

Climate Change Adaptation Strategy 2016

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1. Background

- Our climate system is rapidly warming (observations records)
- Anthropogenic greenhouse gas emissions are rising and are the dominant cause of warming (confirmed)
- Projected to change to further extremes (trend projections)
- Climate change impacts and risks

1.1 Climate observations

Our climate change system is changing

The International Panel on Climate Change (IPCC) states unequivocally that the warming trend observed over the past century has led to changes in rainfall patterns, snow and ice melts and subsequent shifts in hydrological regimes that affect water quality and availability. Climate change is also a factor in shifting seasonal migration patterns, altered distribution of terrestrial and aquatic species, ocean acidification, heatwaves, floods, droughts, cyclones and wildfires (IPCC, 2014b pp 7–13).

The National Aeronautics and Space Administration (NASA) confirm the IPCC statements on global climate change impacts on the environment. They present as evidence shrinking glaciers, early seasonal break up of ice on rivers and lakes, shifting plant and animal ranges, and phenological observations of changing plant and animal life cycle events such as flowering times. Effects of global climate change that scientists predicted in the past are happening now, such as loss of sea ice, accelerated sea level rise and longer, more intense heat waves (NASA, 2015).

Anthropogenic greenhouse gas emissions are rising and are the dominant cause of warming

Anthropogenic greenhouse gas (GHG) emissions have accumulated in the atmosphere since the pre-industrial era. These continue to build in concentration in Earth’s atmosphere. Combined with additional anthropogenic climate drivers, these emissions are regarded by the scientific community to be the cause of the observed warming trend occurring since the mid-20th century (IPCC, 2013).

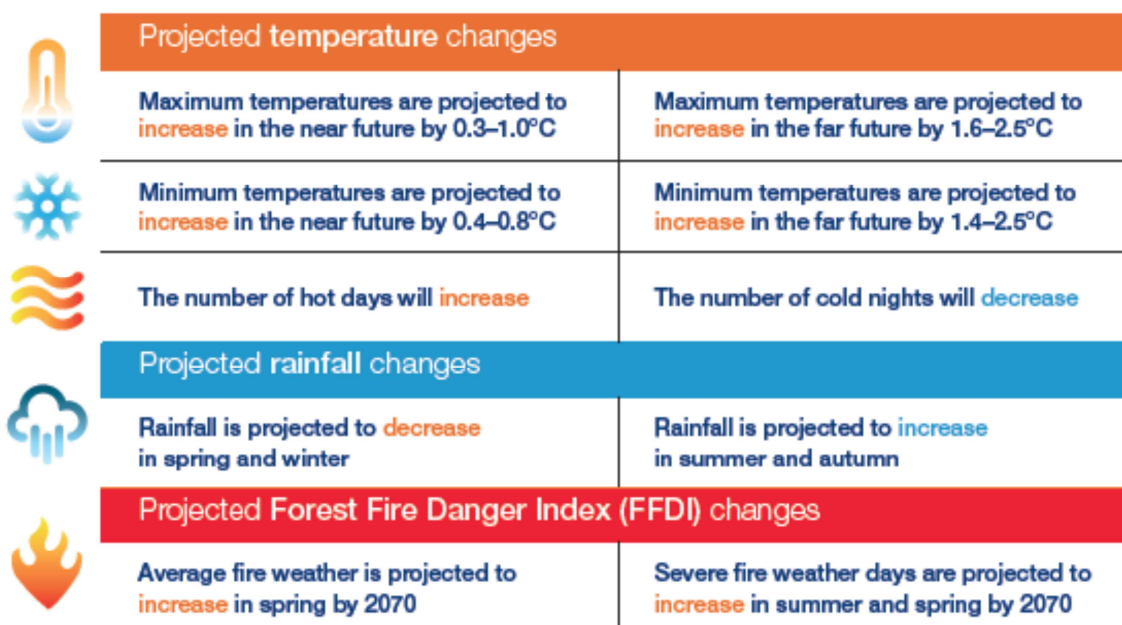


Figure 1: Climate projections for the Sydney Metropolitan region (Source: OEH 2014, p3)

Future intensification of the current warming trend will accelerate the changes that are already occurring. Regional scale modelling presented for the Greater Sydney metropolitan area by NARClIM (NSW/ACT Regional Climate Modelling) (NSW Office of Environment and Heritage, 2015b) provides a basis for forecasting the probability and types of risks associated with climate change in the near and far future. Figure 1 summarises the climate projections for the Sydney Metropolitan region, including the Ku-ring-gai area. A full summary of climate change observations and projections at a global, national, state and regional level is attached to the Ku-ring-gai Council Climate Change Policy 2015 as Attachment 1: Climate Change: observations, projection, impacts and risks.

1.2 History and local trends of extreme weather events in a warming climate

Bushfire

According to the NSW Rural Fire Service (RFS) six major bushfire events have occurred over the past half century. Of note in terms of loss of houses are the 1994 fires and 2002 fires. On average one to two bushfire events hit Ku-ring-gai around every ten years. Not all end the loss of life and property but some, such as the 1990–91 fires did result in a state of emergency being declared (NSW RFS, 2008). Often major bushfires occur during or toward the end of a drought period. The climate modelling detailed in Figure 1 predicts an increase in bushfire weather as the number of hot days increase late winter and spring rainfalls decline. It is likely that the major bushfire events of the past could increase in scale and frequency as greenhouse gases continue to build in concentration in the atmosphere.

Extreme heat

In Ku-ring-gai the average maximum temperature is likely to increase by 0.4 to 1.0 degrees with a mean of 0.7 degrees over the near term (2020–2039), and increases could be as high as 1.6 to 2.5 degrees with a mean of 1.94 degrees in the longer term (2060–2079) (NSW Office of Environment and Heritage, 2015a). More Australians die as a consequence of extreme heat events than any other type of natural disaster. New research strongly indicates that climate change has already exacerbated extreme heat events in the past 50 years; the number of record heat days has doubled and heatwaves in Sydney now occur significantly earlier in the season (Steffen 2015b). These projected increases in average maximum temperatures come with an increase in frequency and duration of heatwaves, and pose more of a risk without adaptive measures.

Storms

Scientists anticipate extremely varied rainfall patterns across eastern Australia. In Ku-ring-gai there will be little change to overall annual rainfall, with a strong likelihood that most of the rain will occur in summer and autumn while winter and spring will be drier (OEH, 2015a). Intense rainfall events associated with the summer storm season is likely to feature more prominently in the future (OEH, 2015b). According to meteorologist Dick Whittaker, Ku-ring-gai has a persistent record of large storms rising over the Blue Mountains in the west and travelling eastward toward the coast, tracking across the length of the municipality. Between 1871 and 2013 Whittaker (2014) recounts 17 severe storms in the Ku-ring-gai area that caused destruction of homes and loss of life, often due to the formation of supercell thunderstorms. These storms exhibit distinctive features including large hail, wind gusts over 90 km/h as a result of downbursts, periods of intense rainfall leading to flash flooding and, in a few instances, the formation of tornadoes.

Drought

Ku-ring-gai is at an increased risk of drought conditions in the coming years as a result of climate change (Steffen 2015a). Droughts across south eastern Australia are likely to worsen in severity and duration. As a result urban water scarcity in cities including Sydney will become increasingly challenging.

Ku-ring-gai has frequently been cited as one of the highest per capita water consumers in Australia (Frew, 2007). The average household consumption of water in Ku-ring-gai is 1.0 mL/person/yr, around 43 per cent higher than the average Sydney consumer (ACF, 2007). Droughts have a range of consequences on the community including increases in mental health issues, impacts on local economies with downturns in tourism, reduction in the viability of already stressed habitats and species, water restrictions and increases in the water price, which also translate to increased food prices (Steffen 2015a).

1.3 Climate change impacts

Recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal that some ecosystems and many human systems are significantly exposed and vulnerable to current climate variability (*very high confidence*). The impacts of such events include altered ecosystems, disrupted food production and water supply, damage to infrastructure and settlements, and negative mental health and human well-being consequences, including morbidity and mortality. For countries at all levels of development, these impacts are consistent with a significant lack of preparedness for current climate variability in some sectors (IPCC 2014b). Direct and in-direct impacts can result in significant monetary and non-monetary losses to both the community and Council, most of which can be reduced through implementing adaptive measures and being better prepared.

As the warming trend continues so does the likelihood of severe, pervasive and irreversible changes to the natural resources on which communities depend. The IPCC (2014b, p.14–15) notes impacts on natural resources of a climate warming at the current rate include:

“...intensifying competition for water..., increase sediment, nutrient and pollution loadings from heavy rainfall..., species that cannot adapt fast going extinct..., fire impacts intensifying as species becoming less resilient as a consequence of the combined impact of multiple stressors..., increased tree mortality and forest dieback...”

Each of these effects has significant relevance to Ku-ring-gai communities, particularly residents living in bushfire prone land areas and Council land managed to conserve local biodiversity including terrestrial, aquatic and marine resources. In addition, some sectors of the community are more vulnerable to conditions such as heat stress, storm impacts and periods of water scarcity where water restrictions are applied. These sectors include aged care institutions, seniors particularly those living alone, childcare and day care groups, people with disabilities, low income earners, and residents for whom English is a second language.

1.4 Climate change global risks

The IPCC (2014b) describes five integrative reasons for concern (RFCs), to illustrate the implications of warming and of adaptation limits for people, economies, and ecosystems across sectors and regions. The risks for each RFC are summarised in Box 1 (all temperatures refer to global average temperature change relative to 1986–2005).

Box 1: Impacts of human interference with the climate system (Source: IPCC 2014b, p12)

- 1) Unique and threatened systems:** Some unique and threatened systems, including ecosystems and cultures, are already at risk from climate change (*high confidence*). The number of such systems at risk of severe consequences is higher with additional warming of around 1°C. Many species and systems with limited adaptive capacity are subject to very high risks with additional warming of 2°C, particularly Arctic-sea-ice and coral-reef systems.
- 2) Extreme weather events:** Climate-change-related risks from extreme events, such as heat waves, extreme precipitation, and coastal flooding, are already moderate (*high confidence*) and high with 1°C additional warming (*medium confidence*). Risks associated with some types of extreme events (e.g., extreme heat) increase further at higher temperatures (*high confidence*).
- 3) Distribution of impacts:** Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development. Risks are already moderate because of regionally differentiated climate-change impacts on crop production in particular (*medium to high confidence*). Based on projected decreases in regional crop yields and water availability, risks of unevenly distributed impacts are high for additional warming above 2°C (*medium confidence*).
- 4) Global aggregate impacts:** Risks of global aggregate impacts are moderate for additional warming between 1–2°C, reflecting impacts to both Earth’s biodiversity and the overall global economy (*medium confidence*). Extensive biodiversity loss with associated loss of ecosystem goods and services results in high risks around 3°C additional warming (*high confidence*). Aggregate economic damages accelerate with increasing temperature (*limited evidence, high agreement*), but few quantitative estimates have been completed for additional warming around 3°C or above.
- 5) Large-scale singular events:** With increasing warming, some physical systems or ecosystems may be at risk of abrupt and irreversible changes. Risks associated with such tipping points become moderate between 0–1°C additional warming, due to early warning signs that both warm-water coral reef and Arctic ecosystems are already experiencing irreversible regime shifts (*medium confidence*). Risks increase disproportionately as temperature increases between 1–2°C additional warming and become high above 3°C, due to the potential for a large and irreversible sea level rise from ice sheet loss. For sustained warming greater than some threshold, near-complete loss of the Greenland ice sheet would occur over a millennium or more, contributing up to 7 m of global mean sea level rise.

Key risks are potentially severe impacts relevant to Article 2 of the United Nations Framework Convention on Climate Change, which refers to ‘*dangerous anthropogenic interference with the climate system*’. The criteria used to identify these risks are: large magnitude; high probability, or irreversibility of impacts; timing of impacts; persistent vulnerability or exposure contributing to risks; or limited potential to reduce risks through adaptation or mitigation (IPCC 2014b, p11).

Risks to global human systems

Human risks identified by the IPCC (2014b) with a high degree of probability, severe consequences and sufficient data to validate a high level of certainty include:

- Systematic risks from extreme weather events leading to a breakdown in infrastructure networks, critical services including power, water and health support;
- Risk of mortality and morbidity during periods of extreme heat, particularly for vulnerable populations and those working outdoors;

- Risk to food security and breakdown of food systems due to drought, fluctuations and changes in magnitude of climate and precipitation variability;
- Risk of loss of terrestrial biodiversity, ecosystem goods and service functions;
- Risk of infrastructure overloads arising from energy demand for heating and cooling;
- Challenges to the insurance system;
- Risks from reduced labour productivity;
- Risk of increase in food and water borne disease.

Risks to natural systems

The impact of rapidly warming conditions on biodiversity is a common problem for land managers across the world. It is important to recognise the reasons why conserving biodiversity is critical to the health and wellbeing of a community. Ackerly et al. (2012) nominate carbon storage, forage production, enhanced water supply and quality, pollinator support and outdoor recreation as just a few of the values that may be impacted with a decline in biodiversity.

Many terrestrial and freshwater species risk increased extinction rates under projected climate trends during and beyond the 21st century, especially as the climate compounds other stressors, such as habitat modification, over-exploitation, pollution, and invasive species (*high confidence*). While lower rates of change will pose fewer problems, any additional stress to that already being experienced will be too much for many species. Some species may be able to adapt to new habitats in different climate zones if they are available and they are able to migrate. Many species, however, will be unable to migrate to more suitable climates under mid- and high-range rates of climate change during the 21st century (*medium confidence*). Species that cannot adapt nor relocate will rapidly decrease in abundance or go extinct in part or all of their remnant habitats. Within this century, climate trends associated with medium- to high- emission scenarios pose a high risk of abrupt and irreversible regional-scale changes in the composition, structure, and function of terrestrial and freshwater ecosystems, including wetlands (*medium confidence*) (IPCC 2014b).

As the pressures created by a shift in climate unfolds so vegetation communities will respond by gradually moving in the direction of more favourable conditions. In an urban environment, the option to shift is constrained by manmade barriers such as cities, roads and dwellings. Some species can shift more readily than others, for example those species whose seed dispersal techniques include wind, water or birds. The mode of seed dispersal combined with the range of climatic conditions a vegetation type can thrive under will determine those species that have the best chance of survival into the future.

According to Ackerly et al. (2012) a direct result of shifts in the range and diversity of vegetation types can be a significant reorganisation in bird communities. This subsequently has ramifications in the form of altered interactions between species and community structure. Compounding these more transparent changes are unseen shifts such as a reduced capacity for carbon storage in trees, changing hydrological conditions leading to altered fire regimes to name but a few. Cumulative effects resulting from the many different types of impacts on the natural world have the power to disrupt the ebb and flow of elemental cycles in nutrients, hydrological and gaseous exchange none of which are likely to be favourable to the human condition.

Risks to financial and insurance systems

Across the world disasters have become less deadly over the past decade due to better preparation, better warning systems, better building codes, and the adoption of simple, low cost measures to improve resilience by home owners (The Economist 2015). Converse to this downward trend in lives lost is a very evident escalation in the cost of disaster recovery.

The Economist (2015) considers the reason for the rising cost is increasing development in disaster prone localities, such as near forests, rivers and unstable geological formations. As an example, the article compares Victoria's deadliest bushfire in 2009 to a similar event in 1939, which burned similar but even more extensive parts of the state. Had the population in 1939 been analogous to that in 2009, the 1939 mortality rate would have been far greater than the 2009 fires simply because of the greater number of people living in bushfire hazard areas.

Compounding the population issue is the companion 'problem' of people generally being wealthier than in years past. The financial loss is now much greater as more money is invested in infrastructure and properties. On top of this is the additional cost attributed to the expense of compliance with bushfire resilient building standards, which should result in a decline in losses over time.

The IAG (2014) describes natural disasters as 'everyone's business'. Risks to life and property are managed through government sanctioned systems of regulation and compensation and the insurance industry. Insurers play a fundamental role in any community-based risk scenario and are by necessity good at evaluating risks albeit risks to the industry's profit margins. Insured losses from bushfires are comparatively less costly in terms of recovery and repairs than floods or severe hail storms. Severe hail storms such as the one that devastated Sydney's eastern suburbs in 1999 caused \$1.5B in insured losses in under an hour (BoM 2015).

Mallon, Lamb and Wormworth (2014) investigated how insurance companies are dealing with escalating losses caused by extreme weather events to Australian homes, businesses and government agencies. In a very price sensitive market, there is an imperative for insurers to accurately reflect the risks in policy price, both for company profitability and the welfare and security of the community. Insurance companies believe they have no option but to raise premiums when evidence demonstrates a higher probability of loss. Mallon et al. (2014) consider this to be an integral failure of the property sector that leaves home owners and buyers exposed to significant financial risk. In many cases home owners realise too late that they underestimated the scale of the threat and the real cost of recovery. As a result they lack the funds to recover to the same level they enjoyed prior to the loss occurring.

Improving property resilience is rapidly shaping up as an economic necessity. This was demonstrated in the Blue Mountains bushfire in 2013, where the financial burden of disaster recovery landed directly on property owners. Many residents in Springwood and Winmalee failed to adequately factor into their insurance premiums losses arising from the cost of rebuilding to a mandatory higher bushfire resilient building standard than was required when they built or purchased their home.

According to Blue Mountains City Council Mayor, Mark Greenhill:

'At a time when a significant number of our residents face the challenge of rebuilding their homes destroyed by the October 2013 bush fires, this situation remains unacceptable. When we hear that these people, in good faith, insured their homes only to find out at the worst time possible, that the added cost of complying with the NSW Government bush fire building code is up to \$200,000 and beyond, we all feel disbelief.' (BMCC 2014)

Under current disaster compensation arrangements, this trend may eventually result in homeowners being unable to afford adequate insurance coverage. Given the unfortunate legacy of past poor planning decisions, plus the continuing pressure to intensify urban land use, the number of homes in risk exposed locations such as bushfire prone, flood prone or low lying coastal areas may well increase the magnitude of loss in the face of climate change. It is the community that bears the cost of recovery, whether that is in the form of higher insurance premiums, increased taxation or devaluation of property.

Insurance conglomerate IAG has investigated methods to more accurately identify property specific risk exposure to contextual hazards. IAG found it is possible to differentiate between the risk exposure for particular properties and this information to more accurately assess each property's premium (IAG 2014). It is now likely that insurance products for some high risk homes may become unaffordable unless home owners take action to build their resilience. If the insurance companies take a balanced view then savings on premiums should be offered for homes can demonstrate their resilient or are located in areas with minimal risk exposure.

A similar trend has been forecast around the globe; that is, more severe and/or frequent extreme weather events and/or hazard types are projected to increase losses and loss variability in certain regions and challenge insurance systems to offer affordable coverage while raising more risk-based capital (IPCC 2014b). This has been confirmed by the Australian Business Roundtable for Disaster Resilience and Safer Communities, which claims that the cost of natural disasters in Australia will quadruple in the next few decades from approximately \$A6.3B to A\$23B (Deloitte Access Economics 2013).

2. Rationale for climate change adaptation

- Rate of warming = rate of increase in risk
- Delayed action = higher costs
- Biodiversity conservation is a key community value aspiration.

The warming trend in global temperatures and subsequent changes in climate systems is at the heart of why communities need to adapt to climate change impacts. The rate of increase in Greenhouse Gas (GHG) emissions is proportionate to rate of increase in the risk of climate related impacts; the higher the concentration of GHGs in the atmosphere the greater the likelihood and magnitude of impact.

While the challenge of achieving substantial and sustained reductions in GHG emissions grows in urgency so does the imperative to have communities adapt to altered conditions. A delay to curbing emissions results in a higher probability of the rate and magnitude of impact and a steady rise in the cost of effective adaptations (Stern 2007, Garnaut 2011).

Even if there was sufficient momentum now for the world's governments to halt the rising volume of GHG emissions, it would still take a few decades to arrest the global warming trend due to the lag phase between cause and effect (Taplin et al. 2010). According to the US Office of Technology Assessment (1991) the lag time between GHG emissions and their full impact on the climate is decades to centuries as is the time needed to reverse these effects. So, for the medium term at least, the imperative to adapt will not diminish and to do nothing would likely result in significant financial, social and environmental consequences (Taplin et al. 2010).

Community and personal resilience is highly dependent on where people are located and individual circumstances. Urban dwellers generally have faster access to emergency services, hospitals and formalised recovery networks. In the bush people tend to be more independent and rely on informal assistance from neighbours and their personal social networks. However, both types of communities have their strengths and weaknesses and both could improve their resilience using a 'shared responsibility' approach as recommended in the National Strategy for Disaster Resilience (COAG 2011).

The National Strategy for Disaster Resilience (2011) states: *'Potential escalation in the frequency and magnitude of hazards and our increasing vulnerability to disasters presents governments with unprecedented calls on their resources and expertise. Governments' desire to help communities in need and pressure to help*

those affected may be creating unrealistic expectations and unsustainable dependencies. Should this continue, it will undermine community capability and confidence. Therefore, communities need to be empowered to take shared responsibility for coping with disasters.'

The National Strategy for Disaster Resilience (2011) also notes the value of increased resilience in preparing communities for a wider range of disasters such as pandemics, animal disease and terrorist events.

Vulnerability to extreme weather extends well beyond the human dimension. In addition to adaptations to human systems, the need for action to minimise as much as possible the negatives effects of climate change on biodiversity is obvious. San Francisco is one of the best examples of a city taking action to minimise the impacts of climate change on biodiversity assets. Strategic conservation planning in the Bay area aims to enhance local biodiversity by continuing to acquire open space for conservation and to conserve heterogeneous landscapes to maintain the diversity in assets. Complementary research is improving knowledge around the projected change in weather regimes so that adaptation strategies can be refined as more information becomes available.

If Ku-ring-gai is to avoid some of the more deleterious impacts of climate change on the natural assets of the area then more research is required to better understand and prepare for these impacts. The costs and benefits of any loss of habitat or biodiversity assets need to be very carefully weighed against the longer-term community vision for Ku-ring-gai. Only development that can demonstrably enhance biodiversity assets should be encouraged.

3. Context for climate change adaptation in local government

- External institutional arrangements around climate change in Australia bequeath action on climate change to local level
- Barriers to adaptation exist in all levels of government
- Council's response to the need to adapt to date has been effective and aligned to recommendations made in federal government inquiries.

As strategic asset owners, service providers and decision makers, councils need to have a clear understanding of how and when to adapt to potential increased risks from climate change (Inglis et al. 2014). The inadequate resilience of communities across Australia has been witnessed with recent extreme events, clearly demonstrating the need for councils to provide leadership in climate adaptation by building climate resilience into its operations, service delivery and that of their constituent communities (Climate Commission 2013). Parallel to this, substantial emissions reductions over the next few decades can minimise climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of long-term mitigation, and contribute to climate-resilient pathways for sustainable development (IPCC 2014a).

3.1 External institutional arrangements

Until fairly recently federal and state governments have paid less attention to climate change adaptation than managing Greenhouse Gas emissions. Inquiries into aspects of climate change impact and adaptation management have occurred under the Federal Attorney-General and the Productivity Commission.

Inquiring into the costs of recovery from climate disasters, the Attorney-General stated that *'[the cyclone Yasi] disaster last summer was exacerbated by a lack of investment in disaster mitigation initiatives and poor planning decisions which have left communities exposed to very significant disaster risk'* (McClelland 2011).

In 2012 the Productivity Commission released its *Barriers to Effective Climate Change Adaptation* report. The Commission found that government at all levels should embed climate change into their risk management strategies to improve their resilience. At the community level a range of strategies were suggested to help overcome current barriers inhibiting effective and efficient adaptation. These strategies included:

- Reduce perverse tax incentives that impede mobility of capital and labour
- Improve natural hazard mapping
- Clarify roles, responsibilities and legal liability of local government and improve their capacity to manage climate risks
- Review emergency management arrangements, and
- Reduce tax and regulatory distortions in insurance markets (Productivity Commission 2012).

The Commission went on to find that a more flexible land use planning regulation needs to be implemented, and that the regulation and building codes need to take the effects of climate change into account over the life of the building. Introducing these measures would assist in reducing some of the barriers associated with climate change. However, whilst ever climate change is subject to federal political point scoring, there is little chance of overcoming the major barrier of community confusion and indifference as they are faced with conflicting policy positions and information.

In NSW, the Office of Environment and Heritage has developed and made available climate adaptation information and resources for use by planners and decision makers across the state. These resources are aimed at assisting those working close to the ground where much of the adaptation work urgently needs attention. For example, coastal councils attempting to control development in areas exposed to extreme hazards relating to sea level rise, and coastal and riverine flood exposed councils around Australia, have struggled to come to terms with the often conflicting advice coming from higher levels of government (Solomons and Willacy 2014).

Climate change resilience has emerged recently as a priority for investment by Australian federal and state governments (McClelland 2011, Productivity Commission 2012). Local government has long recognised the imperative for adaptation and has collectively made substantial progress in the development of climate change adaptation strategies to strengthen the resilience of their local communities. A shared responsibility between government (commonwealth, state and local), business, non-government organisations and individuals is the fundamental basis underpinning the entire national resilience approach.

According to the Federal Attorney-General (2009), '*While the [National] Strategy [for Disaster Resilience] focuses on priority areas to build disaster resilient communities across Australia, it also recognises that disaster resilience is a shared responsibility for individuals, households, businesses and communities, as well as for governments. The Strategy is the first step in a long-term, evolving process to deliver sustained behavioural change and enduring partnerships*'.

The Federal Attorney-General (2009) nominated six criteria to guide subsidiary levels of government in their disaster resilience work. These criteria are outlined below, each accompanied by an explanation of the manner in which Ku-ring-gai Council has addressed each one criteria to date:

-
1. Developing and implementing effective, risk-based land management and planning arrangements and other mitigation activities

Bushfire hazard zone intensification prevention, mapping and management of riparian areas, flood studies

2. Having effective arrangements in place to inform people about how to assess risks and reduce their exposure and vulnerability to hazards

Climate Wise Communities (CWC) hazard analysis by location and sector. UNSW ADFA work on identifying vulnerable community sectors, methods developed for self-assessment of personal, property and neighbourhood scale risk factors and how to improve resilience

3. Having clear and effective education systems understand what options are available and what the best course of action is in responding so people to a hazard as it approaches

Work with RMIT and Bushfire CRC to develop award winning methods to better educate the community on the risks associated with extreme weather events and provide people with a method to determine which actions to take and what to do when plan a fails. Contingencies and alternatives are clarified, resourced and rehearsed

4. Supporting individuals and communities to prepare for extreme events

CWC is liaising with community groups and others around the possibility of the development of a network for disaster preparedness, response and recovery

5. Ensuring the most effective, well-coordinated response from our emergency services and volunteers when disaster hits

Work across agencies and connecting agencies with the community for better preparation, response and recovery capacity

6. Working in a swift, compassionate and pragmatic way to help communities recover from devastation and to learn, innovate and adapt in the aftermath of disastrous events

CWC has worked with the Red Cross looking at disaster resilience in such a way as to not just recover but use recovery is an opportunity for betterment of the resilience of affected communities etc.

The *National Strategy for Disaster Resilience* (2011) notes common characteristics of disaster resilient communities, individuals and organisations. These characteristics are:

- function well while under stress;
- achieve successful adaptation;
- possess self-reliance; and
- enhance social capacity.

These characteristics should be developed by any project designed to improve the resilience of a community group, local area or entity. Developing social networks, overcoming barriers to engagement in discussions with community regarding the need to strengthen resilience and improving how the increasing level of risk arising from climate change can be managed is a key question for every level government, emergency management agencies, community groups and residents. Communities that fail to adapt will likely suffer wide ranging consequences including but not limited to refusal of insurance or unaffordable premiums; extended periods of 'down time' for business as they wait for in demand tradesmen to repair damage to infrastructure and premises; potential isolation, and longer periods without the benefits of power, water and waste removal services.

3.2. Legal and institutional developments

- Courts are increasingly willing to take the environmental impact of climate change into decisions
- Economic interests are no longer the overriding priority in planning with social and environmental considerations now given equal weighting by decision makers
- The absence of a clear climate change policy leaves decision makers open to litigation
- Ku-ring-gai's approach to climate adaptation is founded on the ESD principles and consistent with current legal recommendations in the literature.

While over recent years the courts have focused on whether or not to allow new developments in areas exposed to sea level rise, the judgements are instructive in guiding decision makers towards acceptable strategies to minimise climate risks. The Attorney-General, in McClelland (2011), discussed the legal risks associated with climate change as involving responsibility to mitigate impacts, the need to take climate change into account when making decisions and the impact of climate change on national security. The courts, notes the Attorney-General, are willing into account to take the environmental impact of climate change in decisions.

Peel (in McClelland, 2011) explains that environmental groups have turned to litigation to achieve positive environmental outcomes by pushing environmental issues into the decision making arena more effectively through the courts. Incorporating environmental criteria into any strategy designed to deal with and promote climate resilience is essential for any agency, not only because of the leadership demonstrated by the courts but also because it is necessary to link resilience with improved sustainability of natural assets and their interdependent ecosystem services on which human health and wealth rely.

For some years decision makers have shown a clear bias toward economic development in NSW as the keystone criteria in the approval process for changes in land use (Oriti 2015). More recently, the NSW Minister for Planning Rob Stokes, has gone on the record saying,

'The careful deliberation of environmental, economic and social issues is fundamental to good planning. This proposed amendment [of the Mining State Environmental Planning Policy] reflects the importance of balance in assessing the likely impacts of mining developments' (in Oriti 2015)

If this shift in NSW government policy flows on into land use decision making process in local government, more balanced decisions should result. While climate change adaptation strategies do not always involve a change of land use, it is often the case. Basing priorities and decision making on well informed sustainability science is considered necessary if outcomes are to be efficient and effective. As discussed in the 2010 Ku-ring-gai Climate Change Adaptation Policy and Strategy, applying the Principles of Ecologically Sustainable Development (ESD) in a triple bottom line framework allows climate change to be considered in the land use planning forum (Ku-ring-gai Council 2010, Baker-Jones 2015).

Baker-Jones (2015) goes on to say that there is an established body of jurisprudence on ESD available, which clarifies the meaning of ESD as 'recognising our duty to each other, to future generations and to the Earth itself' (p. 20). According to Preston (2015), climate change litigation is slowly progressing with legal developments looking to utilise human rights legislation to include damage from climate change. Preston (2015) also notes there are obstacles to overcome in 'greening' human rights law, with a Model Statute on Legal Remedies for Climate Change leading the way to the adoption of domestic procedural and substantive laws.

These developments have implications for local government. In the absence of a clear climate change policy, governments are increasingly at risk of litigation particularly around land use planning decisions. Baker-Jones (2014) notes a case in the US where an insurer sought to effect change in local government through litigation. The author details the action being taken against 100 cities, villages and towns for failing in their duty to provide safe, adequate stormwater mitigation, storage and conveyance. The insurer was seeking to demonstrate that the local government authorities were negligent and as result caused economic loss to the plaintiffs. The insurer further claimed that the local governments were the sole authorities in charge of the conveyance of stormwater and should have known that adaptations to the increase in intensity, duration and frequency in rainfall as a result of climate change were needed (Baker-Jones, 2014).

For local government this case demonstrates that councils need to assess their efforts against those of other councils to rationalise any decisions to or reasons for inaction. Secondly informed guidance in decision making is essential. Baker-Jones (2014) notes that almost all litigation in Australia and internationally has occurred where ill-informed decisions were taken. This highlights the importance of an up to date and comprehensive climate mitigation and adaptation policy as the basis of well informed decisions.

On the other hand Francis (2010) believes the courts are reluctant to take on civil litigation cases where the accusation of negligence lies in the merit of a policy decision. Establishing whether a duty of care to the individuals affected ever existed and whether a legal duty of care was breached by a negligent act is complicated by the fact that public agencies have a many areas of responsibility (Francis, 2010). Indeed plaintiffs do have, within reason, a duty of care to look after themselves and where this not possible a number of agencies have contingences and programs to assist residents build their capacity to better look after themselves in an extreme event.

The use of ESD principles to prioritise Council's adaptations allowed an established and accepted set of 'standards' to form a basis for well-informed and comprehensive decision making. More recently cases have shown that attention by the Courts in determining planning issues around climate change has shifted toward the application of ESD principles (Foerster, McIntosh and McDonald 2015). In terms of adaptation two central themes emerge. Firstly, the need to use planning laws to prevent further people being placed in harm's way from the impacts of climate change. Secondly, where existing community sectors and locations are currently at an elevated risk from climate impacts, adaptations must improve resilience by ensuring any change is compatible with the public interest in terms of financial (effectiveness, efficiency and cost benefit), social (equity, legal rights, security) and environmental (biological enrichment, health and risk positive) attributes.

4. Climate change adaptation approach

4.1 Climate resilient pathways

- Decision making regarding climate change adaptation occurs necessarily under the caveats of uncertainty
- The Principles of Ecologically Sustainable Development (ESD) can be used to deal with uncertainty
- Preventing risks from occurring is the most effective and efficient form of risk management

To understand the consequence of the changes in the frequency and severity of extreme weather events, it is necessary to first investigate the vulnerability and current resilience of physical, social and financial characteristics of a locality and population. Decision making under the caveats of uncertainty, timing and magnitude of impact of future climate events can benefit from the application of the Principles of Ecologically Sustainable Development (ESD). Applying the Precautionary Principle as a lens to assess the risk exposure

to the companion ESD principles (inter and intra generational equity, conservation of biodiversity and applying true valuations to environmental goods and services) to climate change has already served Council well. A sustainability based framework has assisted Council to better understand the financial and non-financial costs and benefits of possible adaptations and prioritise high return adaptations for Council investment. The application and use of the ESD principles is examined in more detail in Section 4.2.

Prospects for successful climate-resilient pathways for sustainable development are related fundamentally to the degree to which the world accomplishes climate change mitigation (*high confidence*, IPCC 2014). Mitigation reduces the magnitude of warming and also allows society more time to adapt to a more punishing level of climate change, potentially by several decades. Conversely, delaying progress on mitigation may reduce options and increase costs for future successful climate-resilient pathways.

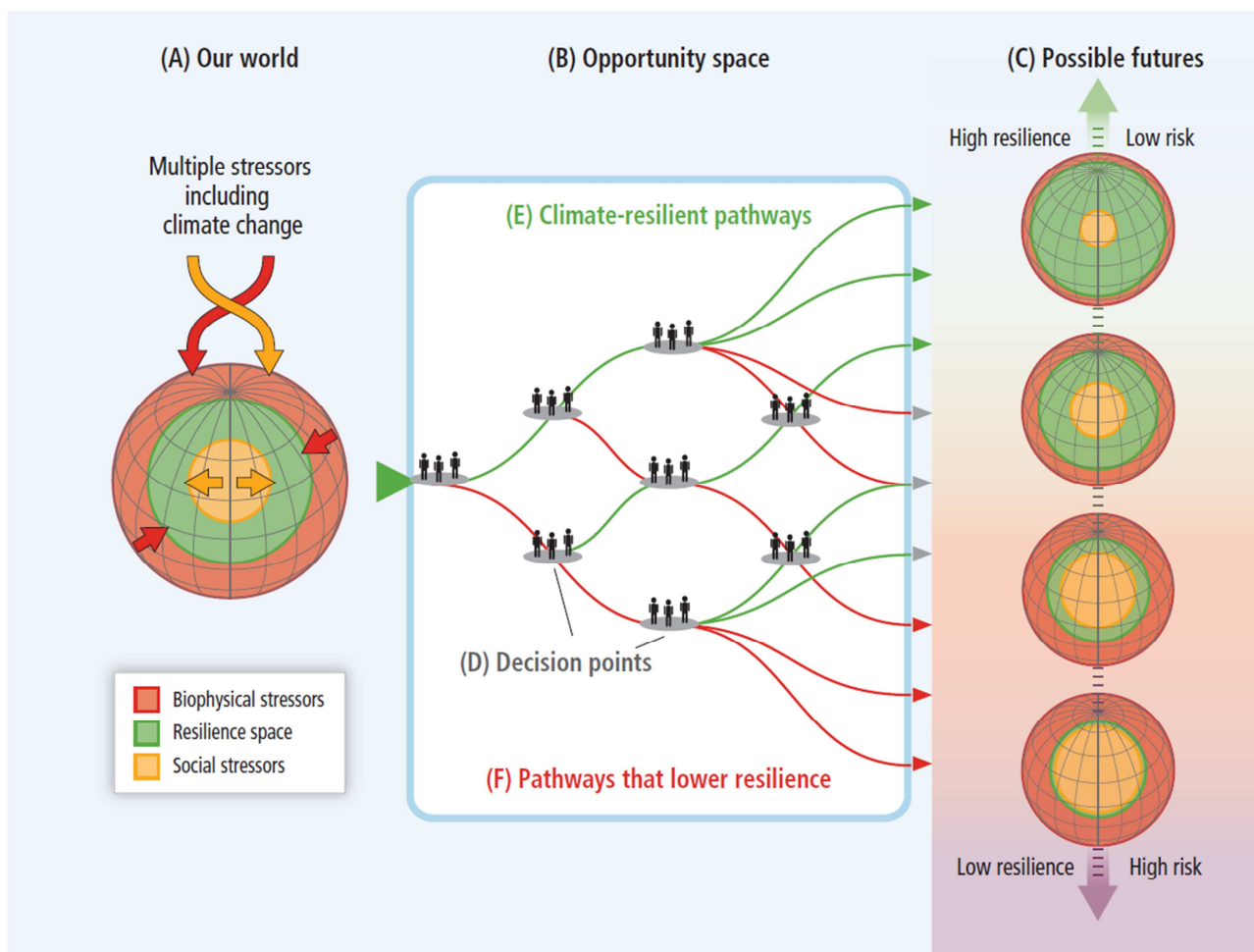


Figure SPM.9 | Opportunity space and climate-resilient pathways. (A) Our world [Sections A-1 and B-1] is threatened by multiple stressors that impinge on resilience from many directions, represented here simply as biophysical and social stressors. Stressors include climate change, climate variability, land-use change, degradation of ecosystems, poverty and inequality, and cultural factors. (B) Opportunity space [Sections A-2, A-3, B-2, C-1, and C-2] refers to decision points and pathways that lead to a range of (C) possible futures [Sections C and B-3] with differing levels of resilience and risk. (D) Decision points result in actions or failures-to-act throughout the opportunity space, and together they constitute the process of managing or failing to manage risks related to climate change. (E) Climate-resilient pathways (in green) within the opportunity space lead to a more resilient world through adaptive learning, increasing scientific knowledge, effective adaptation and mitigation measures, and other choices that reduce risks. (F) Pathways that lower resilience (in red) can involve insufficient mitigation, maladaptation, failure to learn and use knowledge, and other actions that lower resilience; and they can be irreversible in terms of possible futures.

Figure 2: Climate resilience pathways (Source: IPCC 2014a, p29)

Figure 2 demonstrates how climate-resilient pathways (in green) shift society to a more resilient and robust world through adaptive learning, increasing scientific knowledge, effective adaptation and mitigation measures, and other choices to reduce risk. Pathways that fail to respond to the increased risks and effectively lower resilience (in red) are a result of maintaining the status quo; affirming policies that allow insufficient mitigation, maladaptation and which fail to learn from current knowledge (IPCC 2014a, p29). Actions that lower resilience can result in irreversible consequences and limit the scope of possible futures for generations to come.

Greater rates and magnitude of climate change increase the likelihood of exceeding adaptation limits (*high confidence*). Limits to adaptation occur when actions to avoid intolerable risks for a set of objectives or for the needs of a system are not possible or are not currently available. Value-based judgments of what constitutes an intolerable risk may differ. Limits to adaptation emerge from the interaction among climate change and biophysical and/or socioeconomic constraints. Opportunities to take advantage of positive synergies between adaptation and mitigation may decrease with time, particularly if limits to adaptation are exceeded. In some parts of the world, insufficient responses to emerging impacts are already eroding the basis for sustainable development (IPCC, 2014b).

Transforming economic, social, technological and political decisions and actions can enable climate-resilient pathways (*high confidence*). Strategies and actions can be taken to move society onto climate-resilient pathways for sustainable development, and at the same time help to improve livelihoods, social and economic well-being, and responsible environmental management.

At the national level, transformation is most effective when it reflects a country's national circumstances, priorities and approaches to achieving sustainable development, and will benefit from periodic review and iterative learning, deliberative processes and innovation (IPCC, 2014b).

Investment in disaster prevention is currently regarded as the leading initiative to reduce rising costs associated with recovery (IAG 2014, OEH 2015b). An alternative option is to move people out of harm's way; however, while effective, the cost is prohibitive in terms of bushfire, problematic for storms except if it is to move people out of flood zones, and inappropriate for extreme heat and drought. Where improving resilience is financially prohibitive or impractical, moving people out of harms' way may be the only effective solution when the scale is manageable and spatial impact is very well defined. The re-building of areas of the city of Christchurch after the 2011 earthquake is such an example (Statistics New Zealand, 2012).

5. Climate change adaptation guiding principles and frameworks

- Ecologically Sustainable Development (ESD) is strongly related to other policy guidance frameworks for the development of high quality resilience
- Public Interest environmental values add detail and give guidance to the application of the ESD principles
- A shared responsibility framework for the preparation, response and recovery to natural disasters is sustainable, allow public interest environmental values to be activated and ESD principles engaged in the decision making process.

Given the courts are determining climate change issues by applying the judicious use of the Principles of ESD, it is intended that any future adaptations will be scrutinised using the same process as staff applied to the first iteration the Climate Change Adaptation Strategy (2010). The Principles of ESD are sufficiently

flexible to allow staff to take into account criteria developed over the past five years to better assess the effectiveness and efficiency of adaptations aimed at reduce vulnerability or increasing resilience of Council.

Application of the ESD principles as a guide to prioritising investment in adaptations has served Council very well to date. Council is continuing with the current prioritised adaptations as they fit very neatly into the IPCC's prioritisation hierarchy with the majority falling in the 'avoid' and 'accommodate' categories. Invariably the cheapest and often most effective way of dealing with a risk of any kind is to prevent the impact from occurring in the first place. Subsequent investment in adaptations designed to prevent an impact are going to be less expensive than for those that require an impact to be accommodated or absorbed. Impacts that are accommodated or absorbed create a cost burden to someone or something and so typically require investment to control and often compensate those affected for the loss.

While the analysis doesn't explicitly apply the Principles of ESD in the adaptation prioritisation modelling undertaken by Council in 2010, it does implicitly apply the Principles using a form of financial and non-financial cost benefit analytical criteria against each of the possible adaptations.

Applying a precautionary approach, value identification and framing responses

For many years, scientists have warned governments of the risks associated with climate change. More recently economists such as Nicholas Stern in the UK and Ross Garnaut in Australia clarified the financial costs if these risks eventuate. In 2013, Nicholas Stern reinforced his statement from 2007 that climate change poses a major threat to the world's economies. However the original report relied on the premise of a 75 per cent chance of two to three degrees global warming scenario. In 2013 the science has shifted and Stern admits he grossly underestimated the impact; it is now probable that global warming to four to five degrees will occur (Stewart and Elliott 2013). The lesson from this is that adaptations need to be less energy intensive and sustainable across the Triple Bottom Line to have any chance of being effective in the face of these expected levels of warming.

Due to the levels of uncertainty associated with the rate and magnitude of changes to the climatic system and its associated impacts, it is appropriate for Council to continue to apply the Precautionary Principle in responding to the challenge of climate change. This states that where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason of postponing measures to prevent environmental degradation (Preston n.d.)

The Precautionary Principle prompts the application of risk analysis. In undertaking this risk analysis, the 'at risk' values are the companion principles of Ecologically Sustainable Development (ESD), namely precautionary principle, inter-generational and intra-generational equity, conservation of biological diversity and ecological integrity and the internalisation of external environmental costs (Preston n.d.). Under the NSW *Local Government Act 1993*, councils must manage the local environment with consideration to the ESD principles. The purposes of the Act set out in Section 7e, require '*councils, councillors and council employees to have regard to the principles of ecologically sustainable development in carrying out their responsibilities*'.

Public interest environmental values

In addition to the ESD principles, there are other frameworks that may be useful in the development of public risk management responses to climate change. Public Interest Environmental Values (PIEV) are being recognised and are influencing decision making in Victoria where litigation around climate change is a topical issue (Foerster et al. 2015). PIEVs are considered by some to be representative of public environmental goods and services. Environmental services, economic performance and social good are so closely entwined, notes Foerster et al. (2015), that it is sometimes difficult to prevent trade-offs from occurring. An example of a

typical trade-off occurs at juncture between biodiversity conservation and private property rights. In some instances planning laws have changed to reflect the increase in risk in the landscape, for example flood zones and bushfire hazard zones. Conservation of biodiversity on the other hand has yet to benefit from a similar level of protection. While the risks emerging from climate change can be measured against the ESD principles, the Public Interest Environmental Values help give meaning and detail to these principles, making it easier to evaluate the level of risk imposed by extreme weather events.

Shared responsibility framework

Responding to the risks imposed by climate change is going to require a shift from the status quo. Communities must have an active role in building resilience capacity as the scope of the problem is such that neither government nor the insurance industry alone can absorb the cost of doing so.

Climate change adaptation poses significant challenges to Australian communities. The potential impacts of a warming world are both a challenge to anthropocentric and non-anthropocentric assets, systems and values. To make any real traction in building resilience, it is essential that the investment and energy applied to the problem comes from all sectors of government and the community. The federal Department of Environment promotes a shared responsibility approach as the best way of dealing with the issue of climate adaptation (Commonwealth Department of Environment 2015).

The National Strategy for Disaster Resilience (2011) states:

'The application of a resilience based approach is not solely the domain of emergency management agencies; rather it is a shared responsibility between governments, communities, business and individuals'.

Council has operated under the 'shared responsibility' framework for climate adaptation since 2010, working with community groups, business, residents, emergency services, Red Cross, and various state government agencies. The shared responsibility framework appears to be the only viable route toward strengthening community resilience currently available. For a variety of reasons it is difficult to reduce natural hazards such as tree and limb failure, excessive storm flow volumes and extended periods of extreme heat. Often attempts to reduce a perceived hazard associated with trees, for example, lead to unintended consequences that may exceed the benefit, such as the 10/50 vegetation clearing entitlement introduced by the NSW State government under the Rural Fire Service (Ku-ring-gai Council 2015).

Although Council's principle climate adaptation strategy, Climate Wise Communities, has made considerable progress since 2010, much remains to be done. The Climate Wise Communities program has conducted over twenty workshops, made presentations to many other agencies, conferences and workshops, and engaged directly with an audience of over 700 people. There remains nevertheless a gap in Council's adaptation planning and resilience capacity building concerning Council's own internal resources, processes and services. The vulnerability of these resources and services needs careful analysis to determine which adaptations will best serve Council's interests in terms of risk prevention of social, financial and environmental obligations. The IPCC (2014b) gives some guidance to interpreting the need to adapt effectively.

IPCC principles for effective adaptation

The IPCC (2014b) outlines a series of principles for effective adaptation, detailed in Appendix 3. Box 2 demonstrates how Ku-ring-gai Council has acknowledged and will continue to apply these principles.

Box 2: Ku-ring-gai Council's response to IPCC principles for effective adaptation

1. Adaptation is place- and context-specific, with no single approach for reducing risks appropriate across all settings

Council's adaptation assessments and plans need to occur as close to the ground as possible. Adaptations should be determined by those who are most familiar and responsible for the asset, process or service.

2. Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments

Council's adaptation plans need to be mindful of state and federal government grants, and developments in legislation including land use planning, insurance, environment and civil liability. Requirements for Local Government to demonstrate sustainability in investment options may emerge.

3. A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability

Each department needs to conduct its own vulnerability assessment. This will include the vulnerability of assets, resources, supply chains, services, essential processes and people. Resilience strategies already in place need to be included in the vulnerability assessment. Risks need to be prioritised in order of magnitude to enable adaptations to be incorporate into the five year operational plan.

4. Adaptation planning and implementation at all levels of governance are contingent on societal values, objectives, and risk perceptions

Community expectations as expressed in the Community Strategic Plan need to be taken into account when prioritising adaptations for future investment. Legal risks, corporate standards and industry standards of practice should help guide priority and scale of investment required.

5. Decision support is most effective when it is sensitive to context and the diversity of decision types, decision processes, and constituencies

Staff engagement is critical to the efficacy and success of any internal adaptations. Departmental silos are often a barrier to collective action. In this instance it is likely that cross departmental strategies will be needed. Facilitating cross departmental planning and action on adaptation should be encouraged.

6. Existing and emerging economic instruments can foster adaptation by providing incentives for anticipating and reducing impacts

Council should seek to co-operate with other councils in adaptation strategies where mutual benefit is likely. This is more commonly found in mitigation strategies but, nevertheless, neighbouring councils with communal assets such as contiguous bushland corridors, creeks and rivers or neighbourhoods may offer opportunities for collaboration.

7. Constraints can interact to impede adaptation planning and implementation

The above criteria will be built into the adaptation design method. It will allow staff to establish the likely risk to their areas of responsibility, consider how significant the risk is, the potential

adaptations that might reduce vulnerabilities identified and strengthen resilience, and keep expectations simple, realistic and in proportion to the scale of the vulnerability identified.

8. Poor planning, overemphasizing short-term outcomes, or failing to sufficiently anticipate consequences can result in maladaptation

Examples of maladaptation exist and serve as a reminder that poorly crafted and analysed adaptations can lead to range of unintended consequences. Sometime these types of adaptation have been put in place as a 'quick fix' to a problem that the electorate is agitating for action on. For example, the aforementioned 10/50 Vegetation clearing entitlement provisions, the approval of further urban intensification in areas deemed at high risk of impact or the softening of water restrictions imposed in drought times. These adaptations or removal of adaptations demonstrate a poorly constructed policy base for decisions regarding adaptations. Instead of solid risk and sustainability provenance, these maladaptations are more often imposed by political and/or financial pressure from powerful individuals.

9. Limited evidence indicates a gap between global adaptation needs and the funds available for adaptation

While global adaptation costing goes well beyond the scope of local government, it is useful for councils to monitor and share the costs arising from their own adaptation programs. These costings can prove valuable to state and federal levels of government when determining the cost benefit of implementing programs to improve the benefits arising from adaptation, more realistic allocation of funding and will also assist to minimise barriers to adaptation as the cost/benefit becomes more transparent.

10. Significant co-benefits, synergies, and trade-offs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions

Council has recognised the synergies that exist between mitigation and adaptation. Accordingly Council is investing in programs to reduce energy and water consumption and encourage renewable energy and the capture and re-use of stormwater. In addition the analysis of the cost benefit of potential adaptation includes Greenhouse Gas emissions that may arise from the implementation of each adaptation. This is acknowledged as a cost to Council as further investment would be required to offset those emissions to allow Council to reach its commitment of a 20 per cent reduction in Greenhouse Gas emissions by 2020.

5.1 Decision making process for building internal resilience

The IPCC (2014) outlines the decision making process for the assessment of future climate risks and potential responses, summarised below:

- Responding to climate-related risks involves decision making in a changing world, with continuing uncertainty about the severity and timing of climate-change impacts and with limits to the effectiveness of adaptation (*high confidence*).
- Adaptation and mitigation choices in the near term will affect the risks of climate change throughout the 21st century (*high confidence*).

- Uncertainties about future vulnerability, exposure, and responses of interlinked human and natural systems are large (*high confidence*). This motivates exploration of a wide range of socioeconomic futures in assessments of risks.

In terms of Ku-ring-gai Council this means that although climate modelling on the regional scale has improved greatly in the past five years there remain caveats around the timing and severity of impacts. As a result any adaptation planning needs to be iterative and flexible to allow the adaptations to be adjusted as new information comes to light. Stern and Garnaut's message regarding 'early investment' remains as relevant now as it did in 2010.

Investing in adaptations to strengthen the resilience of both the community's and Council's resources and values is more efficient if not left until the impacts have begun. Prevention of the impacts has been demonstrated to be more cost effective than mitigation after impacts have occurred (Stern 2007, Garnaut 2011, Stewart and Elliot 2013). Early adaptation is an underlying theme across the internal and external resilience capacity building in the coming years.

6. Development of 2016 Climate Change Adaptation Strategy

- *External* community adaptation process well underway and continuing
- Avoid trade-offs as they come at a cost to someone or something at sometime
- Adaptations should (in priority order) avoid, accommodate, protect and finally retreat from hazards
- Evaluating *internal* resilience in Council, requires determination of vulnerability and resilience by department, service function and asset

6.1 External (community adaptations)

Roll out of the 2010 Climate Change Adaptation Strategy priority actions is intended to continue over the next strategy period. The objectives of the 2010 model were two-fold: firstly to explore and prioritise geographic areas and community sectors which the evidence suggested were more vulnerable to a range of extreme weather events, and secondly to prioritise according to least cost for most benefit the potential adaptations that could reduce these identified vulnerabilities and improve resilience.

The 2010 climate adaptation planning was based on the identification of:

1. changes in regional weather trends (based on latest downscaled modelling available)
2. local risks arising from changed weather trends (based on probability and consequence)
3. Ku-ring-gai's vulnerability and resilience factors (based on physical and socio-economic factors)
4. and prioritisation of adaptation strategies to improve resilience to the risks in Ku-ring-gai (based on triple bottom line and risk performance)

In determining vulnerability to extreme weather events, the full spectrum of direct and indirect impacts was considered. Such impacts may be due to the physical location or socio-economic characteristics of a household or business.

The process applied in Ku-ring-gai to identify vulnerable locations relied upon existing information. Council conducted research to bridge any knowledge gaps where data was available. Vulnerability factors for the four key risks identified for Ku-ring-gai — bushfire, storms and flooding, heat stress and drought — are:

1. Bushfire vulnerability

Bushfire risk arising from the physical location of a property is reasonably well understood. Bushfire hazard zones have been identified, on ground verified and mapped. Around 14,000 properties in Ku-ring-gai are located in areas mapped as at high level of risk. Socio-economic groups identified as more vulnerable to bushfire are the aged and disabled living in their own homes; family day care, child care and pre-schools for the very young; people for whom English is a second language; residents recently arrived in the area (particularly those from another country); nursing homes and retirement businesses; women at home caring for young children; carers, and those without transport.

Bushfires cost the Australian community in excess of A\$77 million per annum on average (ABS 2008). With the changes in weather patterns as a result of climate change, this figure is already rising.

2. Storms and flooding

Information on storm vulnerability mapping has proved difficult to acquire but Council is pursuing information that indicates a strong likelihood of the existence of a 'storm corridor' across Ku-ring-gai. This confidence is based on material that has emerged from research undertaken by meteorologist Dick Whittaker who has mapped storm paths occurring over the past 100 years. There appears to be a trend in the direction and path storms take across Ku-ring-gai, which would allow Council to focus the storm resilience work to properties within this corridor.

Mapping of flood prone areas is currently underway by consultants to Council and will augment the storm information. Storms on average cost the Australian community over A\$284 million per annum (ABS 2008), although a single storm event in Ku-ring-gai in 1991 created a clean-up bill that exceeded A\$600 million. This particular storm was extreme but it is likely that these types of severe storms will occur with greater frequency and could intensify as a result of climate change.

3. Heat stress

'More Australians die each year from extreme heat than any other type of natural disaster' (Steffen 2015b). The Climate Council notes that heat waves in Sydney now typically start 19 days earlier in the year than the norm and since 1950 the number of heat wave days has increased from an average of six per year to nine per year in 2011. In 1950 there were one to two heat wave events in a typical year while in 2011 this had become two to three heatwaves per year (Steffen 2015b).

As the urban footprint of Ku-ring-gai continues to grow and intensify so the 'heat island' effect builds. The ability of Ku-ring-gai to keep cool during extreme events appears to be declining, with the removal of trees, expansion of the area covered by heat absorbing footpaths and pavements, and increasing numbers of air conditioning units pumping hot air out of buildings adding to this effect. In cities such as London and Glasgow, where these changes in land use characteristics have been quantified, differences of up to six degrees have been detected (Rohinton 2015). To date in Ku-ring-gai vulnerability to heat stress has focused on those residents considered most vulnerable to heat stress; that is, the aged and very young as well as pets. Losses attributed to heat stress are difficult to quantify but as an example, Pricewaterhouse Coopers, in a report for the Commonwealth Department of Climate Change and Energy and Efficiency (2011), found financial losses associated with the 2009 extreme heat event, mainly as a result of power outages, transport service disruptions and response costs, estimated at AUD800 million.

There is a need to build information relating to where hot spots occur in Ku-ring-gai. This data gap was identified by UNSW/FBE (2010). Research into the heat signatures of buildings and urban designs that may

be beneficial in identifying areas vulnerable to heat and heat retention continues. It is known that components of built environment and urban design can contribute waste heat to the local landscape causing heat islands to occur. Hot spots may also be due to building design, orientation, height, geography and tree cover. 'Cool design' of urban centres seeks to reduce the transference of heat from buildings and structures into the air (UNSW/FBE, 2010). The capacity to determine which urban areas are more likely to be vulnerable to heat emissivity may be one way to locate hot spots and combination with socio economic data allow Council to target sectors and locations deemed most vulnerable to heat stress.

Heat sinks are the other important aspect that needs to be better understood. For example, nature conservation areas, whilst managed for their ability to conserve species and protect ecosystem functions, may also act as heat sinks in urban areas. If so, incorporation of conservation lands throughout urbanised areas may be a major contributor to reducing the impacts of longer, hotter heat waves.

4. Drought

As the natural cycles of the past continue to be altered by climate change, so the rainfall patterns across the country will change. As is apparent in regional data, overall Ku-ring-gai already appears to be experiencing warmer and wetter weather in summer but winter and spring are becoming drier (OEH 2015a). Droughts when they occur are likely to be longer, which means periods of water stress lasting a decade or more could be more common place.

High priority *external* community adaptations continue to be refined and implemented

Over the next five years the Climate Wise Communities program will continue to build on the shared network principle and address key locations and sectors deemed particularly vulnerable to existing and future hazards. With the evident success of the CWC program, modifications will only be made where and when improved hazard identification methods are developed, climate forecasts shift significantly or potential new adaptations are developed.

In the 2010 Climate Change Adaptation Strategy, adaptations were divided into groups according to hazard type and internal or external to Council. The external resilience high priority adaptations are listed in Table 1.

Hazard type	Priority 1	Priority 2	Priority 3	Priority 4	Priority 5
Bushfire	Install fire resilient products around the home	Voluntary compliance with AS3959	Install and maintain own firefighting equipment	Monitor fire warnings, be aware of appropriate actions and when to act on them	Build psychological preparedness by practicing fire drills
Storms	Replace roofing with storm resilient materials	Install storm resistant fixtures and fittings	Landscape for increased overflow	Voluntary compliance with building code	Undertake disaster risks assessment of property
Extreme Heat	Contribute to schemes to place power infrastructure underground	Insulate buildings including windows, walls and roof.	Apply passive solar design principles to reduce dependence on mechanical heating and cooling.	Know what to do to keep your home cooler on extreme heat days.	Install renewable power supply to sustainable energy at times of peak load on the poles and wires system.
Drought	Install a rainwater tank and connect toilet and laundry	Participate in education programs on water efficiency	Education for minimising health risks possible from water savings	Purchase low water and energy rated appliances	Install water efficient dual flush toilet cisterns.

Table 1: Top five 2010 highest priority adaptations by hazard type for *external* application by Council

These high priority adaptations are combined in the CWC multi-hazard education program to engage residents in a discussion about vulnerability and resilience to extreme weather events, which focusses on preparedness and emphasises:

- A shared responsibility between residents, property owners, government and industry is the most practical means of dealing with an increasing risk of extreme weather events;
- Preparedness across the four hazard types allows for synergies and improved cost benefit resilience;
- Good emergency management starts with a well-informed, prepared and connected community;
- Vulnerability is a multi-dimensional proposition that needs to be addressed at the personal, property and neighbourhood scales, and
- Resilience may be easy to learn but can be difficult to master.

An important and evolving aspect of the climate adaptation work in the community in 2015–16 is the development of a network linking Council and the community to emergency service agencies such as:

- Rural Fire Service (RFS)
- State Emergency Service (SES)
- NSW Fire and Rescue
- NSW Police
- National Parks and Wildlife Service
- RSPCA
- Australian Red Cross
- NSW Department of Health
- NSW Department of Education
- Small business networks
- Culturally and Linguistically Diverse (CALD) community groups
- Aged care providers
- Carers networks
- Childcare agencies
- Community groups

This list continues to grow as more knowledge surrounding who and what is vulnerable becomes available.

6.2 Internal (Council) adaptations

Council's current approach to internal climate risk management was organised using principles specifically set by ACLEG (2014) to guide climate change adaptation programs for local government, namely:

- Clear, shared framing of climate adaptation challenges for a council starting with a climate adaptation vision and climate change adaptation goals, targets and objectives
- Key strategic documents reflect and incorporate the climate adaptation vision/goals and they don't conflict
- Clear roles and responsibilities for delivery of the adaptation plan activities
- Time and resources allocated specifically to climate adaptation tasks and activities
- Time and resources invested in planning, preparing and ensuring the right mix of skills and knowledge are applied to the process
- Take a risk-based approach – involving all parts of council
- Address risks associated with today's climate variability and extremes as a starting point towards taking anticipatory actions to address risks and opportunities associated with longer-term climate change
- Manage climate and non-climate risks using a balanced approach – assess and implement your approach to adaptation in the context of overall sustainability and development objectives that includes managing climate and non-climate risks

- Focus on actions to manage priority climate risks – identify key climate risks and opportunities and focus on actions to manage them
- Identify champions
- Communicate effectively with key internal stakeholders
- Work in partnership – identify and engage your community and ensure they are well informed
- Gain high-level support for the process from key internal stakeholders. Implement ‘low’ and ‘no regret’ embedding actions now where possible
- Use adaptive management to cope with uncertainty – recognise the value of a phased approach to cope with uncertainty
- Recognise the value of no/low regrets and win–win adaptation options in terms of cost effectiveness and multiple benefits
- Avoid actions that foreclose or limit future adaptations or restrict the adaptive actions of others.
- Review the continued effectiveness, efficiency, equity and legitimacy of adaptation decisions by adopting a continuous improvement approach that also includes monitoring and re-evaluations of risks
- Frame and communicate SMART (specific, measurable, achievable, results-oriented and time-bound) objectives/outcomes before starting out.

In reference to the ACLEG (2014) guide, Ku-ring-gai Council’s approach to climate change adaptation can best be described as a hybrid approach. This involves cross-departmental responsibilities and action on broader infrastructure development, maintenance and planning pathways, in the context of the full array of climate hazards and risks, rather than one climate issue or event.

The 2016 Climate Change Adaptation Strategy will continue to be divided into an internal and external component. Increased focus will be placed on internal resilience as less attention was paid to this compared with external community-based resilience in the 2010 Climate Adaptation Strategy. Conversely, most other councils have tackled internal resilience first with few councils having attempted the more problematic community based adaptation.

Developing adaptations to internal Council risks arising from altering weather patterns

By constructing a vulnerability (weakness) and resilience (strength) analysis of Council assets, services and functions, managers will be able to determine whether action needs to be taken to reduce the potential risk exposure or whether there is already sufficient resilience to the forecast changes in extreme weather events.

Vulnerability and resilience is best determined by those as close as possible to the ‘ground’ and with responsibility for the asset, service, function or people that may be exposed to the risk. Identification of current resilience is the first step in a risk evaluation process. In this instance a process has been identified that allows managers to best determine where their areas of responsibility might be most exposed to climate related risks and plan adaptations.

6.3. Methods for developing internal (Council) adaptations

Council developed a method that investigated extreme weather risks to Council, then identified and implemented adaptations to reduce these risks to an acceptable level:

1. Scoping the likelihood of risks occurring

Council managers and their staff identify risks that are likely to occur from an intensification or increase in frequency of extreme weather events (what is the probability of the risk occurring?). This

assessment should consider financial, environmental and social risks including governance, political and reputational risk.

2. Vulnerability analysis

Consider the consequences of the most likely extreme events occurring cited from Step 1. Consider impacts to financial, environmental and social assets. Using likelihood and consequence results in Council's Risk Matrix (Appendix 1), determine the level of acceptability of each risk identified. This should take into account existing risk controls. If acceptable, no further action is required; otherwise adaptations are identified to reduce the risk to an acceptable level (Step 3).

3. Planning adaptations

What actions are required to reduce the risk to an acceptable level? These may be short-, medium- or long-term actions, phased in or undertaken at one time. In some cases the response may be to fill a knowledge gap with research or liaise with another agency over a shared solution. Actions may often depend on the availability of funding, and may require grant applications or future internal funding allocations.

4. Implementation plan of prioritised adaptations

Consider monetary and non-monetary costs and benefits. Which actions should we invest in first?

5. Residual risk assessment

Pre-implementation risk rating – post implementation risk rating = residual risk (acceptable y/n)

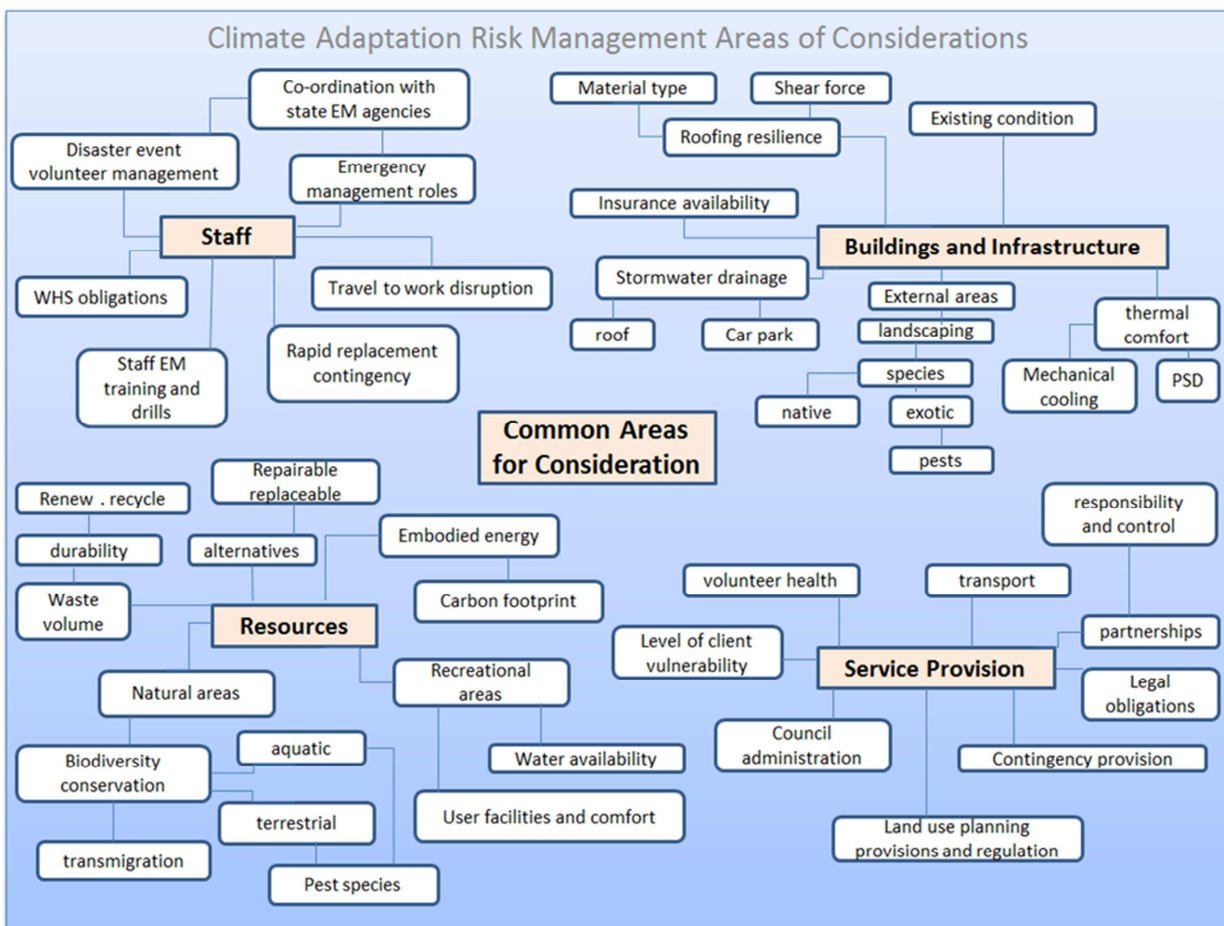


Figure 3: Scoping the risks

Step 1: Scoping the risks – identify the range of areas at risk from extreme weather events

Current projections for changes to local weather patterns and an explanation of what this means in terms of the frequency and intensity of future extreme weather events are used to consider the likely impact of these changing weather conditions to services, assets and resources within each area of responsibility. Figure 3 encapsulates the broad scope of Council activities that may be affected by climate change. These include but are not limited to service buildings and critical infrastructure; service provision; physical, financial and social resources, and staff. In completing this step, the full scope of climate vulnerable assets, services, people and policies are considered. These are then scrutinised more closely in Step 2.

Step 2: Vulnerability analysis – understanding consequence and probability

Evaluating the consequences of a specific risk

Understanding the consequences of an extreme weather event can be complex. An initial impact can cause a subsequent or secondary impact and so on. Following these threads exposes the full ramifications of a risk occurring.

One way of identifying these threads is by using a consequence evaluation network model as demonstrated in Figure 4. In this example, the extreme weather risk is catastrophic bushfire weather. The primary impact is a rapidly evolving wildfire. The secondary impacts occur to those Council assets, service functions or staff most exposed to the wildfire; that is, anything or anyone located in or around bushfire hazard areas, or dependent on them. At the tertiary level there may be multiple consequences and these can be listed and dealt with either individually or collectively as appropriate.

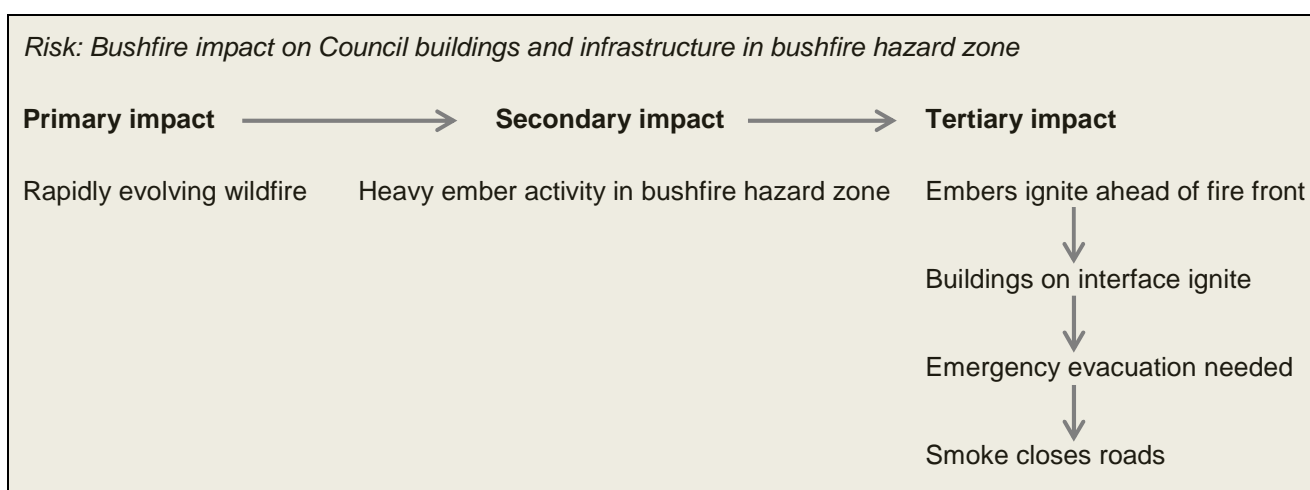


Figure 4: Examples of primary, secondary and tertiary impacts for wildfire in a bushfire hazard zone

Evaluating the probability of harm occurring from an catastrophic wildfire event

The degree of vulnerability depends not only on the exposure to the impact by wildfire but also the resilience of the Council asset in question. In the Figure 4 example, the conditions necessary for a catastrophic fire incident that is *very likely* to impact the urban interface is affecting Ku-ring-gai. Any built assets in the path of the fire are vulnerable to destruction unless measures have been taken to improve the resilience of the asset to ember attack.

On extreme weather days like this, fire fighters have little to no chance of controlling the fire, resources will be stretched beyond capacity and people will need to make fast decisions. A building that is secure from ember attack and radiant heat will not only survive, it may also be an asset utilised during the recovery phase of the

event. Built assets are generally straightforward risk assessments based on well researched formulae used by the Rural Fire Service to determine risk exposure.

Council’s *Bushfire Prone Land Map* can be used to identify where built assets may be at risk. Identification and analysis of the tertiary impacts will provide a better appreciation of who or what is vulnerable. For example, bushfire may affect Council services as a result of the need for staff and other resources to be diverted to disaster response duties, potential road closures, inability to access areas affected, and where staff or other service providers may have homes located in areas at risk and not be available to come to work. Vulnerable Council assets might include fencing and signs in the bushfire hazard areas, rare and endangered species habitat, or loss of vegetation from high erosion risk slopes.

The level of acceptability of each risk is determined using Councils’ Risk Matrix. For the example in Figure 4, the bushfire risk to a childcare facility located in a bushfire hazard zone requires the consideration of several factors. The vulnerability of the facility is not only based on its physical location but also the logistics of a childcare facility being able to respond quickly in a bushfire emergency. The existing level of preparedness for emergency response and evacuation would be an important factor to consider when assessing the facility’s overall vulnerability and whether the level of risk is acceptable or not. In this example, Council’s Risk Matrix would rate the consequences of a wildfire impacting a childcare facility as *major* and the likelihood as *likely*, placing the risk firmly within the category of *unacceptable* risks requiring immediate action.

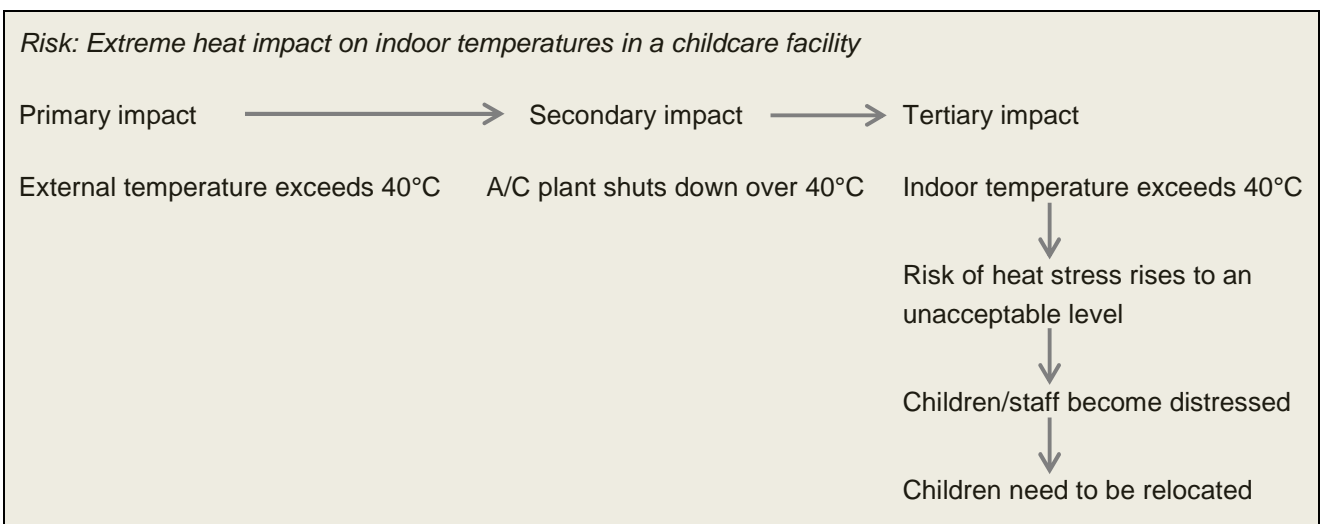


Figure 5: Consequence of a heatwave on a childcare facility

The example in Figure 5 uses NARClIM projections, which forecast an *almost certain* probability of extreme heat events occurring in the Ku-ring-gai area. The consequence assessment requires an understanding of context and the people that make it vulnerable to extreme heat. In this example, the consequence is determined to be *major* because young children are known to be highly vulnerable to extreme temperatures, and the childcare facility in question has no passive solar design features so internal temperatures are likely to exceed comfort levels. The air conditioning unit is aged and has an upper operating temperature of 41°C and could reasonably be considered as likely to fail. Using the Risk Matrix the risk is determined as *unacceptable*.

Establishing the likelihood of these impacts occurring requires consideration of the most recent climate forecasting in relation to extreme weather combined with the significance of the tertiary impacts with no adaptations in place. If the risk arising from the ‘do nothing’ option is unacceptable, then control actions should be considered. The potential risks may be physical, financial, legal, social, reputational, political or environmental. Risks deemed to be ‘acceptable’ in their current state require no further action at this stage.

Step 3: Planning adaptations

Any risks deemed other than acceptable require actions to be determined to reduce the risk(s). In the case of a bushfire for example, retrofitting buildings against ember attack and radiant heat is an option. Assets at risk in bushland need strategies to reduce the impact of fire such as a policy to replace assets constructed with flammable material to be replaced when due with low flammability material. The cost of conserving the asset needs to take into account the replacement cost compared with the upgrade to non-flammable materials. For essential services such as Meals on Wheels, accessing clients in bushfire hazard zones needs to be factored into Council's bushfire response planning. Bushfire risk at a childcare facility may be mitigated by a combination of factors including increasing the building's resilience to ember attack, and developing a facility bushfire fire risk management plan including procedures for emergency evacuation combined with a communication strategy to reassure parents and keep them updated.

In the heatwave scenario for a childcare facility (Figure 5) where the air conditioning system fails at temperatures above 40°C, contingency adaptations to add some latitude to that temperature limit may be put in place. Most manufacturers will make suggestions of how to do this, such as installing the unit on the southern side of a building. Some manufacturers may recommend restricting cooling to one room to reduce the load or in some cases let a garden sprinkler cool the air conditioning unit in the hottest parts of the day. Using passive solar design techniques and insulation can also reduce the load on an air conditioning unit.

Step 4: Implementation plan of prioritised adaptations

Cost/benefit analysis of the proposed adaptations (or controls) allows adaptations to be prioritised in order from the most strongly positive cost/benefit to the least. The method used to prioritise each adaptation is based on a set of values across the Triple Bottom Line and the capacity of each adaptation to reduce the risk nominated. The process is based on the method used to prioritise the external adaptations aimed at strengthening community resilience in Council's *Climate Change Adaptation Strategy (2010)*.

Where possible, opportunities to share responsibility with relevant external agencies such as Sydney Water, Office of Environment and Heritage and NSROC are considered, as are potential external funding sources such as grants. Examples of Council-focused adaptations are contained in Table 2, which shows the top five high priority adaptations from the 2010 *Climate Change Adaptation Strategy*. These may inform the development of high priority adaptations in this internal Strategy.

Step 5: Residual risk assessment

PRE-IMPLEMENTATION RISK RATING — POST IMPLEMENTATION RISK RATING = RESIDUAL RISK
(acceptable y/n)

The residual risk ranking is not intended to be definitive but rather to suggest a way of determining those adaptations that appear to offer the most potential effect for the least cost. Analysis will demonstrate the strengths and weaknesses of each control adaptation, and provide objective information to substantiate any case for funding outside normal recurrent budgets to ensure control actions are taken to reduce risk.

Hazard type	Priority 1	Priority 2	Priority 3	Priority 4	Priority 5
Bushfire	Increase percentage of new homes compliant with AS3959	Conduct community and agency education program	Invest in R&D projects to reduce fire risk in bushland	Build and operate a new RFS brigade	Improve planning provisions to reduce bushfire risk
Storms	Look for opportunities to relocate power and communication networks underground	Conduct community education program	Discount or rebates on storm resilient installations e.g. metal roofing, window shutters	Promote SMS warning systems to community	Undertake storm risk assessment of key infrastructure
Extreme Heat	Ensure WHS policy up to date with accepted standards around extreme heat and outdoor workers	Insulate Council buildings	Install and operate cooling systems with an independent power source	Invest in low energy cooling technology	Conduct community education program to raise awareness of the risk of heat stress and how to manage risks.
Drought	Undertake community education programs	Evaluate stormwater harvesting for Council facilities	Monitor water consumption for leaks and anomalies	Install stormwater harvest for community use (e.g. community gardens)	Use flexible materials for paths (porous?)

Table 2: 2010 highest priority adaptations by hazard type for internal application by Council

7. Results of the adaptation planning workshops

A workshop was conducted for managers to step them through the adaptation planning process. A framework was provided for each manager and their staff to identify and evaluate risks according to their likelihood and consequence. Where requested, Strategy and Environment staff also attended team meetings to assist managers and staff to identify and evaluate risks and plan adaptations. Each risk identified as either 'unacceptable', 'undesirable' or 'acceptable with controls' was required to have an adaptation nominated. The Risk Matrix used to inform this assessment is included as Appendix 1.

To make the Adaptation Strategy seamless with Council's Risk Register, where an extreme weather risk nominated by a manager aligned with risks identified within the Risk Register, the correlation and nominated controls were recorded in the Notes and comments column of the Adaptation Planning Table. The latest scientific predictions around climate change and extreme weather risks were used to carefully scrutinise and, where necessary, re-evaluate risk levels in light of more frequent and severe extreme weather events, and included as risk controls in the Adaptation Planning Table. The raw data for these tables for each functional area of Council appears in Appendix 2.

The results highlight areas where Council is most vulnerable to extreme weather events. Some risks are specific to a context (e.g. evacuation preparedness for a childcare centre located in a bushfire hazard zone). Other risks ranged across Council and are more or less generic, for example staff inability to access their workplace, or loss of power, water and internet. These risks were also noted across multiple hazard types, most often bushfire and storm. The importance of interrelationships and interdependencies become evident with cost benefit analysis of each adaptation.

The cost benefit of each adaptation is presented as a prioritised list, ordered according to the least impact across the triple bottom line (cost) and the best potential to reduce climate specific risks (benefit). Part of this cost benefit analysis will identify those adaptations that could have benefit across multiple Council assets, programs or staff roles. Such adaptations can then be considered for priority implementation. Integration of these adaptations into Council's operational plan will allow implementation to be monitored and performance over time assessed.

8. Biodiversity and climate change

Definitions – commonly used in relation to climate change and biodiversity conservation include:

- *Resilience*: the extent to which ecosystems can cope with a changing climate and continue to exist in their current state, in terms of human and built systems to put in place measures to return a value to its original state or better post impact;
- *Vulnerability*: to be easily hurt or damaged;
- *Climate refugia*: parts of the landscape (such as places with permanent water or a variety of landforms) that are likely to be particularly important for helping species persist during extreme events like drought and bushfire and times of ongoing environmental change (DECCW 2010).

This section of the Climate Change Adaptation strategy responds to the objectives in Council's Climate Change Policy 2015 and Biodiversity Policy 2016 (draft), namely:

- To reduce Council's, the community's and the natural and built environment's vulnerability and increase its resilience to the impacts of climate change
- To continue to review Council's greenhouse gas emission reduction targets, emissions budget and climate change mitigation and adaptation activities based on international, regional and local climate science and modelling
- To protect and restore the carbon stocks in Ku-ring-gai's ecosystems to mitigate against climate change and implement adaptive management responses to address the impacts of climate change on Ku-ring-gai's biodiversity.

Land management agencies around the world are developing strategies to reduce the vulnerability and improve the resilience of biodiversity assets to the intensifying impacts of climate change. In Australia, federal, state and local government agencies are working to better understand the impact of climate change on the natural areas under their care, and the adaptation options available to conserve biodiversity under changing conditions (CSIRO 2016, DECCW 2010).

Ku-ring-gai has a rich diversity of vegetation and habitats due to the geographical, biophysical and climate characteristics of the area, including rainfall, soil variety, aspects, slopes and bushland connectivity in the region. While much of the remnant vegetation is highly fragmented and subject to a range of impacts from urbanisation, there remains reasonable prospects of conserving these patches. Many of the larger patches of remnant bushland are owned and managed by public agencies but a significant percentage of the overall vegetation and habitat exists in private ownership.

Given the mix of ownership and legal status, tailored management strategies are needed to maximise the resilience of these remnant areas to a suite of impacts, including those imposed by a warming climate. Factors that can potentially affect these ecosystems include weather, soils, animal and insect interactions, and threats to and impacts from fire, urban runoff, feral animals, weeds, pathogens, recreational activities, clearing and bushfire hazard reduction. The resilience of local biodiversity assets to climate change depends on, at least in the first instance, how well these existing impacts are managed. If management is targeted and well controlled, biodiversity assets should exhibit improved resilience to the additional impacts imposed by a changing climate.

Ku-ring-gai has 119 bushland reserves varying in size and condition with many containing threatened and endangered species. Council has a range of policies designed to reduce the impacts generated by local land use and intensifying development, and is already implementing strategies designed to mitigate these existing

impacts. Council has developed a rating system to rank bushland reserves and enable prioritised management of those that would benefit most from investment.

Which strategies are most likely to increase biodiversity resilience to the impacts of climate change at this point in time is the central question.

Due to the uncertainty around the climate projections and their potential impacts, there needs to be a broad range of management strategies and a mix of actions at each of the species, community and landscape levels (DECCW 2010). Management actions, such as protecting a diversity of habitats, maintenance of genetic diversity, assisted species migration and dispersal, manipulation of disturbance regimes (e.g. fires, floods) and reduction of other stressors, such as intensifying pressures from increased urbanisation, can lessen but not eliminate risks of impacts to terrestrial and freshwater ecosystems, as well as increase the inherent capacity of ecosystems and their species to adapt to a changing climate.

Hughes (2008) states that conservation programs that build functional connectivity (which Mackey et al. 2009 describe as having four aspects – landscape connectivity, habitat connectivity, ecological connectivity and evolutionary connectivity) will increase the viability of populations (in DECCW 2010, p 19). Maintaining and improving connectivity between landscapes and habitats at different scales allows species to progressively adjust their ranges in response to shifting climatic zones (DECCW 2010).

Changes in the frequency, intensity and seasonality of extreme weather events (floods, droughts, storms and fire) may have larger impacts on many species than directional shifts in average temperatures and changes in rainfall patterns (Steffen et al. 2009, in DECCW 2010, p 21). As a result there will be a need to identify and protect climate refugia that will help species persist during extreme conditions, protect large areas of habitat to maintain population viability and genetic diversity and conduct revegetation activities which can moderate climate extremes (DECCW 2010).

Knowledge gaps need to be addressed and built into a prioritised and funded management strategy if biodiversity assets are going to have the robustness to adapt to a warming environment. Uncertainties around the thresholds that trigger the collapse of ecosystems require the Precautionary Principle to be applied and preventative actions implemented to avoid serious or irreversible harm.

Many existing conservation actions will need to be maintained or (potentially) enhanced to preserve biodiversity under climate change (Howden et al., 2003). The willingness of Council to explore and question the effectiveness of current strategies to deal with the additional stressors created by climate change (CSIRO, 2016) is essential to the successful management of species, habitats and ecosystems. Where current projects may fall short of enabling biodiversity richness and fecundity to be conserved, additional measures may be warranted.

CLIMATE CHANGE IMPACTS	=	A DIMINISHING PROCESS
CLIMATE CHANGE RESILIENCE	=	A NOURISHING PROCESS

According to NSW DECCW (2010) there are three adaptation principles to guide biodiversity conservation for climate change:

- Build resilience to give species, ecological communities and ecosystems the best chance to adapt
- Many existing conservation approaches are likely to continue to be important under climate change
- Spread risk by implementing a range of conservation strategies, coupled with adaptive management approaches.

Accordingly, management responses to guide biodiversity adaptation in Ku-ring-gai have been identified as:

- Reduce existing threats to biodiversity as far as practicable;
- Increase the level of protection of remnant vegetation areas and functional connectivity;
- Protect climate refuges Commit resources to management actions where a good understanding of climate change impacts is available but is imperfect;
- Prioritise actions to address climate change conservation priorities based on ecological, cultural, economic and societal values (adapted from DECCW, 2010 pp12–13).

These five responses provide a management framework to inform Council's strategy to manage the impacts of climate change on local biodiversity. These responses will require research, design, implementation and review to determine the rate of progress in achieving the desired objectives. All five responses are complementary; that is, they are interdependent and interconnected.

These responses are consistent with the NSW Office of Environment and Heritage (OEH) Priority Action Statements (PAS), designed to guide land managers, such as councils, in their climate change adaptation efforts. These are:

1. Identify and promote ways to increase landscape permeability for species range shifts (Medium*);
2. Improve understanding of climate change impacts on biodiversity including identification of species and ecosystem most at risk (High*);
3. Support research into the effects of climate change on disturbance regimes (e.g. invasive species, bushfires, pathogens) (High*);
4. Evaluate the adequacy of the reserve system to retain biodiversity and to support changing species and ecosystems (High*);
5. Strengthen the resilience and connectivity of existing protected areas by identifying strategic future habitats and corridors (High*);
6. Develop conservation planning tools to model scenarios and effects of climate change on biodiversity (High*);
7. Foster relationships with relevant authorities, research institutes and other States to improve understanding of impacts of climate change and potential management (Medium*);
8. Identify the need for ex-situ conservation of species most at risk (Low*);
9. Design and implement indicator programs to detect changes in biodiversity (High*).

* Priority rating

Council is already using these PAS in developing strategies to manage bushland reserves under Council's care and control. Adaptation actions developed for the next five years need to continue to be consistent with the aspirations identified in the PAS.

9. Conclusion

Work on this Climate Change Adaptation Strategy has reached its final stages at a time when monitoring of the global atmospheric CO₂ concentration shows the 400ppm threshold has been passed (NASA, 2016). As a result, the need to improve resilience to extreme weather events occurring more frequently and fiercely becomes all the more pertinent. Building resilience to extreme weather events in a precautionary and timely manner has strong financial, environmental and social benefits (Stern, 2007; Garnaut, 2011). Ku-ring-gai Council is fully aware that delays in capacity building resilience could result in unnecessarily costly and time consuming demands on Council funds and staff.

Council has developed a comprehensive set of tools to analyse, prioritise and plan resilience measures for Council and the community to the risks arising from climate change. The objective in this term of the strategy is continue to identify and better understand areas of vulnerability and to prioritise adaptation strategies that are able to create the most effective resilience for the least cost.

This strategy has established a basis on which to build both internal (within Council) and further extend the reach of the external (within the local community) resilience capacity. Externally this strategy relies on a continuation of the Climate Wise Communities program that targets vulnerable community sectors and locations to raise awareness of climate change induced extreme weather events, self-assess vulnerability, plan for and implement adaptations to improve their personal, property and neighbourhood climate resilience.

Internally this strategy is rolling out a process to assist Council managers to understand the vulnerability to extreme weather events of assets, programs and staff which they are responsible for. Once the vulnerability was determined, staff then planned adaptations (or 'controls' as they are termed in Council's risk strategy) to reduce the potential risks to an acceptable level according to Council's risk matrix. While some risks identified appeared within the risk register, many climate risks appeared to be under reported or omitted.

While many other councils around the world have addressed climate change adaptation, they have frequently relied on generic templates. It is important to understand when generic templates are used (usually framed by socio-economic criteria such as 'agriculture', 'water resources' and human health') they have a tendency to produce similar adaptations across multiple contexts which can be of limited value. The capacity of generic templates to reduce risks is limited because to be effective, adaptations need to be tailored to specific contexts and this can only happen when adaptations emerge from the people and places closest to the ground.

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Appendices

Appendix 1: Risk matrix for Step 2

LIKELIHOOD	CONSEQUENCE		
	Minor	Moderate	Major
	First aid treatment. Minimal pollution. Less than \$1,000 damage.	Medical / Hospital attention with up to a week off work. Low level pollution. \$1,000 to \$70,000 damage.	Death or permanent disability. Severe pollution. Greater than \$70,000 damage
Almost certain	MEDIUM 4	HIGH 6	HIGH 7
Is expected to occur in most circumstances. Common.			
Likely	MEDIUM 4	MEDIUM 5	HIGH 7
Will probably occur routinely. Has happened.			
Possible	LOW 3	MEDIUM 5	HIGH 6
May occur at some time but not normally anticipated. Could happen.			
Rare	LOW 1	LOW 2	LOW 2
Not likely to occur. Reasonable to assume it will not happen.			

A risk rating of High, Medium or Low is identified based on the likelihood and consequence of a risk occurring. The numbers associated with each risk rating level assists in prioritising the risks and controls.

HIGH

Requires immediate action to eliminate the risk. If the risk cannot be eliminated use the hierarchy of controls to determine control measures to be implemented. The work activity will not commence until the control measures have been implemented.

MEDIUM

Requires action to eliminate the risk where possible. If the risk cannot be eliminated use the hierarchy of controls to determine control measures to be implemented. The work activity should not commence until the control measures have been implemented.

LOW

Requires action to eliminate the risk where possible. If the risk cannot be eliminated use the hierarchy of controls to determine an appropriate control measure to be implemented. Implementation and monitoring of the control measure is required Low risks should continue to be monitored and re-evaluated on a regular basis to ensure that the risk is being controlled. Low risks can generally be treated with routine procedures or Safe Work Method Statements. In some instances it may be appropriate to accept the risk.

Appendix 2: Climate change adaptation risk controls

Primary Hazard 1: Drought													
Functional area	Secondary Impacts	Risk type	Risk Category	Tertiary impacts	Consequence rating	Likelihood rating	Risk matrix score	Proposed control(s)	Notes/ comments	Responsibility	Timeline	Estimated cost / benefit score	Residual risk ranking
Community and Recreational Services	severe water stress in recreational facilities (golf courses, ovals, parks)	Operational	Operational impact	Drought and water restrictions impact landscaping and turf areas of Fitness and Aquatic Centre	Moderate	Possible	5. MEDIUM	Landscaped areas use drought tolerant native species; artificial turf used in high traffic and shaded areas - could be expanded; other turf areas watered to conserve grass and prevent dust/dirt going into swimming pool					
Community and Recreational Services	water restrictions applied	Operational	Operational impact	Increased water usage costs at Fitness and Aquatic Centre due to restrictions and Sydney Water reverting to desalination supply	Moderate	Possible	5. MEDIUM	Recycled greywater used in toilets; use of covers can reduce some evaporative loss from pool; potential to review charges/lease fees					
Community and Recreational Services	water restrictions applied	Operational	Operational impact	Drought and water restrictions limit water supply at halls and meeting rooms	Minor	Possible	3. LOW	Some venues have rainwater tanks installed to supplement water supply; bypass systems in place if tanks are dry					
Community and Recreational Services	disruption to ecological flows	Operational	Assets	Dry conditions and shifting of foundations cause minor structural faults to some halls or venues	Moderate	Rare	2. LOW	Reactive maintenance as required					
Community and Recreational Services	disruption to ecological flows	Operational		Landscapes and trees around meeting halls and venues decline	Moderate	Possible	5. MEDIUM	Maintenance checks of trees to ensure safety and prevent limb fall; some landscaped areas have water harvesting in place					

Community and Recreational Services	severe water stress in recreational facilities (golf courses, ovals, parks)	Operational	Assets	Lack of water makes sport field surfaces dangerous and/or unplayable	Major	Likely	7. HIGH	Winter maintenance to ensure good coverage of grounds for summer; closed when dangerous; improve diversity of sports field surfaces - investigate option of synthetic surfaces in some instances; work with sporting clubs to negotiate contingency plans for long-term closures							
Community and Recreational Services	severe water stress in recreational facilities (golf courses, ovals, parks)	Operational	Environmental effects	Pond at the Wildflower Garden dries up during drought	Minor	Rare	1. LOW	Programs are modified; potential to perform remedial works to pond to prevent excessive leaking							
Community Development	severe water stress to trees and other plants in facilities	Operational	Environmental effects	Declining tree health at premises - reduced amenity and shade, potential for limb loss or tree failure	Moderate	Possible	5. MEDIUM	Tree health visual assessment included in daily playground safety checklist plus quarterly and annual playground safety assessment	This checklist complies with Child Care Regulations and national law						
Compliance and Regulation	water restrictions applied	Compliance	Compliance legal	Servicing the demands and reports across the general community	Minor	Likely	4. MEDIUM	Officers kept informed of water restrictions and current penalties for non-compliance	This control was previously introduced some 5 year plus ago, by Sydney Water and Council was a partner in regulating controls						
Corporate Communications and Events	severe water stress in recreational facilities (golf courses, ovals,	Strategic	Service delivery/reputation	Customer dissatisfaction with service delivery provided	Moderate	Possible	5. MEDIUM	Customer complaint referral process in place including documenting, reviewing and responding	See Risk Register: R0132; C00298						

	parks)							to the complainant					
Corporate Communications and Events	severe water stress in recreational facilities (golf courses, ovals, parks)	Strategic	Service delivery/reputation	Failure to effectively communicate Council actions to respond to drought impacts with external stakeholders as a result of poor external communication strategy	Moderate	Possible	5. MEDIUM	External Communication Strategy template available; Media monitoring and reporting to GMD; Community Survey feedback/continual improvement process in place	See Risk Register: R0170; C00388; C00389; C00390				
Engineering Operations	excessive long-term dryness affecting soil structure	Operational	Assets	Shifting or cracking of soil structure results in damage to underground drainage system	Major	Possible	6. HIGH	Investigate most cost-effective mechanism to monitor, assess and create an audit of the condition of the drainage network (e.g. CCTV)					
Insurance and Risk Management	increase in insurance claims	Strategic	Financial / Marketing / Customer. Work Health & Safety	Increase workload. Increase in Insurance Premium. Budget exceedance	Moderate	Almost certain	6. HIGH	Shared knowledge. Database to manage claims. Temp staff / secondment. Contingency / reserves					
Integrated Planning, Property & Assets	water restrictions applied	Operational	Assets	Impacts on tenants if restrictions are applied during business hours	Minor	Possible	3. LOW	Officers kept informed of water restrictions and current penalties for non-compliance	This control was previously introduced some 5 year plus ago, by Sydney Water and Council was a partner in regulating controls	Managing Agents Facility Manager Property Manager			
Integrated Planning, Property & Assets	water restrictions applied	Operational	Assets	Impacts on plant and equipment if operations rely on water supply	Moderate	Possible	5. MEDIUM	Programmed maintenance for impacted plant and equipment	Programmed maintenance in place for commercial property portfolio	Managing Agents Facility Manager Property Manager	*** Before 2020		

Integrated Planning, Property & Assets	water restrictions applied/supply restrictions	Strategic	Compliance Governance	Impacts on achievement of objectives/actions/tasks/projects across Council's Integrated Planning and Reporting Framework	Moderate	Possible	5. MEDIUM	Monitor any impacts of applied water restrictions and supply and report to GMD and Council as part of quarterly and bi-annual reviews	Quarterly and bi-annual reviews of the Operational Plan and Delivery Program are required under the LGAct	Asset Management Steering Group	*** Before 2020		
Integrated Planning, Property & Assets	water restrictions applied/supply restrictions	Strategic	Service delivery/reputation	Impacts on Council's customer service satisfaction levels	Moderate	Possible	5. MEDIUM	Monitor any impacts of applied water restrictions and supply on community satisfaction levels and report to GMD and Council	Community satisfaction surveys are undertaken every two years	Integrated Planning Coordinator	*** Before 2020		
Integrated Planning, Property & Assets	water restrictions applied/supply restrictions	Strategic	Service delivery/reputation	Services, projects and programs to include contingencies for delays and extra costs	Moderate	Possible	5. MEDIUM	Drafting of tasks, performance measures and project bids to include consideration of potential risks of extreme heat	Can be included in requirements for preparation of tasks, project bids and Operational Plans	Integrated Planning Coordinator	*** Before 2020		
Libraries and Cultural Services	disruption to ecological flows	Operational	Assets	Dryness in soil affecting building foundation strength and stability - could cause movement, cracking and compromise building integrity	Moderate	Rare	2. LOW	Regular inspection of buildings for signs of damage and to determine need for remedial action					
Libraries and Cultural Services	water restrictions applied	Operational	Operational impact	Lack of water for drinking and toilets - affects staff and public - may have to restrict service availability	Minor	Rare	1. LOW	Water harvesting and storage at local sites to extend sustainability					

Natural Area and Catchment Planning	Impact to Water Sensitive Urban Design (WSUD) controls that capture litter and sediment in runoff	Operational	Environmental effects	After period of drought, first rain event will wash a large volume of accumulated debris, litter and exposed earth into Gross Pollutant Traps, trash racks, rock checks, basins, wetlands and ponds which may fill device and stop it from treating further rain events until maintenance undertaken. Will require fast turnaround for cleaning - maintenance staff likely to be pre-occupied with other assets at this time	Moderate	Likely	5. MEDIUM	Have trained contractor familiar with control locations and types ready to go to clean out controls and undertake any maintenance to repair damage as in house maintenance services unlikely to be available						
Natural Area and Catchment Planning	Reduction in water quality for stored water that may impact public health when used.	Compliance	People injury/disease	prolonged drought may result in stagnant water in water harvesting tanks below pump level. Harvested water not treated with chemicals so pathogens / growth of algae / reduction in water quality to levels above recommended quality guideline limits possible	Minor	Rare	1. LOW	Undertake water quality testing (dip samples from tank) to see if water quality is above recommended guideline levels. If so, dose water with chlorine or other chemical (check impact on grass) to manage water quality, or pump all water out of tank (not to be released to waterway)						
Natural Area and Catchment Planning	severe water stress in recreational facilities (golf courses, ovals, parks)	Operational	Environmental effects	Vegetation dies in filter gardens reducing water quality treatment to water harvested for reuse on ovals or released to receiving environment	Minor	Almost certain	4. MEDIUM	Scenario likely to correspond with water restrictions, but if possible hire contractor to periodically water existing filter gardens to keep vegetation alive during drought period						

Natural Area and Catchment Planning	severe water stress in recreational facilities (golf courses, ovals, parks)	Strategic	Environmental effects	Vegetation in grassed swales dies. Next large rainfall event will scour swale, resulting in loss of topsoil and increased sediment loading in waterways	Minor	Likely	4. MEDIUM						
Natural Area and Catchment Planning	supply restrictions to water dependent facilities (plant nursery, pool)	Operational	Environmental effects	With vegetation dying the effectiveness of a vegetated filter system will be lost. Replanting costs and time delay for plant establishment	Moderate	Possible	5. MEDIUM	Include water holding crystals at installation and supply intermittent watering to keep gardens in functioning order		m.drago	*** Before 2020		
Open Space Operations	severe water stress in recreational facilities (golf courses, ovals, parks)	Compliance	Compliance legal; People injury/disease	Stormwater irrigation water not meeting NSW Health irrigation requirements	Major	Possible	6. HIGH	Stormwater harvesting compliance program in place (Not Implemented / Effective)	See Risk Register: R0469; C00611				
Open Space Operations	severe water stress; disruption to ecological flows	Operational	Environmental effects	Deterioration and disease of trees to a lesser standard and greater chance of failure and increased liability	Major	Possible	6. HIGH	Tree maintenance program in place	See Risk Register: R0532; C00945				
Open Space Operations	severe water stress in recreational facilities (golf courses, ovals, parks)	Operational	Operational impact	Excess heat and lack of water burns/damages greens at golf course	Moderate	Possible	5. MEDIUM	Increased watering regime for greens to reduce damage; hand watering of asset if required					
Open Space Operations	severe water stress in recreational facilities (golf courses, ovals, parks)	Operational	Operational impact	Deterioration of parks asset to a lesser standard and greater chance of failure and increased liability	Major	Possible	6. HIGH	Weekly Inspection program using Routine Playground Inspection Checklist Template	See Risk Register: R0394, C01040				

Open Space Operations	water restrictions applied	Operational	Operational impact	Water scarcity results in deterioration of gardens and sports fields; potential for decreased safety on playing fields	Moderate	Possible	5. MEDIUM	Additional water storage installed at some facilities; use drought tolerant species as appropriate; reduce asset use to prolong usability; shift to synthetic playing field surfaces ; information sharing to reduce quality expectations and advise of impacts as irrigation levels are reduced; install further water harvesting infrastructure	Water harvesting and storage has limited benefits in drought - limited capacity means stored supply usually exhausted within a short time frame				
Open Space Operations	water restrictions applied	Operational	Operational impact; Financial; Service delivery	Ability to water stock disrupted; additional costs to meet needs	Moderate	Possible	5. MEDIUM						
Strategic Projects	severe water stress in natural areas	Operational	Environmental effects	Ongoing drought may affect availability of seed or timing of collection from endemic plants for plant production	Minor	Possible	3. LOW	Find alternative sources of seed and/or plants					
Strategic Projects	severe water stress in recreational facilities (golf courses, ovals, parks)	Operational	Operational impact	Cost for procurement of plants for landscaping will increase due to additional maintenance needs during establishment	Moderate	Possible	5. MEDIUM	Build costs into contracts; allow for changes to works program timetable so plants not purchased/planted in severe dry period; select more drought tolerant plants wherever plans allow					
Strategic Projects	water restrictions applied	Operational	Assets	Future limited water supply to new or existing assets	Moderate	Possible	5. MEDIUM	New facilities built with option to reconnect plumbing to incorporate grey water use in future; use of stormwater harvesting as alternative water source for playing					

								fields					
Strategic Projects	water restrictions applied	Operational	Operational impact	Nominated plants not being available as per planting schedules	Moderate	Possible	5. MEDIUM	Early ordering of plants or change to plant selection					
Urban Heritage and Planning	water restrictions applied	Strategic	Assets	Loss of trees/ landscaped areas that are water reliant, specifically public parks/squares/streets. Appeal of these places is diminished, loss of public enjoyment	Moderate	Possible	5. MEDIUM	Build in water detention/retention systems for re-use as irrigation. Water Sensitive Urban Design (WSUD) implemented in public domain design. Select drought tolerant species to cope					

Primary Hazard 2: Bush fire													
Functional area	Secondary Impacts	Risk type	Risk Category	Tertiary impacts	Consequence rating	Likelihood rating	Risk matrix score	Proposed control(s)	Notes/ comments	Responsibility	Timeline	Estimated cost / benefit score	Residual risk ranking
Community and Recreational Services	evacuation preparedness	Operational	People injury/disease	Fitness and Aquatic Centre in bushland - high risk of bushfire and potential for isolation in evacuation if access road blocked	Major	Possible	6. HIGH	Contract with leasee requires emergency evacuation plan including multiple exit points and shelter in place scenario; maintenance includes managing asset protection zone					
Community and Recreational Services	continuity of water and power supply	Operational	Operational impact	Power loss shuts down air circulation, pumping and filtering systems	Moderate	Likely	5. MEDIUM	Shut down and evacuation of facility including cancellation of booked lessons and events					
Community and Recreational Services	ember attack; radiant heat; spatial transference	Operational	Assets	Fitness and Aquatic Centre in bushland - damage to or destruction of asset from bushfire	Major	Possible	6. HIGH	Fire resilience built into design; maintenance includes managing asset protection zone					
Community and Recreational Services	evacuation preparedness	Operational	People injury/disease	Extreme heat day with large crowds degenerates into bushfire scenario requiring evacuation	Major	Possible	6. HIGH	Facility emergency plan includes multiple exit points and shelter in place contingency; procedure in place for manager to monitor weather conditions and to close and evacuate pool as required; ensure pool management registers for bushfire alerts via Fires Near Me					
Community and Recreational Services	continuity of water and power supply	Operational	Operational impact	Power loss to lighting, electricity and air conditioning (where available) systems	Minor	Likely	4. MEDIUM	Shut down and evacuation of facility including cancellation of bookings					

Community and Recreational Services	evacuation preparedness	Operational	People injury/disease	Halls and meeting rooms in or near bushfire prone land need to be evacuated	Major	Possible	6. HIGH	Each venue has current documented evacuation procedures that are provided to regular and casual users of the facility; procedures include stay in place option and criteria						
Community and Recreational Services	ember attack; radiant heat; spatial transference	Operational	Assets	Halls and meeting rooms in or near bushfire prone land - damage to asset from bushfire attack	Major	Possible	6. HIGH	Fire resilience built into design; maintenance includes managing asset protection zone						
Community and Recreational Services	ember attack; radiant heat; spatial transference	Operational	Service delivery/reputation	Halls and meeting rooms in or near bushfire prone land - damage to asset from bushfire attack affects service delivery	Major	Possible	6. HIGH	Business contingency planning to determine option for transferring service to another facility/venue						
Community and Recreational Services	ember attack; radiant heat; spatial transference	Operational	Work Health & Safety	Tools and equipment at Men's Shed used outdoors on hot day spark bushfire	Major	Possible	6. HIGH	Instigate documentation and implementation of Work Health and Safety procedures	Currently no agreements in place					
Community and Recreational Services	ember attack; radiant heat; spatial transference	Operational	Work Health & Safety	Bushfire and safety risk if gas bottle storage and transport inappropriate at sporting clubs - compliance not well regulated	Moderate	Possible	5. MEDIUM	Provide WHS and compliance information to sports clubs; conduct safety checks; ensure clubs have evacuation procedures in place						
Community and Recreational Services	evacuation preparedness	Operational	People injury/disease	North Turrumurra Recreation area is identified as a place of last resort in the event of an emergency evacuation	Major	Possible	6. HIGH	Ensure site is signed and maintained in case of emergency, including access and egress						
Community and Recreational Services	ember attack	Operational	Assets	Synthetic fields may be damaged by ember attack	Minor	Rare	1. LOW	Reactive maintenance - can be patched if required						

Community and Recreational Services	ember attack; radiant heat; spatial transference	Operational	Work Health & Safety	Bushfire requires evacuation of event at showground	Major	Possible	6. HIGH	Council provides an evacuation plan for the site to event organisers; some regular users have their own emergency plans which are reviewed by Council; updated Plan of Management includes assessment of emergency planning; large events have safety compliance requirements that Council regulates					
Community and Recreational Services	ember attack; radiant heat; spatial transference	Operational	People injury/disease	Wildflower garden in bushfire prone area - risk of people being isolated/injured in the event of a bushfire	Major	Possible	6. HIGH	Fire risk signs installed at Garden; staff will close the site on catastrophic fire risk days; evacuation points are being improved especially around the nursery; better way finding signs have been installed around the Garden					
Community Development		Strategic	Compliance legal	Failure of Family Day Care Educators to hold adequate insurances	Major	Possible	6. HIGH	Co-ordinator monitors insurance currency and reviewed monthly	See Risk Register: R0247, C00447				
Community Development	continuity of water and power supply	Operational	Work Health and Safety; People injury/disease	Loss of mains power, water, phone system and internet to child care and community centres; inability to access records and phone; closure of facility	Moderate	Possible	5. MEDIUM	Control actions identified in Business Continuity Plan for Children's Services include assessing time to rectify issue, when to contact parents and/or to reallocate service to alternate premises; recovery actions also outlined in the Children's Services Policy and Procedures Manual					

Community Development	continuity of water and power supply	Operational	Service delivery/reputation; Work Health and Safety; People injury/disease	Loss of mains power, water, phone system and internet to child care and community centres; inability to access records and phone; closure of facility	Moderate	Possible	5. MEDIUM	Ensure Family Day Care and Family Day Care Scheme have a short term Business Continuity Plan in place for emergencies requiring service closure which includes when to contact parents and/or to reallocate service to alternate premises, and the need to have hard copy documentation of relevant contact details etc.						
Community Development	ember attack; radiant heat	Strategic	Assets	Damage to buildings within or in close proximity to bushfire prone areas from radiant heat or ember attack	Major	Possible	6. HIGH	Audit/assessment of buildings to determine potential retrofit options to improve resilience to extreme weather events	Cost-benefit analysis of options to determine those that provide multiple benefits					
Community Development	evacuation preparedness	Operational	People injury/disease	Bushfire danger requires activation of evacuation procedures and/or closure of child care facilities	Major	Possible	6. HIGH	Evacuation procedures in place and regularly practiced at child care centres; arrange workshop or professional development for staff to reinforce preparedness and need for contingency plans	Climate Wise Communities workshops to be arranged					
Community Development	evacuation preparedness	Operational	People injury/disease	Bushfire danger requires activation of evacuation procedures and/or closure of holiday care/camps	Major	Possible	6. HIGH	Evacuation procedures in place; arrange workshop or professional development for staff to reinforce preparedness and need for contingency plans	Climate Wise Communities workshops to be arranged					

Community Development	evacuation preparedness	Operational	People injury/disease	Bushfire danger requires activation of evacuation procedures and/or closure of St Ives Resource Centre (playgroup facility)	Major	Possible	6. HIGH	Evacuation procedures are in place for closure of Centre in high risk fire danger periods. Arrange workshop or professional development for staff to reinforce preparedness and need for contingency plans	Climate Wise Communities workshops to be arranged				
Community Development	evacuation preparedness	Strategic	People injury/disease	Family Day Care locations unknown to emergency services	Moderate	Likely	5. MEDIUM	Need to ensure that all Family Day Care providers are registered with emergency services/LEMO in case of evacuation	Speak to Doone Trovato and Matt Drago				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health and Safety	Failure of Family Day Care educators to have adequate emergency or contingency plans in place	Major	Possible	6. HIGH	Documented evacuation procedures in place including annual review and equipment checks; quarterly evacuation reviews by educators in place	See Risk Register: R0244, C00444				
Community Development	evacuation preparedness	Strategic	People injury/disease; Work Health and Safety	Thomas Carlyle Children's Centre is located in high bushfire risk zone	Major	Possible	6. HIGH	Ongoing monitoring of fire risk level by senior centre staff on high fire risk days	See Risk Register: R0233, C00430				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health and Safety	Failure to have adequate emergency evacuation wardens at Thomas Carlyle Children's Centre	Major	Possible	6. HIGH	Documented evacuation procedures and training in place	See Risk Register: R0229, C00425				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health and Safety	Failure of Youth Services to have in place adequate emergency or contingency plans	Major	Possible	6. HIGH	Evacuation procedures and training in place	See Risk Register: R0264, C00461; context and risk level will depend on location(s) of				

									service				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health and Safety	Failure to have adequate emergency evacuation wardens at Vacation Care programs	Major	Possible	6. HIGH	Documented evacuation procedures and training in place	See Risk Register: R0309, C00515				
Community Development	radiant heat	Compliance	Compliance legal	Family Day Care providers located in bushfire prone areas don't meet standards and need to be closed down	Moderate	Likely	5. MEDIUM	Legislated requirements for Family Day Care to meet specific standards if located in bushfire prone area; some required modification to ensure compliance otherwise close down. Ensure up to date details of Family Day Care Providers are included in Emergency Services and other relevant registers	Who is assessing the bushfire standards of these facilities? This might need to be an action --> follow up. Existing educators in fire zones need to provide Bushfire Consultants Report and ensure compliance to enable continuation of service. New educators have to fully comply with Bushfire Policy prior to registration.				

Compliance and Regulation	loss or damage to private buildings	Compliance	Compliance legal	Demand on Building Surveyors to determine structural adequacy of remaining damaged buildings and follow up demand on assessing new construction certificates	Major	Almost certain	7. HIGH	Ability to engage additional staff to assist in the assessment of damages and construction certificates							
Corporate Communications and Events	continuity of water and power supply	Operational	Service delivery/reputation	Bushfire cuts power to event	Minor	Possible	3. LOW	External contractors manage power supply at all events; generators used as required; enact Emergency Response Procedures if required							
Corporate Communications and Events	continuity of water and power supply	Operational	Work Health & Safety	Power failure leads to injury to staff member working in an office/indoor environment	Moderate	Possible	5. MEDIUM	Safe Systems of Work (Safe/Standard Operating Procedures) followed; undertake regular Workplace Hazard Inspection Checklist (using TRIM 2009/20558)	See Risk Register: R0136; R0169; R0176; C00834; C00837; C00839; C00842; C00843; C00844						
Corporate Communications and Events	emergency communication preparedness	Strategic	Service delivery/reputation	Failure to effectively communicate Council actions to respond to and recover from bushfire event with external stakeholders as a result of poor external communication strategy	Moderate	Possible	5. MEDIUM	External Communication Strategy template available; media monitoring and reporting to GMD; community survey feedback/continual improvement process in place	See Risk Register: R0170; C00388; C00389; C00390						
Corporate Communications and Events	evacuation preparedness	Operational	People injury/disease	Failure to have adequate event risk management practices in place	Major	Possible	6. HIGH	Standardised Event Risk Management Templates to be used as found in the draft Council Event Risk Management Manual	See Risk Register: R0157; C00353						
Corporate Communicatio	evacuation	Operational	People	Major emergency/disruption	Major	Possible	6. HIGH	Emergency Response Procedures documented	See Risk Register:						

ns and Events	preparedness		injury/disease	situation at event				and followed; Trained First Aid Personnel at all events	R0164; C00381; C00382				
Corporate Communications and Events	evacuation preparedness	Operational	Work Health & Safety; Service delivery/reputation	Need to postpone, cancel or alter an event due to adverse conditions and/or bushfire warning	Moderate	Possible	5. MEDIUM	Adverse Weather Conditions Policy - Events (TRIM 2015/031487) outlines conditions and decision making process	Suggest review of policy to better detail process for seeking advice and notifications				
Development and Heritage Assessment	bushfire controls are not applied to Development Applications in bushfire affected areas	Compliance	Compliance legal	Risk and liability exposure to Council due to potential financial loss, property damage and loss of life	Major	Rare	2. LOW	Ensure relevant conditions of consent are imposed through the use of checklists, peer reviews and other review procedures	Processes and procedures are in place to ensure Council's risk exposure is minimised in this regard				
Engineering Operations	continuity of water and power supply	Operational	Operational impact	Sewer mining plants inoperable due to loss of power	Moderate	Possible	5. MEDIUM	Ensure back up power supply is available					
Engineering Operations	continuity of water and power supply	Operational	Operational impact	Street lights inoperable	Minor	Possible	3. LOW						
Engineering Operations	evacuation preparedness	Operational	People injury/disease	Fallen trees block evacuation routes	Major	Likely	7. HIGH	Ultimate responsibility for evacuations is shared. Council must maintain roads and associated infrastructure; emergency services responsible for the evacuation itself					
Engineering Operations	evacuation preparedness	Operational	People injury/disease	Roundabouts, chicanes and other traffic management infrastructure slow down evacuation efforts	Moderate	Likely	5. MEDIUM	Identify most at risk evacuation routes; assess cost-benefit of design aspects of traffic					

								management infrastructure such as being removable					
Engineering Operations	radiant heat	Operational	Assets	Bushfire damages or destroys street furniture and other structures	Moderate	Likely	5. MEDIUM	Low tier (value) items considered sacrificial (e.g. timber pedestrian bridges, benches); alternative materials possible for some structures, but some deform in high heat. Concrete structures installed where vulnerability is high, e.g. along fire trails					
Engineering Operations	radiant heat	Operational	Operational impact	Fallen trees or branches on power lines start fire and/or cut power supply	Moderate	Likely	5. MEDIUM	Where opportunities and funding available, install underground cabling or aerial bundled cabling (ABC)					
Engineering Operations	radiant heat	Operational	Operational impact	Some gross pollutant traps may be affected by bushfire (e.g. ash blockage)	Minor	Possible	3. LOW						
Engineering Operations	radiant heat	Operational	Operational impact	Timber poles of street lights and electricity grid destroyed	Moderate	Possible	5. MEDIUM	Where opportunities and funding available, install underground cabling or request steel poles in new developments					
Engineering Operations	radiant heat; ember attack	Operational	Assets	Bushfire damages or destroys buildings or other infrastructure	Major	Possible	6. HIGH	Maintenance to ensure compliance; build assessment of vulnerability/resilience to fire into condition maintenance reporting; engage expert to professionally assess all infrastructure/buildings, to evaluate cost-benefit and					

								create priority list for further action					
Information Technology	continuity of telecommunication services	Operational	Information systems & data	Loss of productivity and delivery of services	Moderate	Possible	5. MEDIUM	Business Continuity Plans					
Information Technology	continuity of water and power supply	Operational	Information systems & data	Loss of productivity and delivery of services	Moderate	Possible	5. MEDIUM	Business Continuity Plans					
Insurance and Risk Management	continuity of water and power supply	Operational	Work Health & Safety; service delivery; operational impact	Injury / Illness. Loss of productivity and delivery of services	Moderate	Possible	5. MEDIUM	Business Continuity Plans; Crisis Management Plans					
Insurance and Risk Management	ember attack	Operational	People injury/disease; service delivery; operational impact	Injury / Illness. Loss of productivity and delivery of services.	Major	Likely	7. HIGH	Emergency Evacuation Plans; Business Continuity Plans; Crisis Management Plans; independent testing of preparedness; insurances					
Insurance and Risk Management	ember attack	Strategic	Assets; service delivery; reputation	Loss of facilities	Major	Likely	7. HIGH	Business Continuity Plans; insurances					
Insurance and Risk Management	emergency communication preparedness	Operational	Information systems & data; service delivery; operational Impact	Loss of productivity and delivery of services	Moderate	Possible	5. MEDIUM	Business Continuity Plans; Crisis Management Plans					
Insurance and Risk Management	evacuation preparedness	Operational	Work Health & Safety	Injury	Major	Likely	7. HIGH	Emergency Evacuation Plans; Business Continuity Plans; Crisis Management Plans; independent testing					

								of preparedness					
Integrated Planning, Property & Assets	continuity of water and power supply	Operational	Assets	Impacts on tenants and through disruption of services	Moderate	Possible	5. MEDIUM	Contingency plans for critical assets are in place		Asset Custodians	*** Before 2020		
Integrated Planning, Property & Assets	ember attack	Operational	Assets	Impacts on tenants and loss of income through vacancies of damaged properties	Major	Possible	5. MEDIUM	Ensure adequate Asset Protection Zone (APZ) in vicinity of rented properties adjacent to fire prone lands	Programmed maintenance undertaken regularly and funded	Managing Agents Facility Manager Property Manager	*** Before 2020		
Integrated Planning, Property & Assets	emergency communication preparedness	Compliance	Information systems & data	Impact on landlord for non-compliance	Moderate	Possible	6. HIGH	Programmed testing of evacuation systems and alarms carried out regularly		Managing Agents Facility Manager Property Manager	*** Before 2020		
Integrated Planning, Property & Assets	evacuation preparedness	Compliance	People injury/disease	Reputational risk and impact on landlord for non-compliance	Major	Possible	7. HIGH	Evacuation plans and procedures in place; regular practice evacuations carried out		Managing Agents Facility Manager Property Manager	*** Before 2020		
Integrated Planning, Property & Assets	loss or damage to private buildings	Operational	Assets	Loss of property, impacts on tenants and loss of income through vacancies of damaged properties	Major	Possible	5. MEDIUM	Leases contain abatement clauses to protect Council and lessees interests	Insurance cover provides for loss of income; lease documentati on contains abatement clauses	Property Managers	*** Before 2020		

Integrated Planning, Property & Assets	loss or damage to Council assets	Strategic	Assets	Impacts on assets and community service delivery	Major	Possible	6. HIGH	Asset Management Plans developed to incorporate responses to severe weather conditions; contingency Plans in place for critical assets; programmed maintenance includes bush fire preparedness works (e.g. gutter cleaning, site clearance) in affected areas	Contingency plans for critical assets are currently in place	Asset Management Steering Group	*** Before 2020		
Integrated Planning, Property & Assets	loss or damage to Council assets	Strategic	Compliance governance	Impacts on Council's achievement of objectives/actions/tasks/projects in its IPR plans and documents	Moderate	Possible	4. MEDIUM	Monitor any impacts of applied water restrictions and supply and report to GMD and Council as part of quarterly and bi-annual reviews	Quarterly and bi-annual reviews of the Operational Plan and Delivery Program are required under the LGAct	Integrated Planning Coordinator	*** Before 2020		
Integrated Planning, Property & Assets	loss or damage to Council assets	Strategic	Service delivery/reputation	Services, projects and programs to include contingencies for delays and extra costs	Moderate	Possible	3. LOW	Drafting of tasks, performance measures and project bids to include consideration of potential risks of extreme heat	Can be included in requirements for preparation of tasks, project bids and Operational Plans	Integrated Planning Coordinator	*** Before 2020		
Libraries and Cultural Services	continuity of water and power supply	Operational	Operational impact	Without water and power, service is suspended	Minor	Rare	1. LOW	Educate users about remote access to electronic resources; divert affected users to alternative service locations. Extent of controls depends upon	Spreadsheet does not allow likelihood to be "Unlikely" which is in the risk				

								length and timing of issue	matrix and which we nominate for this impact				
Libraries and Cultural Services	ember attack	Operational	Assets	Embers, fire, tree damage to building; repair/replacement cost of asset; disruption to service	Moderate	Rare	2. LOW	Keep buildings clear of overhanging trees; don't build in bushfires zones or build to specifications maximizing protection					
Libraries and Cultural Services	ember attack	Operational	Operational impact	Building becomes too dangerous to occupy - staff and public need to be evacuated - could need alternative service site depending on how long danger is experienced	Moderate	Rare	2. LOW	Have alternative service points available.					
Libraries and Cultural Services	emergency communication preparedness	Operational	People injury/disease	If unable to communicate, may send someone to check and report back - risk of those sent being hurt or isolated. May be waste of resources and unnecessary risk if site not actually in danger	Moderate	Rare	2. LOW	Documented emergency and evacuation procedures includes multiple communication mechanisms able to be used; staff trained and drilled in safe, effective evacuation procedures					
Libraries and Cultural Services	evacuation preparedness	Operational	Operational impact	Severe chemical or bush smoke causes service sites to be evacuated	Minor	Rare	1. LOW	Documented emergency and evacuation procedures; staff trained and drilled in safe, effective evacuation procedures	Spreadsheet does not allow likelihood to be "Unlikely" which is in the risk matrix and which we nominate for this impact				
Libraries and Cultural Services	evacuation preparedness	Operational	People injury/disease	People could panic, not be able to reach their home or refuse to leave. Site could	Minor	Rare	1. LOW	Documented emergency and evacuation procedures; staff trained	Spreadsheet does not allow				

				become a place of refuge				and drilled in safe, effective evacuation procedures	likelihood to be "Unlikely" which is in the risk matrix and which we nominate for this impact				
Libraries and Cultural Services	radiant heat	Operational	Assets	Building burned down or damaged so severely it cannot be used	Minor	Rare	1. LOW	Keep buildings clear of overhanging trees; don't build in bushfires zones or build to specifications maximizing protection; have alternative service points available					
Libraries and Cultural Services	smoke	Operational	Operational impact	Breathing difficulties for staff and public; tiredness; respiratory distress; potential damage to stock (depending on source)	Minor	Rare	1. LOW	Practised evacuation procedures. Have flexible plans for options					
Open Space Operations	ember attack	Operational	Assets	Damage to synthetic playing fields' surfaces from embers	Minor	Possible	3. LOW	Accepted loss; covered by insurance					
Open Space Operations	emergency preparedness	Operational	Operational impact	Although Council is not a combat agency, our plant can be commandeered by emergency service agencies in event of a fire	Moderate	Possible	5. MEDIUM	Ensure all plant and equipment are maintained appropriately for this potential usage; asset replacement program					
Open Space Operations	emergency preparedness	Strategic	Service delivery/reputation	Bushfire risk to community and assets	Major	Likely	7. HIGH	Involvement in development and delivery of local Bush Fire Risk Management Plan					
Open Space Operations	emergency and evacuation preparedness	Operational	Operational impact	Failure to maintain adequate access for fire trucks on access trails	Major	Possible	6. HIGH	Preventative maintenance program in place; monthly reporting into BRIMS (Rural Fire Service Bushfire Risk Information Management System)	See Risk Register: R0529, C01013				

Open Space Operations	evacuation preparedness	Operational	Operational impact	Potential loss of life/injury if people become isolated bushfire event	Major	Rare	2. LOW	May close some facilities on extreme or catastrophic fire risk days; limit or restrict access to bushland areas where there is a risk of fire; communicate advice to keep out of certain areas						
Open Space Operations	evacuation preparedness	Operational	People injury/disease	Bushfire danger requires activation of evacuation procedures or closure of golf course	Major	Possible	6. HIGH	Ensure golf course operators have documented evacuation procedures and training in place	Mark Taylor to check					
Open Space Operations	radiant heat	Compliance	Environmental effects	Potential loss or destruction of threatened species or community	Major	Possible	6. HIGH	Legislated requirement to protect and/or reinstate threatened/endangered communities; requirement to advise Office of Environment and Heritage if threatened species and/or communities are impacted; put actions/infrastructure in place to protect area during regeneration						
Open Space Operations	radiant heat	Compliance	Assets	Potential loss or destruction of heritage assets	Moderate	Possible	5. MEDIUM	Document assets for evidence of status for restoration information; repair and document if damaged						
Open Space Operations	radiant heat; ember attack	Operational	Assets	Damage to property from failure to meet the safety requirements of regional bushfire risk management plan as required by Rural Fires Act	Major	Likely	7. HIGH	Bushfire Risk Management Plan and associated actions	See Risk Register: R0375, C00531					

Records and Governance	radiant heat	Operational	Operational impact	Inability to access critical records or documents which are required to operate effectively in the event of a disaster	Moderate	Possible	5. MEDIUM	Secure backup location provided for business continuity documentation (Not Implemented / Effective)	See Risk Register: R0074, C00187				
Records and Governance	radiant heat; ember attack; spatial transference	Operational	Operational impact	Fire affects Council Chambers in areas where records are stored resulting in loss of or damage to records; loss of records	Moderate	Possible	5. MEDIUM	Records Disaster Recovery Plan (existing); most records stored electronically or offsite in secure facilities (existing); digitisation program for vital/long-term paper-based records (ongoing)	See Risk Register: R0072, C00185, R0456, C00594, C00882	Manager Records & Governance	*** Before 2020	Existing controls	2. LOW
Strategic Projects	ember attack	Operational	Assets	Destruction of Council assets	Moderate	Possible	5. MEDIUM	Some assets are considered sacrificial; assess cost-benefit of choice of building materials in planning and design; include appropriate specifications in design documentation; document guidelines on decision process to build to sacrificial specifications or otherwise					
Strategic Projects	radiant heat; ember attack; spatial transference	Operational	Assets	Destruction of Council assets	Moderate	Possible	5. MEDIUM	Use existing planning instruments (e.g. Bush Fire Prone Land Mapping, Bush Fire Risk Management Plan) to inform design and other conditions					
Strategic Projects	continuity of water and power supply; evacuation preparedness	Operational	Service delivery/reputation	Project delays and increase cost, due to natural disaster, etc.	Minor	Possible	3. LOW	Contingency allowance and indemnification clauses in project budget or time for adverse weather or serious incident downtime mitigate costs to Council; financial checks (score card) and analysis of prospective	See Risk Register: R0583, C01084, C01085, C01086				

								tenders; pre-procurement process					
Urban Heritage and Planning	evacuation preparedness	Strategic	People injury/disease	People in vulnerable groups not being able to evacuate safely in event of major incident	Major	Possible	6. HIGH	Limit housing density in bushfire prone areas for evacuation; restrict vulnerable land uses within bushfire evacuation risk areas (e.g. childcare centres, seniors housing); caps to number of new subdivisions and dwelling via provisions in the LEP					

Primary Hazard 3: Extreme heat													
Functional area	Secondary Impacts	Risk type	Risk category	Tertiary impacts	Consequence rating	Likelihood rating	Risk matrix score	Proposed control(s)	Notes/ comments	Responsibility	Timeline	Estimated cost / benefit score	Residual risk ranking
Community and Recreational Services	residents seek cool community spaces to spend daylight hours	Operational	Work Health & Safety	Fitness and Aquatic Centre attracts large crowds on extreme heat days	Moderate	Almost certain	6. HIGH	Capacity levels restricted by staffing/life guard ratios; Access may be limited as required; all life guards have first aid training; free access to water; shade structures provided					
Community and Recreational Services	residents seek cool community spaces to spend daylight hours	Operational	People injury/disease	Extreme heat day with large crowds degenerates into bushfire or storm scenario requiring evacuation	Major	Possible	6. HIGH	Facility emergency plan includes multiple exit points and shelter in place contingency; procedure in place for manager to monitor weather conditions via BoM and to close and evacuate pool as required (especially for risk of lightning or fire); ensure pool management registers for bushfire alerts via Fires Near Me					
Community and Recreational Services	power failure as demand exceeds supply	Operational	Operational impact	Power loss shuts down air circulation, pumping and filtering systems	Moderate	Likely	5. MEDIUM	Shut down and evacuation of facility including cancellation of booked lessons and events					
Community and Recreational Services	power failure as demand exceeds supply	Operational	Operational impact	Power loss to lighting, electricity and air conditioning (where available) systems	Minor	Likely	4. MEDIUM	Option to shut down and evacuate facility including cancellation of bookings					
Community and Recreational Services	external temperatures rise above 35°C	Operational	Work Health & Safety	Tools and equipment at Men's Shed used outdoors on hot day spark bushfire	Major	Possible	6. HIGH	Instigate documentation and implementation of Work Health and Safety procedures	Currently no agreements in place				

Community and Recreational Services	external temperatures rise above 35°C	Operational	People injury/disease	High temperature days pose health risk for spectators at sports fields	Moderate	Likely	5. MEDIUM	Some venues have adequate shade and/or covered spaces; provide heat safety information to sporting clubs; many clubs (e.g. cricket) have heat policy for players						
Community and Recreational Services	external temperatures rise above 35°C	Operational	People injury/disease	Wildflower garden has a large bushland area where people may be exposed to extreme heat	Major	Possible	6. HIGH	Staff will close the site on days of high risk; evacuation points are being improved especially around the nursery; better way finding signs have been installed around the Garden; programs are modified where conditions are unsuitable or unsafe; basic information on what to take on bushwalks is provided to visitors; water is available at some points						
Community and Recreational Services	external temperatures rise above 35°C	Operational	Service delivery/reputation	Active Ku-ring-gai programs affected by extreme heat - health risk to participants	Moderate	Likely	5. MEDIUM	Provide health and safety information to providers and participants; adjust, postpone or cancel programs where risk is too high; investigate contingency plans for running activities at alternate venues (indoors, more shade etc.)						
Community Development	a/c units exceed operational capacity	Operational	Service delivery/reputation; Work Health & Safety; People injury/disease	Increased indoor ambient temperature beyond comfort levels from A/C failure - health risk to children and staff	Moderate	Possible	5. MEDIUM	Take actions to reduce overheating of A/C unit and minimise use to unnecessary areas of facility; policies and guidelines advise when to close down centre, send children home and/or relocate to alternative						

								premises					
Community Development	external temperatures rise above 35°C	Operational	People injury/disease	Illness or injury to volunteer working in an outdoor environment for Aged Services	Moderate	Possible	5. MEDIUM	Follow Managers Guide to Volunteers and Volunteer Manual	See Risk Register: R0192, C00854				
Community Development	external temperatures rise above 35°C	Operational	People injury/disease	Injury or illness to participant of Aged Services program	Moderate	Likely	5. MEDIUM	First Aid Kit and trained staff; Workplace Inspections; develop and implement guidelines to temperature thresholds for cancellation of activities	See Risk Register: R0214, C00410, C00857				
Community Development	external temperatures rise above 35°C	Operational	Work Health & Safety; People injury/disease	Excessive heat outdoors poses health risk to staff and children at child care or vacation care centres	Moderate	Likely	5. MEDIUM	Installation of shade sails over outdoor areas; policies and guidelines advise when to relocate activities indoors; some premises delivering these services fitted with A/C					
Community Development	indoor thermal levels exceed comfort	Operational	Financial/Marketing/Customer	Increased use of A/C at child care centres increases recurrent energy costs	Moderate	Likely	5. MEDIUM	Monitor energy use and budget; implement energy efficiency measures (e.g. guide to best temperature settings, audit of appliances and energy consumption etc.)					
Community Development	indoor thermal levels exceed comfort	Operational	Financial/Marketing/Customer; Service delivery/reputational	Inability to operate child care and holiday care services due to extended extreme weather conditions and/or loss of power/services	Major	Possible	6. HIGH	Business Continuity Plans reference options for relocating staff and/or service; insurance to cover financial loss	Pertains more to holiday and long day care services; less risk for Youth Services				

Community Development	power failure as demand exceeds supply	Operational	Service delivery/reputation; Work Health & Safety; People injury/disease	Loss of power and internet to child cares and community centres	Moderate	Possible	5. MEDIUM	Control actions identified in Business Continuity Plan for Children's Services include assessing time to rectify issue, when to contact parents and/or relocate service to alternate premises; recovery actions also outlined in the Children's Services Policy and Procedures Manual						
Compliance and Regulation	indoor thermal levels exceed comfort	Compliance	Compliance legal	Increased demand for air cooling systems in private properties leads to noise complaints from inefficient systems or non-compliance with planning laws	Minor	Likely	4. MEDIUM	Planning laws make it clear where systems are permitted to be installed and operational performance standards in regard to noise; Compliance Officers respond to complaints						
Corporate Communications and Events	external temperatures rise above 35°C	Operational	People injury/disease	Failure to have adequate event risk management practices in place	Major	Possible	6. HIGH	Use of standardised event risk management templates as per draft Council Event Risk Management Manual	See Risk Register: R0157; C00353					
Corporate Communications and Events	external temperatures rise above 35°C	Operational	People injury/disease	Need to postpone, cancel or alter an event due to adverse conditions	Moderate	Possible	5. MEDIUM	Adverse Weather Conditions Policy - Events (TRIM 2015/031487) outlines conditions and decision making process	Suggest review of policy to include Extreme Heat/Heatwave					
Corporate Communications and Events	external temperatures rise above 35°C	Operational	People injury/disease	Major emergency/disruption situation at event	Major	Possible	6. HIGH	Emergency response procedures documented and followed; trained First Aid personnel at all events	See Risk Register: R0164; C00381; C00382					

Corporate Communications and Events	power failure as demand exceeds supply	Operational	Service delivery/reputation	Power outage cuts power to event	Minor	Possible	3. LOW	External contractors manage power supply at all events; generators used as required; enact Emergency Response Procedures if required						
Corporate Communications and Events	power failure as demand exceeds supply; indoor thermal levels exceed comfort	Operational	Work Health & Safety	Chambers building uninhabitable for use by customer services	Moderate	Possible	5. MEDIUM	Annual desktop review of Contingency Plan and annual training and consultation with staff	See Risk Register: R0450; C00588					
Corporate Communications and Events	power failure as demand exceeds supply; indoor thermal levels exceed comfort	Operational	Work Health & Safety	Injury to staff member working in an office/indoor environment	Moderate	Possible	5. MEDIUM	Safe Systems of Work (Safe/Standard Operating Procedures) followed; undertake regular Workplace Hazard Inspection Checklist (using TRIM 2009/20558)	See Risk Register: R0136; R0169; R0176; C00834; C00837; C00839; C00842; C00843; C00844					
Engineering Operations	continuity of water and power supply	Operational	Operational impact	Sewer mining plants inoperable due to loss of power	Moderate	Possible	5. MEDIUM	Ensure back up power supply is available						
Engineering Operations	external temperatures rise above 35°C	Operational	Assets	Extreme heat softens bitumen in roads and pathways, which makes them more susceptible to erupting and erosion	Moderate	Possible	5. MEDIUM	Unavoidable, requires reactive maintenance when it occurs						
Engineering Operations	external temperatures rise above 35°C	Operational	People injury/disease	Roads and paths network contributes to local heat island effect	Moderate	Possible	5. MEDIUM	Planning includes tree-lined avenues where possible; cost-benefit needs to be assessed against amenity value, lighting/safety and the potential for falling						

								branches					
Engineering Operations	power failure as demand exceeds supply	Operational	Operational impact	Street lights inoperable	Minor	Possible	3. LOW						
Information Technology	a/c units exceed operational capacity	Operational	Information systems & data	Shutdown of computer room, loss of productivity and delivery of services	Moderate	Possible	5. MEDIUM	Business Continuity Plan.					
Information Technology	power failure as demand exceeds supply	Operational	Information systems & data	Loss of productivity and delivery of services	Moderate	Possible	5. MEDIUM	Business Continuity Plan					
Information Technology	road and rail transport disrupted	Operational	Information systems & data	Staff unavailable to manage and maintain systems	Minor	Possible	3. LOW	Business Continuity Plan					
Insurance and Risk Management	a/c units exceed operational capacity	Operational	People injury/disease	Heat stress, dehydration	Minor	Possible	3. LOW	Fans, ventilation, stop work					
Insurance and Risk Management	external temperatures rise above 35°C	Operational	People injury/disease	Heat stress, dehydration, injury	Moderate	Possible	5. MEDIUM	Safe Work Method Statements; policies; work scheduling; sun safe; training	Policy identifies 40 deg C				
Integrated Planning, Property & Assets	external temperatures rise above 35°C	Operational	Assets	excessive load causes plant failure	Moderate	Possible	5. MEDIUM	Asset Management Plans developed to incorporate responses to severe weather conditions. Contingency Plans in place for critical assets. Programmed maintenance includes extreme heat preparedness for plant & equipment	Contingency plans for critical assets are currently in place	Managing Agents Facility Manager Property Manager	*** Before 2020		

Insurance and Risk Management	indoor thermal levels exceed comfort	Operational	People injury/disease	Heat stress, dehydration. Loss of productivity	Minor	Possible	3. LOW	Business Continuity Plan					
Insurance and Risk Management	power failure as demand exceeds supply	Operational	Information systems & data; service delivery/reputation; operational Impact	Heat stress, dehydration. Loss of operational capacity. Data loss	Minor	Possible	3. LOW	Business Continuity Plan					
Insurance and Risk Management	road and rail transport disrupted	Operational	Service delivery/reputation	Staff unavailable	Minor	Possible	3. LOW	Business Continuity Plan; shared knowledge within Departments					
Integrated Planning, Property & Assets	a/c units exceed operational capacity	Operational	Assets	Aged and redundant plant unable to function adequately	Moderate	Likely	5. MEDIUM	Asset Management Plans developed to incorporate responses to severe weather conditions; contingency plans in place for critical assets; programmed maintenance includes extreme heat preparedness for plant and equipment		Managing Agents Facility Manager Property Manager	*** Before 2020		
Integrated Planning, Property & Assets	external temperatures rise above 35°C; indoor thermal levels exceed comfort	Strategic	Service delivery/reputation	Delays and extra costs in projects due to inclement weather - extreme heat	Moderate	Possible	4. MEDIUM	Drafting of tasks, performance measures and project bids to include consideration of potential risks of extreme heat; services, projects and programs to include contingencies for Delays and extra costs	Can be included in requirements for preparation of tasks, project bids and Operational Plans	Integrated Planning Coordinator	*** Before 2020		
Integrated Planning, Property & Assets	indoor thermal levels exceed comfort	Strategic	Assets	Excessive load causes plant failure	Moderate	Likely	5. MEDIUM	Asset Management Plans developed to incorporate responses to severe weather conditions; contingency plans in place for critical assets;		Managing Agents Facility Manager Property Manager	*** Before 2020		

								programmed maintenance includes extreme heat preparedness for plant and equipment					
Integrated Planning, Property & Assets	power failure as demand exceeds supply	Operational	Assets	Impacts on tenants and through disruption to services	Moderate	Likely	5. MEDIUM	Asset Management Plans developed to incorporate responses to severe weather conditions; contingency plans in place for critical assets; programmed maintenance includes bush fire preparedness works (e.g. gutter cleaning, site clearance) in affected areas		Managing Agents Facility Manager Property Manager	*** Before 2020		
Integrated Planning, Property & Assets	residents seek cool community spaces to spend daylight hours	Strategic	Assets	Impacts on existing facilities to meet community service levels	Moderate	Possible	4. MEDIUM	Asset Management Plans developed to incorporate responses to severe weather conditions; contingency plans in place for critical assets; programmed maintenance includes extreme heat preparedness for plant and equipment		Managing Agents Facility Manager Property Manager	*** Before 2020		
Integrated Planning, Property & Assets	power failures and disruptions to services	Strategic	Compliance governance	Impacts on achievement of objectives/actions/tasks/projects in Council's Integrated Planning and Reporting framework plans and documents	Moderate	Possible	4. MEDIUM	Drafting of tasks, performance measures and project bids to include consideration of potential risks of extreme heat	Can be included in requirements for preparation of tasks, project bids and Operational Plans	Integrated Planning Coordinator	*** Before 2020		
Libraries and Cultural	a/c units exceed operational	Operational	Assets	Overheating of systems spark and/or cause fire hazard	Moderate	Possible	5. MEDIUM	Regular maintenance and upgrade of systems					

Services	capacity												
Libraries and Cultural Services	indoor thermal levels exceed comfort	Operational	People injury/disease; Work Health and Safety	Aged and vulnerable people may suffer negative health conditions; first aid may be required; reduced staff productivity and safety may be reduced due to difficulty in concentrating and feeling tired	Minor	Rare	1. LOW	Advise and check with visitors about hydration and reducing fatigue. Keep first aid qualifications and supplies up-dated	Spreadsheet does not allow likelihood to be "Unlikely" which is in the risk matrix and which we nominate for this impact				
Libraries and Cultural Services	residents seek cool community spaces to spend daylight hours	Operational	Operational impact	Buildings need to be staffed and operational for longer than normal hours... extended hours	Minor	Possible	3. LOW	Cost allowances and processes...					
Libraries and Cultural Services	road and rail transport disrupted	Operational	Operational impact	Staff unable to get to or from work disrupts service provision	Minor	Rare	1. LOW	Multiple service sites available	Spreadsheet does not allow likelihood to be "Unlikely" which is in the risk matrix and which we nominate for this impact				
Natural Area and Catchment Planning	external temperatures rise above 35°C	Operational	Environmental effects	Water Sensitive Urban Design (WSUD) plant filtering stormwater gardens die	Moderate	Likely	5. MEDIUM	Replant hardy species including water holding crystals in soil medium; plant shade tree next to filter garden if possible		m.drago	*** Before 2020		

Open Space Operations	external temperatures rise above 35°C	Compliance	Environmental effects	Extreme heat potentially fatal to some threatened species (e.g. flying foxes) - legislated obligation to protect threatened species	Major	Possible	6. HIGH	Need for guidelines to inform appropriate access and activities of staff and volunteers wanting to take actions to protect species that take into account welfare of animals and WHS of people; requirement to advise Office of Environment and Heritage if threatened species and/or communities are impacted							
Open Space Operations	external temperatures rise above 35°C	Operational	Operational impact	Excess heat burns/damages greens of golf course	Moderate	Possible	5. MEDIUM	Increased watering regime for greens to reduce damage; hand watering of asset if required							
Open Space Operations	external temperatures rise above 35°C	Operational	Operational impact	Excess heat burns/damages gardens	Moderate	Possible	5. MEDIUM	Schedule planting to align with cooler periods of day/week; hand watering of assets if required							
Open Space Operations	external temperatures rise above 35°C	Operational	Operational impact	Excessive temperatures result in overheating and failure of plant and equipment	Moderate	Possible	5. MEDIUM	Prioritise works to ensure more urgent/important activities are achieved, potentially at the expense of lesser priorities; communicate decisions and impacts as required to minimise reputational impacts							
Open Space Operations	external temperatures rise above 35°C	Operational	People injury/disease; Work Health and Safety	Illness or injury to staff member working in an outdoor environment	Moderate	Possible	5. MEDIUM	Safe Systems of Work as outlined in safe operating procedures in place; WHS policies; work scheduling; sun safe health messages and PPE; training	See Risk Register: R0575, C00992						

Open Space Operations	external temperatures rise above 35°C	Operational	Work Health & Safety; Operational impacts	Potential for heat stress requires rescheduling of works and impacts ability to deliver required service levels	Minor	Likely	5. MEDIUM	Prioritise works to ensure more urgent/important activities are achieved, potentially at the expense of lesser priorities; communicate decisions and impacts as required to minimise reputational impacts						
Strategic Projects	external temperatures rise above 35°C	Operational	Operational impact Service delivery/reputation	Construction delays due to inclement weather (excessive heat) affects concrete pours etc. and the need to work around these	Minor	Likely	4. MEDIUM	Contractors being aware of potential heat, mitigation measures being in place before the pour commences (e.g. specification of concrete type)	Also financial and structural risk, especially if not mitigated or corrected before or at time of pour					
Strategic Projects	external temperatures rise above 35°C	Operational	Operational impact	Nominated plants not being available as per planting schedules	Moderate	Possible	5. MEDIUM	Reschedule ordering of plants or change to plant selection						
Strategic Projects	external temperatures rise above 35°C	Operational	Service delivery/reputation	Project delays and increase cost, due to natural disaster, inclement weather etc.	Minor	Possible	3. LOW	Contingency allowance and indemnification clauses in project budget or time for adverse weather or serious incident downtime mitigate costs to Council; financial checks (score card) and analysis of prospective tenders; pre-procurement process	See Risk Register: R0583, C01084, C01085, C01086					
Strategic Projects	external temperatures rise above 35°C	Operational	Work Health & Safety Operational impact	Construction delays due to inclement weather (excessive heat)	Moderate	Possible	5. MEDIUM	Assess need to increase contingency allowance for inclement weather days in contracts and construction programs						

Strategic Projects	external temperatures rise above 35°C	Project	Assets	Increasing frequency of extreme heat events and high temperatures damages materials and surfaces (e.g. paint, fabrics) and/or deterioration reduces asset life	Moderate	Possible	5. MEDIUM	Cost-benefit analysis to determine need for design specifications to specify particular materials etc. (e.g. UV ratings for paint, fabrics) for new assets; may be built into purchasing policy or guidelines						
Strategic Projects	residents seek cool community spaces to spend daylight hours	Strategic	Assets	Urban Heat Island Effect becomes more pronounced as number of extreme heat days increases	Minor	Likely	4. MEDIUM	Ensure provision of shade structures and community facilities for residents' access in new developments and renewal						
Traffic and Transport	external temperatures rise above 35°C	Operational	Work Health & Safety	Excess heat may impact staff health and safety while carrying out site inspections	Minor	Rare	1. LOW	Adjust work schedules to allow staff to stay in office during extreme heat						
Traffic and Transport	external temperatures rise above 35°C	Operational	Work Health & Safety	Health and safety hazard to staff while regulating traffic	Minor	Rare	1. LOW	Staff are trained with appropriate Roads and Maritime Services (RMS) and Worksafe certificates to manage traffic on road, and avoid risk to themselves	No incidents recorded in the last 20 years					
Urban Heritage and Planning	external temperatures rise above 35°C	Strategic	Environmental effects	Heat island effect increases in urban areas and people avoid using facilities --> impacts on local economy	Moderate	Almost certain	6. HIGH	Reduce extent of paved areas, increase green spaces, green walls/roofs, more trees, reflective pavements/roofs etc.						
Urban Heritage and Planning	residents seek cool community spaces to spend daylight hours	Strategic	People injury/disease	Public domain/community facilities do not provide opportunities for heat relief	Minor	Possible	3. LOW	Design public spaces to be shaded/cool during extreme heat. Ensure community buildings are adequately cooled						

Urban Heritage and Planning	road and rail transport disrupted	Strategic	People injury/disease	People avoid roads and public transport --> reliance on active transport such as walking or cycling which could be hazardous in extreme heat	Moderate	Possible	5. MEDIUM	Improved cycling and pedestrian networks; increase shade by including trees etc. and increase facilities such as rest areas/seating/signage						

Primary Hazard 4: Severe storm													
Functional area	Secondary Impacts	Risk type	Risk category	Tertiary impacts	Consequence rating	Likelihood rating	Risk matrix score	Proposed control(s)	Notes/ comments	Responsibility	Timeline	Estimated cost/benefit score	Residual risk ranking
Community and Recreational Services	wind strength / shear force	Operational	People injury/disease	Fitness and Aquatic Centre in bushland - potential for isolation in evacuation if access road blocked	Moderate	Possible	5. MEDIUM	Contract with leasee requires emergency evacuation plan including multiple exit points and shelter in place scenario; maintenance includes managing asset protection zone					
Community and Recreational Services	lightning strikes	Operational	People injury/disease	Lightning strike risk to swimmers at Fitness and Aquatic Centre	Major	Likely	7. HIGH	Facility emergency plan includes multiple exit points and shelter in place contingency; procedure in place for manager to monitor weather conditions via BoM and to close and evacuate pool as required (especially risk of lightning); life guards all first aid trained					
Community and Recreational Services	wind strength / shear force	Operational	People injury/disease	Storm brings down tree or branches onto visitors cars at Fitness and Aquatic Centre	Moderate	Possible	5. MEDIUM	Monitoring of condition and remedial action as part of regular tree maintenance program					
Community and Recreational Services	wind strength / shear force	Operational	Operational impact	Fallen power lines shuts down power and therefore air circulation, pumping and filtering systems	Moderate	Likely	5. MEDIUM	Shut down and evacuation of facility including cancellation of booked lessons and events					
Community and Recreational Services	wind strength / shear force	Operational	Operational impact	Fallen power lines cut supply to lighting, electricity and air conditioning (where available) systems	Minor	Likely	4. MEDIUM	Shut down and evacuation of facility including cancellation of bookings					

Community and Recreational Services	wind strength / shear force	Operational	People injury/disease	Halls and meeting rooms in or near bushland damaged from storm impact	Major	Possible	6. HIGH	Each venue has documented and current evacuation and emergency procedures that are provided to regular and casual users of the facility; procedures include stay in place option and criteria						
Community and Recreational Services	wind strength / shear force; hail; soil saturation; airborne debris	Operational	Service delivery/reputation	Halls and meeting rooms damaged by storm event, affecting service delivery	Major	Possible	6. HIGH	Business contingency planning to determine option for transferring service to another facility/venue						
Community and Recreational Services	wind strength / shear force; hail; soil saturation; airborne debris	Operational	Work Health & Safety	Major storm requires evacuation of event at showground	Major	Possible	6. HIGH	Council provides an evacuation plan for the site to event organisers; some regular users have their own emergency plans which are reviewed by Council; updated Plan of Management includes assessment of emergency planning; large events have safety compliance requirements that Council regulates						
Community and Recreational Services	wind strength / shear force; hail; soil saturation; airborne debris	Operational	People injury/disease	Wildflower garden has many large trees and bushland area - risk of people being isolated/injured in the event of a large storm	Major	Possible	6. HIGH	Staff will close the site on days of high risk; evacuation points are being improved especially around the nursery; better way finding signs have been installed around the Garden; programs are modified where conditions are unsuitable or unsafe						

Community Development	continuity of water and power supply	Operational	Service delivery/reputation; Work Health and Safety; People injury/disease	Loss of power, mains water, internet to Family Day Care centres requires closure of service	Moderate	Possible	5. MEDIUM	Ensure Family Day Care and Family Day Care Scheme have a short term Business Continuity Plan in place for emergencies requiring service closure which includes when to contact parents and/or to reallocate service to alternate premises, and the need to have hard copy documentation of relevant contact details etc.							
Community Development	continuity of water and power supply	Operational	Service delivery/reputation; Work Health and Safety; People injury/disease	Loss of power, mains water, internet to child cares and community centres	Moderate	Possible	5. MEDIUM	Control actions identified in Business Continuity Plan for Children's Services, including assessing time to rectify issue, when to contact parents and/or to reallocate service to alternate premises; recovery actions also outlined in the Children's Services Policy and Procedures Manual							
Community Development	evacuation preparedness	Operational	People injury/disease	Storm damage requires activation of evacuation procedures or closure of child care facilities	Major	Possible	6. HIGH	Evacuation procedures in place and regularly practiced at child care centres; arrange Climate Wise Communities workshop or professional development for staff to reinforce preparedness and need for contingency plans							
Community Development	evacuation preparedness	Operational	People injury/disease	Storm damage requires activation of evacuation procedures or closure of holiday care/camps	Major	Possible	6. HIGH	Evacuation procedures in place; arrange Climate Wise Communities workshop or professional development for staff to reinforce preparedness and							

								need for contingency plans					
Community Development	evacuation preparedness	Operational	People injury/disease	Storm damage requires activation of evacuation procedures or closure of St Ives Resource Centre (playgroup facility)	Major	Possible	6. HIGH	Evacuation procedures in place; procedures are in place for centre not opening; arrange Climate Wise Communities workshop or professional development for staff to reinforce preparedness and need for contingency plans					
Community Development	evacuation preparedness	Strategic	Compliance legal	Failure of Family Day Care Educators to hold adequate insurances	Major	Possible	6. HIGH	Co-ordinator monitors insurance currency on a monthly basis	See Risk Register: R0247, C00447				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health and Safety	Failure of Family Day Care educators to have in place adequate emergency or contingency plans	Major	Possible	6. HIGH	Documented evacuation procedures in place and reviewed quarterly	See Risk Register: R0244, C00444				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health and Safety	Failure to have adequate emergency evacuation wardens at Thomas Carlyle Children's Centre	Major	Possible	6. HIGH	Documented evacuation procedures and training in place	See Risk Register: R0229, C00425				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health and Safety	Failure of Youth Services to have in place adequate emergency or contingency plans	Major	Possible	6. HIGH	Evacuation procedures and training in place	See Risk Register: R0264, C00461				
Community Development	evacuation preparedness	Strategic	Compliance legal; People injury/disease; Work Health	Failure to have adequate emergency evacuation wardens at Vacation Care programs	Major	Possible	6. HIGH	Documented evacuation procedures and training in place	See Risk Register: R0309, C00515				

			and Safety										
Compliance and Regulation	hail	Compliance	Compliance legal	Building failure	Minor	Possible	3. LOW	Ensure retail and commercial areas overhead awnings are regularly checked for structural stability; system has been implemented to remind building owners of their responsibility to have awnings independently checked and certified by a structural engineer so as to ensure they have the capacity to withstand the dumping of hail					
Compliance and Regulation	intense and prolonged rainfall	Compliance	Compliance legal	Overland flooding	Minor	Likely	4. MEDIUM	Ensure on-site hydraulic systems operational and of relevant capacity					
Compliance and Regulation	wind strength / shear force	Compliance	Compliance legal	Building failure	Minor	Rare	1. LOW	Ensure structures built to Australian Building Code standards					
Corporate Communications and Events	intense and prolonged rainfall; soil saturation	Operational	Assets	Corporate Event causes damage to site, property, environment	Moderate	Possible	5. MEDIUM	Annual Site Assessment of sites used for events; access permits for entry to event site; consult asset manager to determine preventative action(s)	See Risk Register: R0160; C00358; C00359				
Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; hail; airborne debris	Operational	People injury/disease	Failure to have adequate event risk management practices in place	Major	Possible	6. HIGH	Standardised Event Risk Management Templates to be used as found in the draft Council Event Risk Management Manual	See Risk Register: R0157; C00353				

Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; hail; airborne debris	Operational	People injury/disease	Major emergency/disruption situation at event	Major	Possible	6. HIGH	Emergency Response Procedures documented and followed; trained First Aid Personnel at all events	See Risk Register: R0164; C00381; C00382				
Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; hail; airborne debris	Operational	People injury/disease	Need to postpone, cancel or alter an event due to adverse conditions	Moderate	Possible	5. MEDIUM	Adverse Weather Conditions Policy - Events (TRIM 2015/031487) outlines conditions and decision making process	Suggest review of policy to include high winds and storms				
Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; airborne debris	Operational	Service delivery/reputation	Storm impact takes down power line, cuts power to event	Minor	Possible	3. LOW	External contractors manage power supply at all events; generators used as required; enact Emergency Response Procedures if required					
Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; hail; airborne debris	Operational	Work Health & Safety	Power failure leads to injury to staff member working in an office/indoor environment	Moderate	Possible	5. MEDIUM	Safe Systems of Work (Safe/Standard Operating Procedures) followed; undertake regular Workplace Hazard Inspection Checklist (using TRIM 2009/20558)	See Risk Register: R0136; R0169; R0176; C00834; C00837; C00839; C00842; C00843; C00844				
Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; hail; airborne debris	Operational	Work Health & Safety	Chambers building uninhabitable for use by customer services	Moderate	Possible	5. MEDIUM	Annual desktop review of Contingency Plan and annual training and consultation with staff	See Risk Register: R0450; C00588				

Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; hail; airborne debris	Strategic	Service delivery/reputation	Failure to effectively communicate Council actions to respond to and recover from storm event with external stakeholders as a result of poor external communication strategy	Moderate	Possible	5. MEDIUM	External Communication Strategy template available; media monitoring and reporting to GMD; community survey feedback and continual improvement process in place	See Risk Register: R0170; C00388; C00389; C00390					
Corporate Communications and Events	wind strength / shear force; soil saturation; lightning strikes; hail; airborne debris	Strategic	Service delivery/reputation	Customer dissatisfaction with service delivery provided in clean up from storm event	Moderate	Possible	5. MEDIUM	Customer complaint referral process in place including documenting, reviewing and responding to the complainant	See Risk Register: R0132; C00298					
Development and Heritage Assessment	Stormwater controls are not applied to development applications subject to flooding or inadequate stormwater retention/detention systems are required to be provided	Compliance	Compliance legal	Risk and liability exposure for Council due to potential financial loss and property damage	Moderate	Rare	2. LOW	Ensure relevant conditions of consent are imposed through the use of checklists, peer reviews and other review procedures	Processes and procedures are in place to ensure Council's risk exposure is minimised in this regard					
Engineering Operations	airborne debris and prolonged rainfall	Operational	Assets	Debris gathers and blocks areas of drainage network; 'ponding'	Moderate	Possible	5. MEDIUM	Remediation work to reduce frequency of flooding in priority areas, including creation of spillways to dissipate water flow energy and reduce ponding on roads						
Engineering Operations	airborne debris and prolonged rainfall	Operational	Assets	Gross pollutant traps become blocked or damaged by debris	Moderate	Possible	5. MEDIUM							

Engineering Operations	continuity of water and power supply	Operational	Operational impact	Sewer mining plants inoperable due to loss of power	Moderate	Possible	5. MEDIUM	Ensure back up power supply is available					
Engineering Operations	intense and prolonged rainfall	Operational	Assets	More frequent and intense rainfall events impact new developments	Moderate	Possible	5. MEDIUM	Hydrological and hydraulic modelling is performed to predict capacity flows for different rain levels --> information is provided to consultants for flood studies etc.; use revised Australian Rainfall and Runoff (ARR) figures to review current modelling for significant discrepancies					
Engineering Operations	intense and prolonged rainfall	Operational	Assets	Increased scouring and erosion of open channels and earth-lined drains, especially with build-up of on-site stormwater detention systems	Moderate	Possible	5. MEDIUM	Proactive investigation and identification of most affected areas where treatment is needed and consideration of remediation options, such as lining with a non-erodible material, and increased lining height					
Engineering Operations	intense and prolonged rainfall	Operational	Assets	Overland flow and flash flooding damages homes, property and infrastructure	Major	Likely	7. HIGH	Flood Risk Management Committee helps inform flood studies and plan for emergency management scenarios; flood management studies to identify hot spots for flooding, following NSW Flood Prone Land Policy. OEH requires this to take Climate Change impacts into account - modelling is done for 10, 20 and 30 per cent increase in rainfall					

Engineering Operations	intense and prolonged rainfall	Operational	Environmental effects	Overflows and flooding result in sedimentation and possibly contaminates reaching natural waterways	Major	Possible	6. HIGH	Contaminates less likely and likely quite diluted in an intense rainfall event; some sediments minimised by gross pollutant traps						
Engineering Operations	intense and prolonged rainfall	Operational	Assets	Car parks with road base surface scoured in severe storm	Moderate	Likely	5. MEDIUM	Unavoidable, requires reactive maintenance when it occurs						
Engineering Operations	intense and prolonged rainfall	Operational	Assets	Intense rainfall/storm/wind damages or destroys buildings or other infrastructure	Major	Possible	6. HIGH	Maintenance to ensure compliance; build assessment of vulnerability/resilience to storms into condition maintenance reporting; engage expert to professionally assess all infrastructure/buildings to create priority list for further action						
Engineering Operations	soil saturation	Operational	Assets	Shifting or slumping of soil structure from excessive rainfall results in damage to underground drainage system	Major	Likely	7. HIGH	Investigate most cost-effective mechanism to monitor, assess and create an audit of the condition of the drainage network (e.g. CCTV)						
Engineering Operations	soil saturation; wind strength/shear force	Operational	Assets	Storms bring down trees, which lift pathways as they fall	Moderate	Likely	5. MEDIUM	Unavoidable, requires reactive maintenance when it occurs						
Engineering Operations	wind strength / shear force	Operational	Assets	Storm damages or destroys street furniture and other structures	Moderate	Likely	5. MEDIUM	Low tier (value) items considered sacrificial including timber pedestrian bridges; reactive maintenance post event						
Engineering Operations	wind strength / shear force	Operational	Operational impact	Loss of power --> street lights inoperable	Minor	Possible	3. LOW							

Engineering Operations	wind strength / shear force	Operational	Operational impact	Fallen trees take down power lines	Major	Possible	6. HIGH	Where opportunities and funding available, install underground cabling or aerial bundled cabling (ABC)						
Information Technology	intense and prolonged rainfall	Operational	Information systems & data	Flooding affects Council Chambers; shutdown of primary computer room, loss of productivity and delivery of services	Moderate	Possible	5. MEDIUM	Business Continuity Plan						
Information Technology	intense and prolonged rainfall	Operational	Information systems & data	Flooding affects depot; shutdown of secondary computer room, loss of productivity and delivery of services	Minor	Possible	3. LOW	Business Continuity Plan						
Insurance and Risk Management	airborne debris	Strategic	Financial/Marketing/Customer; Work Health & Safety; Assets	Increased workload; increased insurance premium; budget exceedance	Moderate	Almost certain	6. HIGH	Shared knowledge; database to manage claims; temporary staff/secondments; contingency reserves						
Insurance and Risk Management	dust storm	Strategic	Financial/Marketing/Customer; Work Health & Safety; Assets	Increased workload; increased insurance premium; budget exceedance; staff safety	Moderate	Almost certain	6. HIGH	Shared knowledge; database to manage claims; temporary staff/secondments; contingency reserves; Safe Work Method Statements						
Insurance and Risk Management	hail	Strategic	Financial/Marketing/Customer; Work Health & Safety; Assets	Increased workload; increased insurance premium; budget exceedance; staff safety	Moderate	Almost certain	6. HIGH	Shared knowledge; database to manage claims; temp staff/secondments; contingency reserves; Safe Work Method Statements						
Insurance and Risk Management	intense and prolonged rainfall	Operational	Financial/Marketing/Customer; Work Health & Safety; Assets	Increased workload; increased insurance premium; budget exceedance	Moderate	Almost certain	6. HIGH	Shared knowledge; database to manage claims; temporary staff/secondments;						

								contingency reserves					
Insurance and Risk Management	intense and prolonged rainfall	Strategic	Financial/Marketing/Customer; Work Health & Safety; Assets	Increased workload; increased insurance premium; budget exceedance; staff safety	Moderate	Almost certain	6. HIGH	Shared knowledge; database to manage claims; temporary staff/secondments; contingency reserves					
Insurance and Risk Management	lightning strikes	Operational	Financial/Marketing/Customer; Work Health & Safety; Assets	Increased workload; increased insurance premium; budget exceedance; staff safety	Moderate	Almost certain	6. HIGH	Shared knowledge; database to manage claims; temporary staff/secondments; contingency reserves; Safe Work Method Statements					
Insurance and Risk Management	soil saturation	Strategic	Financial/Marketing/Customer; Work Health & Safety; Assets	Increased workload; increased insurance premium; budget exceedance	Moderate	Almost certain	6. HIGH	Shared knowledge; database to manage claims; temporary staff/secondments; contingency reserves					
Integrated Planning, Property & Assets	airborne debris	Operational	Assets	Building and property damage	Moderate	Possible	5. MEDIUM	Ensure areas surrounding premises are regularly maintained			*** Before 2020		
Integrated Planning, Property & Assets	dust storm	Operational	Assets	Building and property damage	Moderate	Possible	5. MEDIUM	Quarterly and bi-annual reviews of the Operational Plan and Delivery Program are required under the LGAct					
Integrated Planning, Property & Assets	hail	Operational	Assets	Building and property damage	Moderate	Possible	5. MEDIUM						
Integrated Planning, Property & Assets	intense and prolonged rainfall	Operational	Assets	Property flooding	Moderate	Possible	5. MEDIUM	Ensure on site hydraulic systems operational and of relevant capacity; programmed maintenance			*** Before 2020		

								of gutters, drains, pits etc.					
Integrated Planning, Property & Assets	lightning strikes	Strategic	Assets	Building and property damage Service outages	Major	Possible	6. HIGH	Ensure commercial premises have lightning rods installed on rooftops			*** Before 2020		
Integrated Planning, Property & Assets	soil saturation	Operational	Assets	Building and property damage	Minor	Possible	3. LOW	Programmed maintenance of gutters, drains, pits etc.; regular property inspections carried after serious weather events			*** Before 2020		
Integrated Planning, Property & Assets	wind strength / shear force	Operational	Assets	Building and property damage	Moderate	Possible	1. LOW	Ensure new assets are built to Australian Building Code standards; ensure areas surrounding premises are regularly maintained			*** Before 2020		
Integrated Planning, Property & Assets	Disruptions to delivery of projects, programs and services	Strategic	Compliance governance	Impacts on Council's achievement of objectives/actions/tasks/projects in its IPR plans and documents	Moderate	Possible	3. LOW	Monitor any impacts of disruptions and report to GMD and Council as part of quarterly and bi-annual reviews	Quarterly and bi-annual reviews of the Operational Plan and Delivery Program are required under the LGAct.	Asset Management Steering Group	*** Before 2020		
Integrated Planning, Property & Assets	Disruptions to delivery of projects, programs and services	Strategic	Compliance governance	Services, projects and programs to include contingencies for delays and extra costs	Moderate	Possible	3. LOW	Services, projects and programs to include contingencies for delays and extra costs	Can be included in requirements for preparation of tasks, project bids and Operational	Asset Management Steering Group	*** Before 2020		

									Plans				
Libraries and Cultural Services	dust storm	Operational	Operational impact	Breathing difficulties for staff and public; potential damage to stock (depending on source); tiredness; respiratory distress	Minor	Rare	1. LOW	Practised evacuation procedures; flexible plans for options					
Libraries and Cultural Services	hail	Operational	Assets	Vehicle damage, roof and window damage to buildings, and service disruption; possible flooding; people (staff and public) could be hurt	Minor	Rare	1. LOW	Evaluate safety of running mobile services in hail; procedures for protection and evacuation					
Libraries and Cultural Services	intense and prolonged rainfall	Operational	Assets	Water leaking into buildings causing damage to building, stock, furniture and equipment; loss of stock - cost of replacement - insurance premium price increase; water contact with electricity could lead to fire	Moderate	Likely	5. MEDIUM	Appropriate building design - no box gutters or flat roofs; regular maintenance - gutters cleaned multiple times per year; inspect and repair roof; maintain and clear stormwater drains; training and practice in evacuation					
Libraries and Cultural Services	intense and prolonged rainfall	Operational	Operational impact	Service disruption; immediate water ingress; prolonged danger to fabric of building, floor coverings, collection	Moderate	Likely	5. MEDIUM	Staff trained and drilled in containment, reporting, disaster kit					
Libraries and Cultural Services	lightning strikes	Operational	Assets	Damage/destruction from fire/water	Minor	Rare	1. LOW	Staff trained and drilled in containment, reporting, disaster kit	Spreadsheet does not allow likelihood to be "Unlikely" which is in the risk matrix and which we nominate for this impact				

Libraries and Cultural Services	wind strength / shear force	Operational	Assets	Trees falling - damage to buildings, vehicles, people, access roads - leading to service disruption	Minor	Rare	1. LOW	Alternative service sites available	Spreadsheet does not allow likelihood to be "Unlikely" which is in the risk matrix and which we nominate for this impact				
Natural area and Catchment Planning	intense and prolonged rainfall	Operational	People injury/disease	Sewage network overflow/surcharge in water harvesting catchment	Moderate	Possible	5. MEDIUM	Risk assessment for relevant water harvesting sites previously undertaken; water quality sampling of harvested water for contamination to be undertaken prior to use on fields; if contamination above guideline limits, treat water and re-test prior to use; bypass water harvesting system until water is of suitable quality					
Natural Area and Catchment Planning	intense and prolonged rainfall	Operational	Environmental effects	Release of nutrient load to streams; possible cause of flooding as water not getting away	Moderate	Possible	5. MEDIUM	Re-design capacity of garden to meet expected stormwater flow	options for control 1.to size gardens to meet expected larger flow events 2. allow into the design larger prolonged bypass options to cater for increased flow and	m.drago	** 2020--2030		

									volume				
Natural Area and Catchment Planning	intense and prolonged rainfall	Operational		Increased flooding in urban areas	Moderate	Possible	5. MEDIUM	Flood risk management plans at catchment level (in development) will include actions to address identified risks					
Natural Area and Catchment Planning	wind strength / shear force	Operational	Assets	High winds bring down branches onto assets; debris washed into waterways and block culverts or trash racks causing flooding	Major	Likely	7. HIGH	High risk areas to be identified prior to events; maintenance teams/SES to be able to undertake action quickly when blockage occurs- areas of thick vegetation near or overhanging assets- low lying roads with small culverts that are critical access routes- residents near control points along drainage lines / waterways					
Open Space Operations	emergency preparedness	Operational	Operational impact	Although Council is not a combat agency, our plant can be commandeered by emergency service agencies in event of a storm emergency	Moderate	Possible	5. MEDIUM	Need to ensure all plant and equipment are maintained appropriately for this potential usage; asset replacement program					
Open Space Operations	intense and prolonged rainfall	Compliance/Operational	Environmental effects; People injury/disease	Pollution incident or non-compliance from failure of sewer mining processing	Moderate	Possible	5. MEDIUM	Regular monitoring and maintenance of system	See Risk Register: R0138, C00314; C00315				
Open Space Operations	intense and prolonged rainfall	Operational	Compliance legal	Legal requirement to ensure North Turrumurra dam is maintained and will not overflow in extreme conditions	Moderate	Rare	2. LOW	Regular maintenance and auditing/reporting requirements	Craig Roberts				

Open Space Operations	intense and prolonged rainfall	Operational	Operational impact	Disruption risk or damage caused by sewer mining plant	Moderate	Possible	5. MEDIUM	Contingency Plan (Secondary) - sewer mining plants in place; compliance program to ensure NSW Health and Sydney Water requirements are met	See Risk Register: R0553, C00808; C00809				
Open Space Operations	intense and prolonged rainfall	Operational	Operational impact; Environmental effects	Potential erosion and sedimentation from bulk materials storage area; operational waste generated by the maintenance of vehicles, mowers, and other off-road equipment, or mowed turf escapes into stormwater system	Moderate	Possible	5. MEDIUM	Proper waste management employed	See Risk Register: R0098, C00233				
Open Space Operations	intense and prolonged rainfall	Operational	People injury/disease; Environmental effects	Risk to biota and public from contamination by effluents	Moderate	Possible	5. MEDIUM	Monitoring of effluent; treatment processes employed; irrigation schedules considered; signage erected; pollution and environment insurance in place; cross-connection controls preventing backflow in place; sample water audits of nearby properties undertaken; disinfection treatments available; limiting chlorine dosage; quality and assurance program for all effluent irrigation activities; controlled public access during application or use of recycled water	See Risk Register: R0137; C00303; C00304; C00305; C00306; C00307; C00308; C00309; C00310; C00311				

Open Space Operations	intense and prolonged rainfall	Operational	Operational impact	Disruption risk or damage caused by sewer mining plant at golf course	Moderate	Possible	5. MEDIUM	Contingency Plan (Secondary) - sewer mining plants in development; compliance program to ensure NSW Health and Sydney Water requirements are met	See Risk Register: R0460; C00598; C00610				
Open Space Operations	intense and prolonged rainfall	Compliance/Operational	People injury/disease; Environmental effects	Pollution incident or non-compliance from failure of sewer mining processing at golf course	Moderate	Possible	5. MEDIUM	Regular monitoring of system including testing of shut down mechanism if equipment fails; regular maintenance of system is yet to be developed	See Risk Register: R0551; C00802; C00803				
Open Space Operations	intense and prolonged rainfall	Operational	Operational impact; Environmental effects	Potential erosion and sedimentation from bulk materials storage area; operational waste generated by the maintenance of vehicles, mowers, and other off-road equipment, or mowed turf escapes into stormwater system at golf course	Moderate	Possible	5. MEDIUM	Proper waste management followed	See Risk Register: R0554; C00810				
Open Space Operations	intense and prolonged rainfall	Operational	People injury/disease; Environmental effects	Contamination by effluents present risk to biota and public	Moderate	Possible	5. MEDIUM	Monitoring of effluents undertaken; treatment processes in place Irrigation schedules in planning with extensive consideration of internal and external factors; signage in place in all public accessible areas; pollution and environment insurance taken out; cross-connection controls prevented back flow is scheduled for affixing; sample water audits of nearby properties undertake; disinfection	See Risk Register: R0555; C00811; C00813; C00814; C00815; C00816; C00817; C00818; C00819; C00820				

								treatments available; limiting chlorine dosage documented or formalised; quality assurance program for all effluent irrigation activities to be developed					
Open Space Operations	intense and prolonged rainfall	Operational	Operational impact	Deterioration of recreational facilities asset to a lesser standard and greater chance of failure and increased liability	Moderate	Possible	5. MEDIUM	Weekly equipment inspections	See Risk Register: R0525; C01041				
Open Space Operations	intense and prolonged rainfall	Compliance	Compliance legal	Non-compliance with stormwater harvesting legal/regulatory requirements	Moderate	Possible	5. MEDIUM	Monitoring of water quality regularly and routinely; automatic diversion to sewer if quality is low	See Risk Register: R0152; C00351; C00352				
Open Space Operations	intense and prolonged rainfall	Compliance	Compliance legal; People injury/disease	Stormwater irrigation water not meeting NSW Health irrigation requirements	Major	Possible	6. HIGH	Stormwater harvesting compliance program in place	See Risk Register: R0469; C00611				
Open Space Operations	soil saturation	Operational	Operational impact	Structural failure of asset (Fire Trails and walking Tracks)	Moderate	Possible	5. MEDIUM	Maintenance program on fire trails and walking tracks includes scheduled inspection process	See Risk Register: R0370, C00526				

Open Space Operations	wind strength / shear force	Operational	Operational impact	Fallen trees and branches increase demand on staff, equipment and resources to clear/remove debris and maintain access	Moderate	Possible	5. MEDIUM	Create a contingency budget and work with SES to improve shared responsibility for storm response and clean up; continue to seek applicable grants to offset response costs; develop a proactive tree maintenance program with realistic budget allocation (already a system in place for child care centres and other high profile areas, BUT needs to be re-established and extended)						
Open Space Operations	wind strength / shear force	Operational	Operational impact	Inadequate equipment/plant to meet demand for clearing post-storm debris	Moderate	Likely	5. MEDIUM	Work with SES to improve shared responsibility for storm response and clean up; contingency budget to cover expenses such as hire of additional plant, waste disposal, staff overtime and/or labour hire	Grants through the National Disaster Resilience (NDR) program do not cover 100% of costs. Savings currently need to be found within recurrent budget to cover funding gap of emergency recovery costs. NDR application process also complex, time					

									consuming and slow				
Records and Governance	intense and prolonged rainfall	Operational	Operational impact	Flooding affecting the Council Chambers in areas where records are stored resulting in loss of or damage to records	Moderate	Possible	5. MEDIUM	Records Disaster Recovery Plan (existing); most records stored electronically or offsite in secure facilities (existing); digitisation program for vital/long-term paper-based records (ongoing)	See also Risk Register: R0456, C00594, C00882	Manager Records & Governance	*** Before 2020	Existing controls	2. LOW
Strategic Projects	wind strength / shear force	Operational	Work Health & Safety	Construction delays	Minor	Possible	3. LOW	Allowances made in construction programs					
Strategic Projects	intense and prolonged rainfall	Operational	Service delivery/reputation	Construction delays	Minor	Possible	3. LOW	Allowance in construction programs - may need to increase number of contingency/inclement weather days in contracts					
Strategic Projects	intense and prolonged rainfall	Project	Financial; Service delivery/reputation	Major rain event creates overland flows into site during construction - may result in delays or need to pump out water from site	Moderate	Possible	5. MEDIUM	Allowances made in construction programs					
Strategic Projects	intense and prolonged rainfall	Project	Service delivery/reputation	Prolonged rainfall may affect setting time and/or structural strength of concrete - need to repour	Moderate	Possible	5. MEDIUM	Allowances made in construction programs; may need to revise product specifications; ensure design specifications etc. conform to Australian Standards	Also financial and structural risk, especially if not mitigated or corrected before or at time of pour				

Strategic Projects	soil saturation	Operational	Service delivery/reputation	Construction delays	Minor	Possible	3. LOW	Allowances made in construction programs					
Strategic Projects	intense and prolonged rainfall	Operational	Service delivery/reputation	Project delays and increase cost, due to natural disaster, etc.	Minor	Possible	3. LOW	Contingency allowance and indemnification clauses in project budget or time for adverse weather or serious incident downtime mitigate costs to Council; financial checks (score card) and analysis of prospective tenders; pre-procurement process	See Risk Register: R0583, C01084, C01085, C01086				
Strategic Projects	intense and prolonged rainfall	Strategic	Assets	Potential for flash flooding causing damage to property or infrastructure	Major	Possible	6. HIGH	Use rainfall and flood modelling and projections to determine specifications of tank size for stormwater harvesting and mitigation (e.g. Babbage Rd - built in increased drainage capacity for projected future increased rainfall)					
Strategic Projects	soil saturation and movement/slumping	Operational	Assets	Damage to Council assets	Major	Possible	6. HIGH	Use existing planning instruments (e.g. Flood Management Plan) to inform design and other conditions					
Urban Heritage and Planning	intense and prolonged rainfall; soil saturation	Compliance	Social/cultural heritage	flooding and erosion potentially damage Aboriginal heritage items, e.g. rock carvings	Major	Possible	6. HIGH	Inventory of heritage items exists; legislative requirement to protect heritage items; consideration of heritage items in management decisions; need to put guidelines in place					

Urban Heritage and Planning	intense and prolonged rainfall	Strategic	Assets	Inappropriate development in areas prone to flooding and increased areas subject to flooding	Major	Likely	7. HIGH	Finalise modelling to identify areas at risk; appropriate planning controls in Development Control Plans to deal with flood water mitigation; review zoning to limit inappropriate land uses in potential areas at risk to flooding						
Urban Heritage and Planning	intense and prolonged rainfall; flooding	Strategic	People injury/disease	Inappropriate development in areas prone to flooding and increased areas subject to flooding	Major	Likely	7. HIGH	Caps to number of new subdivisions and dwelling via provisions in the LEP						

Appendix 3: A short summary of the cost benefit analysis of adaptations

The 2010 *Climate Change Adaptation Strategy* developed a method for analysing the cost benefit of adaptation for specific risks that is bushfire, extreme heat, storms and drought. The criteria were developed to assess each potential adaptation include sustainability criteria across the triple bottom line (TBL) and importantly the capacity that adaptation to reduce the weather hazard specific vulnerability of that values contained in that context.

For this exercise, costs were expressed as negative impacts to the TBL and the benefit positive impacts to the TBL combined with the capacity of each adaptation to reduce risks specific to the hazard under consideration. That is:

$$X = +ve \text{ TBL impacts} + \text{risk mitigation performance} + -ve \text{ TBL impacts}$$

Where X = priority score for adaptation

The adaptations devised by staff for their areas of responsibility can be prioritised for their cost/benefit outcomes. This step is particularly useful where there is a need to clarify where investment should be made in the short-, medium- and long-term. Those adaptations likely produce the most positive response for least cost are usually assigned to the short term. Where higher levels of investment are required or the return on investment may be less immediate, medium and longer term time horizons may be more appropriate

Appendix 4: Principles for effective adaptation

(Source: IPCC 2014b, pp. 25–28)

Adaptation is place- and context-specific, with no single approach for reducing risks appropriate across all settings (*high confidence*). Effective risk reduction and adaptation strategies consider the dynamics of vulnerability and exposure and their linkages with socioeconomic processes, sustainable development, and climate change.

Adaptation planning and implementation can be enhanced through complementary actions across levels, from individuals to governments (*high confidence*). National governments can coordinate adaptation efforts of local and subnational governments, for example by protecting vulnerable groups, by supporting economic diversification, and by providing information, policy and legal frameworks, and financial support (*robust evidence, high agreement*). Local government and the private sector are increasingly recognized as critical to progress in adaptation, given their roles in scaling up adaptation of communities, households, and civil society and in managing risk information and financing (*medium evidence, high agreement*)

A first step towards adaptation to future climate change is reducing vulnerability and exposure to present climate variability (*high confidence*). Strategies include actions with co-benefits for other objectives. Available strategies and actions can increase resilience across a range of possible future climates while helping to improve human health, livelihoods, social and economic well-being, and environmental quality. Integration of adaptation into planning and decision making can promote synergies with development and disaster risk reduction

Adaptation planning and implementation at all levels of governance are contingent on societal values, objectives, and risk perceptions (*high confidence*). Recognition of diverse interests, circumstances, social-cultural contexts, and expectations can benefit decision-making processes. Indigenous, local, and traditional knowledge systems and practices, including indigenous peoples' holistic view of community and environment, are a major resource for adapting to climate change, but these have not been used consistently in existing adaptation efforts. Integrating such forms of knowledge with existing practices increases the effectiveness of adaptation

Decision support is most effective when it is sensitive to context and the diversity of decision types, decision processes, and constituencies (*robust evidence, high agreement*). Organizations bridging science and decision making, including climate services, play an important role in the communication, transfer, and development of climate-related knowledge, including translation, engagement, and knowledge exchange (*medium evidence, high agreement*)

Existing and emerging economic instruments can foster adaptation by providing incentives for anticipating and reducing impacts (*medium confidence*). Instruments include public-private finance partnerships, loans, payments for environmental services, improved resource pricing, charges and subsidies, norms and regulations, and risk sharing and transfer mechanisms. Risk financing mechanisms in the public and private sector, such as insurance and risk pools, can contribute to increasing resilience, but without attention to major design challenges, they can also provide disincentives, cause market failure, and decrease equity. Governments often play key roles as regulators, providers, or insurers of last resort.

Constraints can interact to impede adaptation planning and implementation (*high confidence*). Common constraints on implementation arise from the following: limited financial and human resources; limited

integration or coordination of governance; uncertainties about projected impacts; different perceptions of risks; competing values; absence of key adaptation leaders and advocates; and limited tools to monitor adaptation effectiveness. Another constraint includes insufficient research, monitoring, and observation and the finance to maintain them. Underestimating the complexity of adaptation as a social process can create unrealistic expectations about achieving intended adaptation outcomes

Poor planning, overemphasizing short-term outcomes, or failing to sufficiently anticipate consequences can result in maladaptation (*medium evidence, high agreement*). Maladaptation can increase the vulnerability or exposure of the target group in the future, or the vulnerability of other people, places, or sectors. Some near-term responses to increasing risks related to climate change may also limit future choices. For example, enhanced protection of exposed assets can lock in dependence on further protection measures

Limited evidence indicates a gap between global adaptation needs and the funds available for adaptation (*medium confidence*). There is a need for a better assessment of global adaptation costs, funding, and investment. Studies estimating the global cost of adaptation are characterized by shortcomings in data, methods, and coverage (*high confidence*)

Significant co-benefits, synergies, and trade-offs exist between mitigation and adaptation and among different adaptation responses; interactions occur both within and across regions (*very high confidence*). Increasing efforts to mitigate and adapt to climate change imply an increasing complexity of interactions, particularly at the intersections among water, energy, land use, and biodiversity, but tools to understand and manage these interactions remain limited. Examples of actions with co-benefits include (i) improved energy efficiency and cleaner energy sources, leading to reduced emissions of health-damaging climate-altering air pollutants; (ii) reduced energy and water consumption in urban areas through greening cities and recycling

Appendix 5: Additional notes

Relating downscaled climate modelling to Ku-ring-gai Council in 2016

Regional modelling for climate change reveals more days of extreme bushfire weather, more frequent periods of extreme heat, major storms building in intensity and longer droughts. Determining the effect these changes in weather events may have on Council, its assets, services and people needs to be carefully scrutinised and appropriate and timely adaptations planned to implement where and when the level risk is deemed unacceptable. While the changes in average temperature and rainfall may not appear significant, the extremes in the range and duration of temperature and rainfall may be very significant in terms of risk management.

While the 'do nothing' may appear to be the appropriate response for risks deemed highly unlikely or of little consequence, the consequences need to be considered in both the spatial and temporal contexts. In terms of climate change generated extreme weather impacts, the events may be deemed rare or infrequent but the consequences very expensive. While the Council carries insurance where it is available, there is a significant possibility that the availability and cost of appropriate insurance policies will either become unaffordable or the insurance will be refused altogether as that type of insurance cover becomes unsustainable.

To accurately determine whether an unacceptable risk exists or is likely to exist in the future, it is necessary to have a good understanding of the context that is the vulnerability of the location, the asset, service, function or people. Once the vulnerabilities are identified, then the consequence of an extreme weather impact can be estimated. Armed with the probability and consequence data the risk is now well known. The objective of each adaptation initiative is to reduce the either or both probability or consequence down to an acceptable level. The downscaled modelling is very valuable in determining first probability of an extreme event and the increase in intensity translates into consequence. Historical extreme weather events in Ku-ring-gai have given an indication of the scale of the consequences. For example in 1991 a hail and wind storm swept through the northern parts of Ku-ring-gai causing over \$670M in damages. In today's money that would be well over \$1B.

Investment in developing Council's resilience in terms of capacity to respond could assist in reducing these costs the next time an event of this magnitude occurs. If this was a once in a one hundred year occurrence then the costs would be manageable. As global temperatures rise the frequency of this magnitude of storm event will also rise. Depending upon the frequency, the costs associated with this type of storm event could cripple Council's capacity to respond, hamper recovery and see the insurance industry eventually withdraw storm cover from the market.