe Storm *CAWARRA STORM 'the great gale'*	Whole NSW coast	Furious storm, some 20 vessels and over 100 lives lost from Lady Elliot Is to Wollongong 'one of the worst gales ever recorded on the north coast'.
May 1889	Strong East Coast Low	Whole NSW coast	Extreme event, strong southerly gales and heavy seas, damage Sydney and Kiama
May 1896	Breakwater damage	Wollongong	Heavy gales damaged breakwater
Jan 1911	Tropical cyclone	SEQ to all NSW	TC from Gulf to inland NSW, crossed coast Wollongong then E. Severe gale to coast, ships could not enter Moreton Bay and Sydney gusts over 70kts
Jul 1912	Extreme shoreline damage erosion	NSW	Low from NT crossed coast Newcastle 999hPa and deepened. S gales, very rough seas, 235t boulder carried onto Bondi Beach. Shoreline damage and waves breaking over a kilometre offshore inside Sydney Harbour. 50 kg boulders from retaining walls 'tossed like corks' and lifted 3m above HWM. Beach with storm profile and over 3m face in dune 'much like an ocean beach' in a storm
Feb 1934	Severe tropical cyclone	Whole NSW coast	TC tracked from gulf to NSW coast, floods central and SEQ. Heavy N gales and large waves, storm surge in Hervey and Moreton Bays. Moreton Bay gauge, largest recorded storm surge 1.16m Intense gradients to 988hPa Southern Tasman. Very severe coastal storm. Heavy swell on all beaches. 12m waves at Sydney
Jun 1950	Series of storms	Whole NSWE coast	Major damage to Sydney beaches and facilities, seawall collapse at Balmoral, Manly, Nielson Park and Cronulla (surf club collapsed into sea) and extensive damage to foreshore structures along NSW coast
Feb 1978	Severe storm	Sydney and Wollongong	Severe storms affecting the areas of Sydney, Newcastle and Wollongong over the two days and caused damage and power failures to many homes, injured eight people and caused extensive damage. A tornado accompanied one thunderstorm in the Drummoyne/Hunters Hill area of Sydney, lifting the entire roof off one home and damaging many others.
Jan 1988	Severe storm	Wollongong	NSW - Wollongong (south coast) - High winds flattened part of the world scout jamboree camp near Wollongong, causing 40 injuries including broken limbs
Nov 1991	Severe storm	Wollongong	NSW - Manyana, near Nowra - A tornado destroyed 6 houses & damaged 150 houses in the coastal resort village, south of Nowra. Property damage also occurred at nearby Lake Conjola, Cunjurong & Bendalong. The storm cut a swathe about 220m wide & 5km long through these coastal towns before returning to sea. Caravans were overturned in parks & private residences.

			All power to some of the towns had to be cut because of the dangerous fallen wires, which resulted in lengthy power cuts..
Aug 2000	Hailstorm	Wollongong	Following a Weather Bureau severe storm warning, heavy rain and large hailstorms struck about 4.45pm. The hail caused traffic chaos on Mt Ousley Rd sparked by a six-car crash as ice covered the roads. Traffic came to a standstill on the freeway leading into Wollongong from Sydney. The SES received calls from about 10 households whose roofs had been damaged by hail during the downpour. There were about 30-40 minutes of hail.
Sep 2002	Severe storm gale	Sydney and Wollongong	Gale force winds which were raging at more than 90 km/h, caused havoc across Sydney and parts of NSW. A large part of NSW was declared a natural disaster area. The Illawarra and Southern Highlands through to the Lower Hunter were all affected, with extensive damage reported in 30 areas. The Emergency Services Minister stated that the worst affected areas were around Wollongong, Shellharbour, Goulburn, Wollondilly and in the Sutherland Shire.
Jun 2007	Severe Storm	Wollongong (and coastal NSW)	In June 2007 erosion was caused via storms to the beaches, the worst in 30 years.

Attachment 2: Climate change scenarios

Climate Change Scenarios for use in risk assessment - Southern Councils region

Introduction

In 2007 the Intergovernmental Panel on Climate Change (IPCC) released their fourth assessment report, concluding that:

- Warming of the climate system is unequivocal ;
- It is very likely that changes in the global climate system will continue well into the future, and that they will be larger than those seen in the recent past; and
- These changes have the potential to have a major impact on human and natural systems throughout the world including Australia.

Global warming is driven by long-lived greenhouse gases. Of concern is that emissions of greenhouse gases due to human activities have grown by 70% between 1970 and 2004 (IPCC 2007). Regardless of the actions that we take today, further changes to our climate are highly likely. This is because about half of the carbon dioxide emitted by human activities is absorbed by the oceans and biosphere, leaving half in the atmosphere where it has a lifetime of 50–100 years.

In 2000 the IPCC published a series of projected greenhouse gas emissions scenarios that could be used to assess potential climate change impacts. The Special Report on Emission Scenarios, known as the 'SRES scenarios', grouped scenarios into four families of greenhouse gas emissions (A1, A2, B1, and B2) that explore alternative development pathways, covering a wide range of demographic, economic, and technological driving forces:

- **A1** – the story line assumes a world of very rapid economic growth, a global population that peaks mid-century and the rapid introduction of new and more efficient technologies. A1 is divided into three groups that describe alternative directions of technological change: fossil intensive (A1FI), non-fossil energy resources (A1T), and a balance across all sources (A1B).
- **B1** – describes a convergent world, with the same global population as A1, but with more rapid changes in economic structures toward a service and information economy.
- **B2** – describes a world with intermediate population and economic growth, emphasising local solutions to economic, social, and environmental sustainability.
- **A2** – describes a very heterogeneous world with high population growth, slow economic development and slow technological change.

The emission projections are widely used in the assessments of future climate change, and their underlying assumptions with respect to socioeconomic, demographic and technological change serve as inputs to many recent climate change vulnerability and impact assessments. The impacts of increasing greenhouse gases on the earth's climate are assessed using global climate models (GCMs). These models simulate the processes that govern the Earth's climate, including the interaction between the atmosphere, oceans, ice and snow covered regions, and land surfaces with vegetation cover.

Uncertainty in Climate Change Scenarios

Climate change scenarios are inherently highly uncertain. There are many reasons for this uncertainty, including uncertainty in the emission scenarios used to run the GCMs. For example, the SRES scenarios do not include additional climate policies beyond those current at the time and there is no likelihood attached to any of these scenarios. The SRES scenarios, whilst carefully constructed, did not allow for a 'worst case' scenario, or a 'best guess' scenario. Consequently they can be difficult to comprehend, and have **t**he danger of under-estimating the risks.

Confidence in GCM predictions is higher at global and continental scales than at sub continental and regional scales. This is because the climate models are based on an incomplete understanding of a highly complex global climate system and do not as yet realistically reproduce the natural climate cycles (e.g. such as the El Niño Southern Oscillation, the Inter-decadal Pacific Oscillation etc.). This is particularly important for Australia where these climate phenomena are the primary drivers of interannual and multi-decadal variability on a regional scale.

The above limitations result in different climate models producing a wide range of responses to the greenhouse forcing. For certain elements of the climate system, such as surface temperature, there is broad agreement on the pattern of future climate changes between individual GCMs. Other elements, such as rainfall, are related to more complex aspects of the climate system, including moisture transport, and are not represented with the same confidence in models.

Development of climate change projections for Southern Councils Climate Change Risk program

The IPCC Fourth Assessment Reports provide limited detail on Australian climate change, particularly when it comes to regional climate change projections. To overcome this CSIRO and the Bureau of Meteorology have developed climate change projections for Australia and have produced a report entitled 'Climate change in Australia' (CSIRO 2007). This information is based upon international climate change research including conclusions from the IPCC's fourth assessment report. It also builds on a large body of climate research that has been undertaken for the Australian region in recent years.

The spatial resolution of climate change projections (i.e. typically 250km by 250km grid squares) is too course to infer regional impacts, particularly in regions where altitude, distance from the coast, land cover etc vary considerably across the grid squares(which is often the case in coastal Australia). For this reason, researchers have developed various downscaling methodologies in order to provide regionally specific information on climate change impacts. Recently the NSW Department of Environment and Climate Change (DECC) commissioned the University of New South Wales (UNSW) to undertake downscaling of climate change information for the NSW region. Consequently climate change projections for rainfall and temperature have recently been published by DECC for the Illawarra region as part of this joint venture. The climate change projections are provided at a resolution of 50km by 50km, enabling variability in climate change impacts to be assessed within NRM regions.

Given the available information, the climate change projections developed for the Southern Councils Climate Change Risk program are based on:

1) DECC (2008) 'Summary of climate change impacts – Illawarra region';

2) CSIRO (2007) 'Climate Change in Australia'; and

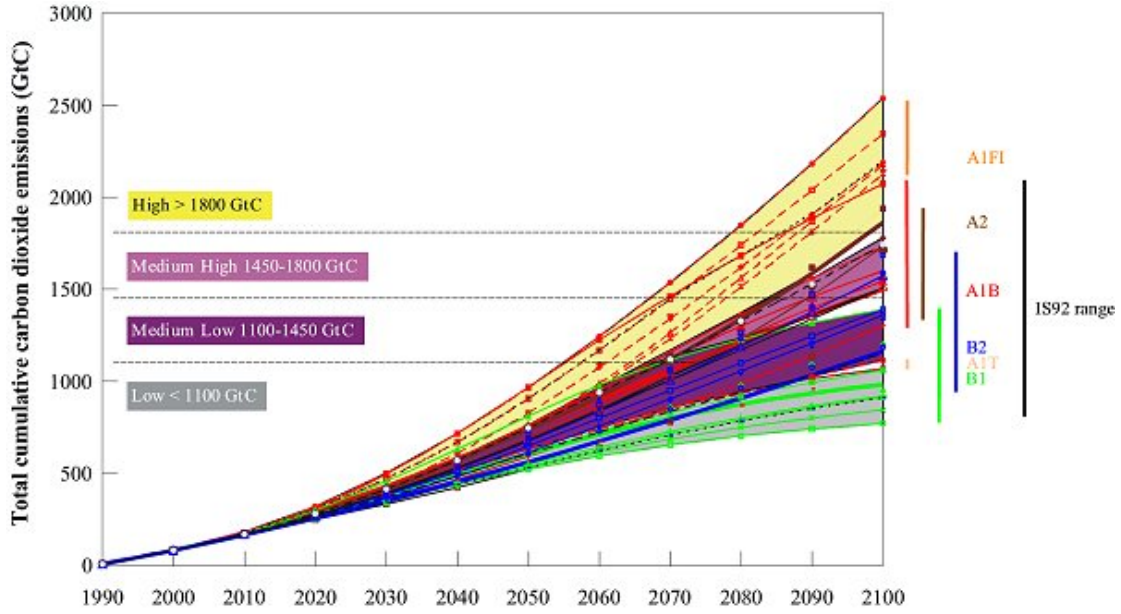
It should be noted that there are several key differences between the climate change projections provided by DECC (2008) and those provided by CSIRO (2007). The CSIRO (2007) climate change scenarios are based on a general consensus among all 23 global climate models (GCMs) included in the 2007 IPCC report. In contrast the DECC (2008) scenarios are based on the four 'best' GCMs (assessed on their ability to replicate the daily rainfall and temperature probability density functions for NSW). DECC (2008) have opted for using fewer models that better replicate the historical record in order to reduce the uncertainty in the climate change projections. There are also differences in the emission scenarios used by DECC (2008) and CSIRO (2007) to generate these projections. DECC (2008) have used a single high global warming emission scenario (i.e. A2), while CSIRO (2007) provide climate change projections based on a low (B1), medium (A1B) and high (A1F1) global warming scenario. The time horizons and resolution of information also differ between the two sources. **Table 2- 1** summarises the key differences between the two sources of climate change information.

- **Table 2- 1 summary of key differences between DECC and CSIRO climate change projections**

Source of information	**CSIRO**	**DECC**
Publication year	2007	2008
Resolution	250km x 250km	50km x 50km
Number of GCMs used in analysis	23	4
Time horizons available	203, 2050, 2070	2050
Emission scenarios	low (B1), medium(A1B), high (A1F1)	high (A2)

In this project the DECC (2008) projections have been adopted as the primary source of climate change information for 2050, with CSIRO (2007) scenarios used to provide an estimate of the range (uncertainty) of possible futures. Climate change scenarios for other time horizons are not currently available from DECC, thus CSIRO (2007) projections have been adopted for the 2070 horizon.

Global emissions are currently tracking higher than the worst case emissions scenario (i.e. the A1F1 or A2) and it is unlikely that emissions will reach the low or median emissions target by 2050, therefore a single high emission scenario has been adopted for 2050. However, there is more uncertainty around emission scenarios for 2070, therefore the climate change projections for all three emission scenarios (low, medium and high) have been compiled for this time horizon. The SRES scenarios are shown in **Table 2-2**.



- **Table 2- 2 SRES scenarios from the IPCC Special Report on Emission Scenarios**

Summary of climate change impacts on the Illawarra/Southern Councils region for 2050 and 2070 relative to 1990

Temperature

Illawarra is likely to become warmer, with more hot days and fewer cold nights. Days are projected to be hotter over all seasons, with the greatest warming in winter, spring and autumn (DECC 2008). Increased peak summer energy demand for cooling is likely, with reduced energy demand in winter for heating. Warming and population growth may increase annual heat-related deaths in those aged over 65, while higher temperatures may also contribute to the spread of vector-borne, water-borne and food-borne diseases.

Rainfall

It is projected that rainfall will increase in all seasons except winter by 2050 (DECC, 2008). This increase is expected to be substantial in summer, while smaller increases are expected in spring and autumn. It is important to note that, although the most likely scenario for rainfall is for an increase during summer, autumn and spring, there is also the potential that rainfall will decrease during these seasons according to CSIRO (2007). By 2070 the range of projections for rainfall is wide, with the potential for both a decrease and increase in rainfall to eventuate (CSIRO 2007).

Evapotranspiration

Evapotranspiration is projected to increase across all seasons, with the most significant change occurring in summer and spring (DECC, 2008). Overall there is likely to be no significant change in average annual runoff by 2050 (DECC, 2008). However there may be a change in the seasonality in runoff, with likely increases in summer and autumn and decreases in winter and spring. If the drier end of the range of climate change projections were realised, towns with smaller water

supplies would need to consider that there may be inflow reductions of 10% during drier periods by 2050 (DECC, 2008). There is currently no reliable information available on projected changes in runoff expected by 2070.

Extreme Weather

The occurrence of extreme weather events are likely to increase. Australia is likely to experience an increase in the occurrence of extreme daily rainfall under climate change. The average number of days per year with very high or extreme fire danger is also predicted to increase. The fire season is also likely to be extended as a result of warmer temperatures. Increases in extreme weather events are likely to lead to increased flash flooding, strains on sewerage and drainage systems, greater insurance losses, possible black-outs, and challenges for emergency services.

Sea Level Rise

Sea level is projected to rise up to 40cm above 1990 mean sea level by 2050 (DECC, 2008), wither further increases expected by 2070 (note projections provided by CSIRO are lower than those of DECC). Coastal erosion is likely to result in a recession of the sandy parts of the coastline. Rising sea levels and the potential for increased storminess are likely to have an impact on beaches, coastal rivers and estuaries. Settlements located along the coast and adjacent to estuaries are likely to face increased risk of flooding as sea levels rise. The rise in sea levels is also likely to increase the risk of flooding in parts of the lower floodplain. Flood producing rainfall events are likely to increase in frequency and intensity, which may result in flooding from urban streams and drainage systems. Major roads such as the Princes Highway are likely to be flooded from time to time at low-lying sections.

Biodiversity

Higher temperatures and drier conditions are very likely to have a major impact on biodiversity (particularly those ecological communities already stressed due to fragmentation).

Quantitative changes in temperature, rainfall, evaporation, runoff and sea level rise for 2050 and 2070 are highlighted in the following tables.

- **Table 2- 3 Summary of climate change projections for 2050 relative to 1990 climate, high emission scenario**

*This information is based on a global average, considerable regional variability is expected

Variable		DECC (2008)	CSIRO (2007) – High emissions scenario		
			10th Percentile	50th percentile	90th percentile
Annual average temperature		N/A	+1 to +1.5°C	+1.5 to +2°C	+2.5 to +3°C
Seasonal average temperature	summer	+1.5 to +3 °C	+1 to +1.5°C	+1.5 to +2°C	+2.5 to +3°C
	autumn	+2 to +3 °C	+1 to +1.5°C	+1.5 to +2°C	+2.5 to +3°C
	winter	+2 to +3 °C	+1 to +1.5°C	+1.5 to +2°C	+2 to +2.5°C
	spring	+2 to +3 °C	+1 to +1.5°C	+2 to +2.5°C	+2.5 to +3°C
Annual average rainfall		N/A	-20% to-10%	-10% to -5%	+5% to +10%
Seasonal average rainfall	summer	+20 to +50%	-20% to -10%	-2% to 2%	+10 % to +20%
	autumn	+10 to +20%	-20% to -10%	-5% to -2%	+10 % to +20%
	winter	-5 to +10%	-40% to -20%	-10% to -5%	+5% to +10%
	spring	+10 to +20%	-40% to -20%	-20% to -10%	+5% to +10%
Annual average potential evapotranspiration		N/A	+2% to +4 %	+4 % to +8%	+8% to +12%
Seasonal average runoff	summer	-1 to +22%	N/A	N/A	N/A
	autumn	-6 to +14%	N/A	N/A	N/A
	winter	-12 to +3%	N/A	N/A	N/A
	spring	-10 to +1%	N/A	N/A	N/A
Sea level rise*		+ 0.4m	+0.096m	N/A	+0.278m

- **Table 2- 4 Summary of climate change projections for 2070 relative to 1990 climate, low emission scenario**

*This information is based on a global average, considerable regional variability is expected

Variable		CSIRO (2007) – Low emissions scenario		
		10th Percentile	50th percentile	90th percentile
Annual average temperature		+1 to +1.5°C	+1.5 to +2°C	+2 to +2.5°C
Seasonal average temperature	summer	+0.6 to +1.5°C	+1.5 to +2°C	+2 to +2.5°C
	autumn	+0.6 to +1.5°C	+1 to +2°C	+2 to +2.5°C
	winter	+0.6 to +1°C	+1 to +1.5°C	+1.5 to +2°C
	spring	+1 to +1.5°C	+1.5 to +2°C	2 to +2.5°C
Annual average rainfall		-20% to-10%	-5% to -2%	+2% to +10%
Seasonal average rainfall	summer	-20% to -10%	-2% to 2%	+10 % to +20%
	autumn	-20% to -10%	-5% to -2%	+10 % to +20%
	winter	-40% to -20%	-10% to -5%	+5% to +10%
	spring	-40% to -20%	-10% to -5%	+5% to +10%
Annual average potential evapotranspiration		+2% to +4 %	+4 % to +8%	+4% to +8%
Seasonal average runoff	summer	N/A	N/A	N/A
	autumn	N/A	N/A	N/A
	winter	N/A	N/A	N/A
	spring	N/A	N/A	N/A
Sea level rise*		+0.145m	N/A	+0.333m

- **Table 2- 5 Summary of climate change projections for 2070 relative to 1990 climate, medium emission scenario**

* This information is based on a global average, considerable regional variability is expected

Variable		CSIRO (2007) – Medium emissions scenario		
		10th Percentile	50th percentile	90th percentile
Annual average temperature		+1.5 to +2°C	+2 to +2.5°C	+3 to +4°C
Seasonal average temperature	summer	+1 to +1.5°C	+2 to +2.5°C	+3 to +4°C
	autumn	+1 to +1.5°C	+2 to +2.5°C	+3 to +4°C
	winter	+1 to +1.5°C	+1.5 to +2°C	+2.5 to +3°C
	spring	+1.5 to +2°C	+2 to +2.5°C	+3 to +4°C
Annual average rainfall		-20% to-10%	-10% to -5%	+5% to +10%
Seasonal average rainfall	summer	-20% to -10%	-2% to 2%	+10 % to +40%
	autumn	-40% to -20%	-5% to -2%	+10 % to +20%
	winter	-40% to -20%	-20% to -10%	+5% to +10%
	spring	-40% to -20%	-20% to -10%	+5% to +10%
Annual average potential evapotranspiration		+2% to +4 %	+4 % to +8%	+8% to +12%
Seasonal average runoff	summer	N/A	N/A	N/A
	autumn	N/A	N/A	N/A
	winter	N/A	N/A	N/A
	spring	N/A	N/A	N/A
Sea level rise*		+0.15m	N/A	+0.413m

- **Table 2- 6 Summary of climate change projections for 2070 relative to 1990 climate, high emission scenario**

*This information is based on a global average, considerable regional variability is expected

Variable		CSIRO (2007) – High emissions scenario		
		10th Percentile	50th percentile	90th percentile
Annual average temperature		+2 to +2.5°C	+3 to +4°C	+4 to +5°C
Seasonal average temperature	summer	+1.5 to +2°C	+3 to +4°C	+4 to +5°C
	autumn	+1.5 to +2°C	+2.5 to +3°C	+4 to +5°C
	winter	+1.5 to +2°C	+2.5 to +3°C	+3 to +4°C
	spring	+2 to +2.5°C	+3 to +4°C	+4 to +5°C
Annual average rainfall		-40% to-20%	-10% to -5%	+5% to +10%
Seasonal average rainfall	summer	-40% to -20%	-2% to 2%	+20 % to +40%
	autumn	-40% to -20%	-10% to -5%	+10 % to +40%
	winter	-40% to -20%	-20% to -10%	+10% to +20%
	spring	-60% to -40%	-20% to -10%	+10% to +20%
Annual average potential evapotranspiration		+2% to +4 %	+4 % to +8%	+8% to +12%
Seasonal average runoff	summer	N/A	N/A	N/A
	autumn	N/A	N/A	N/A
	winter	N/A	N/A	N/A
	spring	N/A	N/A	N/A
Sea level rise*		+0.165m	N/A	+0.471m

Attachment 3: SCG Risk Analysis Criteria

Success Criteria

In order to understand the consequence of a risk posed by climate change it is necessary to identify a number of success criteria. These are selected to align with objectives set by Local Councils. Six success criteria have been chosen for this project;

7) Public Safety
8) Asset Damage
9) Environment and Sustainability
10) Local Economy and Growth
11) Health, Community and Lifestyle
12) Public Administration.

The success criteria have been established in line with the Guidelines provided in Climate *Change Impacts and Risk Management – A Guide for Business and Government* and modified to meet the needs of Kiama Municipal Council. The success criteria are combined with a consequence scale to form a matrix of descriptions, which will be used to define the consequence rank for each risk identified.

The success criteria and consequence scales are provided in **Table 3- 1**.

Table 3- 1 Success Criteria and Consequence Scales

	Public Safety	Asset Damage	Environment and Sustainability	Local Economy and Growth	Community and Lifestyle	Public Administration
Rank	Safety	Assets	Env	Econ	Social	Pol
Catastrophic	Definite fatality(ies) and permanent disabilities	Significant damage to most assets resulting in loss of capability.	Complete loss of environmental amenity and irrecoverable damage	Regional decline leading to widespread business failure, loss of employment and hardship	The region would be seen as very unattractive, unable to support the community	Public administration would fall into decay and cease to be effective
Major	Multiple long term personal injury, illness/possible fatalities	Significant damage to many assets resulting in very limited capability	Serious long term environmental damage to environmental amenity	Regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth	Severe and widespread decline in services and quality of life within the community threatened	Public administration would struggle to remain effective and would be seen to be in danger of failing completely
Moderate	Personal injury/illness requiring medical treatment (no hospitalisation)	Damage to assets resulting in isolated loss of capability	Short term significant but reversible environmental damage	Significant general reduction in economic performance and limitation on growth	General appreciable decline in lcoal services	Public administration would be put under severe pressure on several fronts
Minor	Personal injury (first aid treatment)	Damage to assets resulting in restrictions in capability	Minor damage to isolated assets which could be reversed	Individually significant but isolated areas of reduction in economic performance relative to current forecasts	Isolated but noticeable examples of decline in services	Isolated instances of public administration being under severe pressure
Insignificant	No personal injury	Minor damage requiring increased maintenance	No environmental impact or damage	Minor shortfall relative to current forecasts	There would be minor areas in which the region was unable to maintain its current services	There would be minor instances of public administration being under more than usual stress but it could be managed

Likelihood

A fundamental part of conducting any risk assessment is the consideration of likelihood. For each climate scenario the likelihood of a particular risk occurring is described as Almost Certain, Likely, Possible, Unlikely or Rare. Deciding which likelihood category to assign to a risk is assisted by considering the frequency of that risk occurring. Some risks may be considered as a single event (such as destruction of an endangered species) or recurring events (such as flood damage to buildings). A widely used likelihood scale is shown in **Table 3- 2** which includes descriptions of recurrent and single event risks. This approach will be used for the study.

Table 3- 2 Likelihood Scale

Likelihood	Likelihood of the Scenario Resulting in the Consequence
Almost Certain	**Recurrent risks:** Could occur several times a year; **Single event:** More likely than not - Probably greater than 50%
Likely	**Recurrent risks:** May arise about once per year; **Single event:** As likely as not - 50/50 chance
Possible	**Recurrent risks:** may arise once every ten years; **Single event:** Less likely than not but still appreciable
Unlikely	**Recurrent risks:** May arise once every ten years to 25 years; **Single event:** Unlikely but not negligible - probably low but noticeably greater than zero.
Rare	**Recurrent risks:** unlikely during the next 25 years; **Single event:** negligible - probably very small, close to zero

Evaluating Risks

The last stage of the risk assessment is to prioritise the risks identified to provide direction to the adaptation plan. Risks can be ranked by combining the consequence and likelihood scales to form a matrix, as shown in **Table 3- 3** and interpreted in **Table 3- 4**.

- **Table 3- 3** Risk Priority Levels

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

- **Table 3- 4** Interpretation of Risk categories

Extreme	Risks demand urgent attention at the most senior level and cannot be simply accepted as a part of routine operations without executive sanction
High	Risks that are severe but can be accepted as a part of routine operations without executive sanction
Tolerable	Risks can be expected to form part of a routine operations but they will be explicitly assigned to relevant managers for actions maintained under review and reported upon at a senior level
Low	Maintained under review but is expected that existing controls will be sufficient an and no further action required to treat them
Negligible	Risk can be dismissed as considered to not require review and no controls will be required to treat them