



Climate Change Adaptation Report

Narrabri Special Activation Precinct

Final

May 2023



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Prepared by Umwelt (Australia) Pty Limited on behalf of HATCH RobertsDay

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This report was prepared using Umwelt's ISO 9001 certified Quality Management System.



Acknowledgement of Country

We acknowledge country and pay respects to the Gomeroi/Gamilaroi/Gamilaraay/Kamilaroi people as the Traditional Owners and Custodians of the land and waters on which the Narrabri Special Activation Precinct is located on.

We recognise their continued connection to Country and that this connection can be seen through stories of place and cultural practices such as art, songs, dances, storytelling and caring for the natural and cultural landscape of the area.

We also recognise the continuing living culture of Aboriginal people, and the significance of Narrabri in that living culture. We recognise the contemporary stories of displacement and the cultural significance of Narrabri in the continued journey of self-determination in Australia.

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Executive Summary

In November 2020, Narrabri was declared the sixth and final SAP investigation area, enabled by its strong reputation and location within Australia's highest productive grain region as well as its strong transportation linkages including existing road and rail connections and the future Inland Rail.

This report documents the climate change adaptation planning process for the Narrabri SAP. Its purpose is to highlight climate change risks and adaptation actions for the precinct to inform the development of the Master Plan and Delivery Plan.

At a high level and as shown in **Figure 4.1**, the NENW region is projected to experience:

- increase in average and extreme temperature events
- increase in number of hot day (above 35°C)
- increase in rainfall during autumn
- increase in bushfire risk and intensity
- decrease in rainfall during winter
- decrease in number of cold nights (below 2°C).

The consideration of Climate Change risk and adaptation remains an active process and this report acts as an interim summary of the identified risks and adaptation findings, and how they have been considered within the development of a Land Use plan and eventual Structure Plan for the Narrabri SAP.

It also identifies recommendations for the Master Plan, Delivery Plan and planning framework to ensure continued consideration of climate change through all life cycles of the project from design to delivery and then operation.

Recommendations for the next stage of the master planning process are summarised in Section 7.0.



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1.0 Introduction

1.1 Special Activation Precincts

The New South Wales (NSW) Government, through its introduction of the Special Activation Precincts (SAPs) has identified six distinctive areas throughout regional NSW to bring together planning and investment to stimulate economic growth across a range of industries including freight and logistics, manufacturing, waste management and recycling, energy generation and agricultural and food processing activities. The planning and creation of these areas is partially facilitated and funded through the \$4.2 billion Snowy Hydro Legacy Fund.

The establishment of SAPs is a joint NSW Government Agency initiative by the Department of Regional Growth NSW, Department of Planning and Environment (DPE) and the Regional Growth NSW Development Corporation (RGDC) as part of the 20-Year Economic Vision for Regional NSW. DPE is responsible for preparing the planning framework whereas the Department of Regional NSW manages each precinct.

In November 2020, Narrabri was declared the sixth and final SAP investigation area, enabled by its strong reputation and location within Australia's highest productive grain region as well as its strong transportation linkages including existing road and rail connections and the future Inland Rail. To facilitate the planning within this precinct DPE has engaged Umwelt Environment and Social Consultants to prepare a series of technical studies regarding Climate Change within the Narrabri SAP investigation area.

As part of the master planning process and to inform this technical study two Enquiry by Design (EbD) workshops were organised. A preliminary EbD was held on the 29 and 30 of March 2022 to develop three initial land use scenarios. Following an interdisciplinary assessment of the three scenarios, a final EbD workshop was held between 5 and 8 of September 2022 to study the interdisciplinary constraints of the three scenarios and identify and develop a preferred land use Structure Plan.

This report assesses the land use Structure Plan from the final EbD workshop with regards to Climate Change risks and adaptation.

1.2 Purpose and Objectives

This report documents the climate change adaptation planning process for the Narrabri SAP. Its purpose is to highlight climate change risks and adaptation actions for the precinct to inform the development of the Master Plan and Delivery Plan.

It provides an overview of potential climate change risks and adaptation measures across the Narrabri SAP investigation area which have been used to inform the master planning process including EbDs as well as identify recommendations for other mechanisms of management within the SAPs such as the Delivery Plan.



2.0 Strategic Overview

2.1 Location

Narrabri township is located within the Narrabri Shire local government area (LGA), approximately 530 km northwest of Sydney. As of the 2021 census, the population of Narrabri township was 6,898 persons¹.

The township lies at the junction of the Newell and Kamilaroi highways and has direct rail connection to the Port of Newcastle via the Walgett branch of the Main North line. Once completed, Narrabri will also have a direct connection to the new Inland Rail route which will connect Melbourne to Brisbane via new and upgraded track.

2.2 Strategic Policy Framework

The impacts of Climate Change and the need to take action to mitigate risks and adapt to a changing climate are recognised across International, National and State policy frameworks. A summary of the key policies is outlined in **Table 2.1**.

The following framework has guided this Climate Change Adaptation Report.

Jurisdiction	Policy	Description	Influence on SAP
International	Paris Agreement	The Paris Agreement is an international agreement within the United Nations Framework on Climate Change (UNFCC) which aims to keep global temperature rise this century within 2 degrees Celsius (°C) of pre-industrial levels and further pursue options to limit the temperature rise to less than 1.5°C above pre-industrial levels. ²	Australia committed to reducing their emissions to below 26–28%. This agreement set a benchmark for each state and territory to develop and set their own targets with an emphasis on meeting or exceeding this target.
International	2030 Agenda for Sustainable Development	The United Nation's Sustainable Development Goals (UN SDGs) are a set of 17 holistically developed goals intended to drive better outcomes in terms of the health, dignity and equality of people; sustainable management of natural resources (linked to earlier definitions and principles of ecologically sustainable development); economic prosperity; peace and cross regional to global partnerships.	The UN SDGs are directly applicable to the Narrabri SAP. Appendix A provides a summary of the relevance of each goal to the Narrabri SAP.

Table 2.1Summary of Strategic Policy Framework

¹ ABS, 2021 Census: https://abs.gov.au/census/find-census-data/quickstats/2021/LGA15750

² United Nations (2015) Paris Agreement to the United Nations Framework Convention on Climate Change.



Jurisdiction	Policy	Description	Influence on SAP
National	Climate Change Act 2022	On 14 September 2022 the Climate Change Act 2022 commenced. The Act reflects Australia's updated nationally determined contribution under the Paris Agreement of GHG emissions reduction target of 43% below 2005 levels by 2030 and net zero emissions by 2050.	Australia has strengthened its commitment to climate change action and increased reduction targets. This sets a new benchmark for climate change action and targets across nation. A long-term goal for the SAP includes a framework to reduce emissions. Opportunities and constraints on the emissions profile is included in the Sustainability Report.
National	National Climate Resilience and Adaptation Strategy	The National Climate Resilience and Adaptation Strategy (NCRAS) ³ outlines that climate impacts are imposing economic costs which will continue to increase along with more intense climate change projections however effective and early action to adapt to climate change can reduce and/or avoid the worst of the impacts.	The Narrabri SAP has integrated climate change risk and adaptation into the master planning process.
State	Climate Change Policy Framework	NSW Climate Change Policy Framework (NSW CPF) seeks to achieve net zero emissions by 2050 and maximise the economic wellbeing of NSW.	A long-term goal for the SAP includes a framework to reduce emissions. Opportunities and constraints on the emissions profile is included in the Sustainability Report.
State	Climate Change Adaptation Strategy 2022	The NSW Climate Change Adaptation Strategy 2022 aims to provide a framework that sets out key decision- making principles and objectives for adaptations to climate change. In preparing for climate change, the four objectives outlined within the action plan aim to strengthen and expand short and long-term climate change adaptations.	The Narrabri SAP has integrated climate change adaptations into the master planning process that align with the objectives of this Strategy.
State	Net Zero Plan Stage 1 2020–2030	Staged plan to support NSW achieving Net Zero Emissions by 2050.	The SAP should aim to meet and achieve both interim (50% reduction by 2030) and long-term net zero emissions targets in alignment with existing state government strategies.

³ Department of Agricultural, Water and the Environment (2021) National Climate Resilience and Adaptation Strategy.



3.0 Investigation Area

The investigation area for the Narrabri SAP, finalised at the Final EbD covers an area of approximately 2,668 ha. It is located to the west of the existing township and incorporates two areas separated by an environmental buffer zone. This investigation area is being utilised as a basis for all technical studies, however, will not necessarily form the final SAP boundary which may change throughout the master planning process. See **Figure 3.1**.

Within the investigation area key areas are identified and addressed throughout this report as presented in **Figure 3.2**.

- Special Activation Precinct including:
 - Inland Port and Hub The Inland Port and Hub comprises the proposed Narrabri Inland Port (N2IP) which is anticipated to be delivered as part of the first stage of development and support non-energy (gas) reliant industrial uses and leveraging the containerised siding. This would also include land to enable future circular economy initiatives.
 - Energy Precinct The Energy Precinct to the west of Bohena Creek is anticipated to comprise higher hazard, energy intensive uses proximate to gas with the opportunity for a separate siding.
 - Investigation Areas Bulk grain siding options are to be investigated to the west of the Energy Precinct.
- Town Centre Framework including:
 - Developing Narrabri Town Centre's tourism and 'Eat Street' character.
 - Enhancing the sport, recreation and social infrastructure of the Lakeside Village.
- Mt Kaputar Precinct The Mt Kaputar Precinct is proposed to accommodate residential growth of Narrabri to 2060 including capacity for approximately 3000 dwellings, local community infrastructure and convenience retail, and a health and education precinct.











Figure 3.2 Narrabri SAP Key Areas



3.1 Vision

Through the master planning process, the Department of Planning and Environment have identified the following vision for the Narrabri SAP.

Strengthening our relationship and care for the land, waters and biodiversity of Country, the Narrabri SAP will reinforce the Town Centre as a destination and the heart of Narrabri, unlocking greater economic growth for the town and region, leveraging from the Inland Rail, the Northern NSW Inland Port and the Narrabri Gas Project.

3.2 Design Principles

Through the master planning process, the Department of Planning and Environment have identified 7 principles that build on the Narrabri SAP vision as outlined in **Figure 3.3**.

Through the master planning process, a strong focus on designing with country principles was also identified and have been embedded within the design of the SAP Structure Plan and Town Centre Framework.



EOUITY

Strengthen the existing community and businesses, giving them the skills and reason to stay whilst attracting new economic and residential growth for Narrabri that will 'give back' to Narrabri. Respect the cultural and lifestyle diversity by providing access to housing, health, education, social and community infrastructure to enhance the livability and lifestyle of Narrabri.



IDENTITY

Build and enhance the story of Narrabri by reflecting diversity, protecting and respecting the site's natural features, indigenous and cultural heritage and vegetation and using a cultural lens to inform actions across the entire SAP.

GREENERY & ENVIRONMENT

Use science and local knowledge to define constraints and opportunities, providing sustainable outcomes through the protection of community and environment with a strong focus on safety, flood and bush fire risk, water security and biodiversity values.

URBANITY

Reinforce the Town Centre as the heart of Narrabri, enhancing surrounding neighbourhoods, breaking down boundaries, addressing social needs and embracing diversity to achieve a livable and lovable place that is safe, connected and active.

MOBILITY

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Plan for regional and local equitable access for all residents, visitors and workers, of all abilities and socio economic status, improving health, convenience and social connectedness.

WELLNESS

Be a good neighbour and industry leader by prioritising the community's health, wellbeing and sense of belonging by setting a new environmental sustainability benchmark for energy intensive development.

RESILIENCE

Provide economic resilience by growing and retaining the local small industry community, up-skilling and attracting new industries and enterprises setting a standard for innovation and circular economy across the SAP including energyintensive industries.

Figure 3.3 **Special Activation Precinct Design Principles**



3.3 Special Activation Precinct

The Special Activation Precinct is expected to comprise of:

- The Narrabri Inland Port (N2IP) located in the central core of the investigation area bounded by Culgoora Road to the north, Yarrie Lake Road to the south and Bohena Creek to the west. Land uses and development within this area is envisioned to include:
 - An Inland Port rail siding.
 - Transport and logistics land uses including warehouses, outdoor storage areas, distribution centres, transfer of goods between road and rail.
 - Agriculture and food processing land uses including production, handling, formulating, packaging and storage of agricultural products and food.
 - Manufacturing land uses.
 - Interim potentially hazardous land uses including warehouses that store or handle DGs/hazardous chemicals. Manufacturing and/or storage of DGs/hazardous chemicals.
 - Circular economy and waste management and recycling land uses.
- The Energy Hub located in the western extent of the investigation area bounded by Culgoora Road to the north, Yarrie Lake Road to the south and Bohena Creek to the east. Land uses and development within this area is envisioned to include:
 - Fertiliser and Chemicals.
 - Solar Energy.
 - Bioproducts.
 - o Energy.

3.4 Town Centre and Residential

Alongside the development of the Special Activation Precinct consideration has been given to establishing a Town Centre Framework: A Vision for Growth.

The Town Centre Framework will reinforce and market the unique character areas within Narrabri to attract and retain families, youth and develop a skilled workforce. The framework focusses on two key areas:

- Narrabri Town Centre Eat Street Promoting an active front door and eat street onto Narrabri Creek enabled by a calmer street network.
- Lakeside Village leveraging the emerging sport and recreation identify and further enhancing the social infrastructure provision and place opportunities at the Station.



The Mt Kaputar Precinct is located south of the Town Centre bounded by Newell and Kamilaroi Highways to future proof Narrabri's growth through a vision for a complete community that is a complimentary and genuine extension of Narrabri.

The Mt Kaputar Precinct will deliver the community needs and housing demand for Narrabri up to 2060 including:

- supporting approximately 3,000 dwellings with a focus on diversity of lot size, building type, price point and desired demographic
- option of schools in houses or offices as a short-term solution
- concentration of community and local retail at the centre of the community co-located with the amenity of an enhanced wetland
- connectivity to Narrabri Town Centre via active travel along the Green Loop and bus services
- a flood free area for vulnerable uses such as hospital and/or aged care
- opportunities for business and industry as a buffer to Newell and Kamilaroi Highways
- opportunity for the planned indoor recreation to be located here with an ability to function as an evacuation hub.



4.0 Climate Change

4.1 Scope

The scope of the Climate Change Risk Assessment and Adaptation Plan is for the Narrabri Special Activation Precinct Investigation Area as outlined in **Section 3.0**.

4.2 Data and Projections

Climate change projection data has been informed by the NSW and ACT Regional Climate Modelling (NARCliM) Project Version 1.0 and AdaptNSW climate change projection snapshots.

Narrabri is located within the central west area New England North West (NENW) boundary. Data presented in this document is tailored to the NENW and Narrabri, where noted. Data projections presented below reference projected changes in climate when compared to the baseline period of 2000.

At a high level and as shown in **Figure 4.1**, the NENW region is projected to experience:

- increase in average and extreme temperature events
- increase in number of hot days (above 35°C)
- increase in rainfall during autumn
- increase in bushfire risk and intensity
- decrease in rainfall during winter
- decrease in number of cold nights (below 2°C).

Further details on the projections for region and Narrabri are summarised in Appendix A.





Figure 4.1 New England North West Climate Snapshot

4.3 Methodology

This report and the associated Climate Change Risk Assessment (see **Appendix B**) was supported by a series workshops including:

- Preliminary Climate Change Risk Assessment Workshop held via MS Teams on 9 December 2021 to review the future projected climate risks, how they may impact the precinct and to identify measures to be put in place to reduce and mitigate risk or adapt to climate change across the lifespan of the development.
- Preliminary and Final EbD Workshops.
- Post EbD Interviews interviews were held during October 2022 with authors of technical reports and requests for information made to identify the extent climate change risks and adaptation findings were considered within the relevant reports.



Risk Assessment material has been prepared to follow guidance from a range of sources including:

- NSW Climate Risk Ready Guide⁴
- Climate Change Impact and Risk Management A guide for business and government⁵
- Australian Standard (AS) 5334-2013: Climate change adaptation for settlements and infrastructure A risk based approach⁶
- Climate Compass a climate risk management framework for Commonwealth agencies⁷
- Risk Management Tool Kit for NSW Public Sector Agencies: Volume 1 Guidance for Agencies⁸.

The Climate Risk Ready NSW Guide recommends using climate projections that are moderate to high. Moderate to high projections are most relevant as they will assess potential impacts of physical climate change risk to businesses and projects. Low emissions scenarios are not recommended to assess physical climate risks; but may be useful to assess transition risks as they represent corporate and government behaviour that is consistent with net zero emissions targets.

Note that this risk assessment does not include the impacts of compounding and cascading risk from climate drivers as this is not yet included in a standard climate change risk assessment and the methods are still developing.

Further details on the methodology used to complete the risk assessment is summarised in Appendix A.

⁴ Climate Risk Ready NSW Guide <u>https://www.climatechange.environment.nsw.gov.au/sites/default/files/2021-06/NSW%20Climate%20ready%20guide.pdf</u>

⁵ AGO 2006, Climate Change Impacts and Risk Management: A guide for business and government, Australian Greenhouse Office, Canberra: www.climatechange.gov.au/community/~/media/publications/local-govt/risk-management.ashx

⁶ AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk-based approach <u>https://infostore.saiglobal.com/en-au/Standards/Product-Details-119943_SAIG_AS_AS_251367/ProductID=119943_SAIG_AS_AS_251367</u>

⁷ Climate Compass 2018 - <u>https://www.agriculture.gov.au/sites/default/files/documents/climate-compass-climate-risk-management-framework-commonwealth-agencies.pdf</u>

⁸ TPP12-03B-Risk Management Toolkit Vol 1-Agency Guide.



5.0 Climate Change Risk Assessment

5.1 Preliminary Climate Change Risks

Following the completion of the preliminary climate change risk assessment the top risks to the Narrabri Special Activation Precinct investigation area were identified as:

- 1. Increase in water demand across investigation area causing reduced supply of natural water systems (High).
- 2. Increased instances of heat stress for residential, commercial buildings and precinct occupants resulting in health impacts or lower productivity (High).
- 3. Loss of biodiversity and ecosystem function due to increases in average and extreme temperatures and extended periods without rainfall (High).
- 4. Decreased agricultural and regional productivity due to increase in average and extreme temperatures, drought, water scarcity and fire weather (High to Extreme).
- 5. Loss of life/injury and increased hospital presentations due to bushfire activity (High Extreme).
- 6. Emissions intensive land uses unable to transition to low emission operations (Medium Extreme).

Further information on the outcomes of the preliminary climate change risk assessment is contained in **Appendix B**.

5.2 Further Investigation

During the final EbD workshop, the preliminary risks were considered in the further refinement of the Narrabri SAP investigation area as presented in **Section 3.0** and **Figure 3.1**.

In particular, the workshop had a strong focus on:

- understanding the water demands and sources of water to guide the identification of suitable and sustainable land uses within the Precinct
- identifying locations for emergency centres and blue and green infrastructure throughout the Precinct
- opportunities to avoid impact upon existing vegetation and biodiversity values throughout the Precinct
- energy generation opportunities and emissions intensity of land uses to guide identification of suitable and sustainable land uses within the Precinct.

These elements are also being assessed and analysed as part of the finalisation of the technical reports supporting the Master Plan process.



6.0 Climate Change Adaptation

6.1 Preliminary Adaptation Findings

The preliminary climate change risk assessment was undertaken prior to the identification of specific precinct development options and design. To support the development of the SAP and inform the EbD workshops adaptation considerations were identified to guide the designing out of a number of risks identified in the preliminary climate change risk assessment.

A full list of the adaptation considerations presented is provided in Section 5.0 of Appendix A.

6.2 Further Investigation

The preliminary adaptation findings were investigated further through the EbD workshops and master planning process supported by Technical Investigations. The outcomes of these with respect to the key preliminary adaptation findings are summarised in **Table 6.1** below.

It is noted that as the climate change risks, and adaptation findings were not known during the scoping phase of the technical reports to support the Master Plan that some of the above findings may be out of scope for the respective technical investigations. It is recommended that further consideration is given to findings that have not been addressed or partially addressed during the finalisation of the Master Plan and/or preparation of the Delivery Plan.



Preliminary Finding	Technical Report Addressed by	Addressed Y/N/Partial	Summary of Findings
Investigation of options to maximise onsite renewable energy generation	Renewable Energy Sustainability Structure Plan	Y	The Land Use Plan prepared by Hatch Roberts Day includes allocation of 144 ha for a solar farm. The Renewable Energy Report prepared by WSP recommends the utilisation of land allocation (144 ha) for a small ground mounted solar farm with the option to investigate larger scale solar farms as the transmission network is strengthened. Solar farms located outside of the SAP are recommended by WSP as having the potential to defer distribution network augmentation. WSP also recommend rooftop solar "behind the meter" for a high penetration of solar systems and to reduce the load on the network. The incorporation of onsite generation would also facilitate rebates and savings on electricity bills for each type of consumer. The Sustainability Report prepared by Umwelt recommends maximising onsite renewable energy generation including a large-scale solar farm, rooftop solar, and the potential for out of SAP solar farms.
Ensure utility infrastructure capacity considers additional redundancy requirements for weather conditions associated with the impacts of climate change (i.e., warmer weather, flood risk)	Utilities	Ν	It is understood WSP's Utilities Report does not specifically recommend additional redundancy requirements. It is recommended that this is identified as part of future work undertaken for the SAP to ensure that utility infrastructure proposed can adapt to the impacts of climate change.
Consider location of critical infrastructure in low hazard areas (i.e., underground cabling in fire prone areas or asset elevation for roads in flood prone areas)	Utilities Structure Plan	Ŷ	The Utilities Report prepared by WSP confirms that critical infrastructure such as substations, pump stations (sewer and water), telco stations (BTSs) all have their own design requirements which includes avoidance of hazardous areas. The Bushfire Report considers the location of complying development, potentially hazardous development, SFPP developments and industrial development in terms of bushfire hazard and BAL ratings. It also provides acceptable solutions for roads, water supply electricity and gas.

Table 6.1Preliminary Adaptation Considerations – Summary of findings in work to date



Preliminary Finding	Technical Report Addressed by	Addressed Y/N/Partial	Summary of Findings
Consider location of bores and extraction infrastructure outside of flood zones to prevent surface water contamination.	Flood	Out of Scope	The Flooding and Water Cycle Management Report prepared by WSP did not consider location of bores and extraction infrastructure likely to be located in flood zones. It is noted that the location of bores is unlikely to be identified at this stage of the planning process. It is recommended that this is identified as part of future work undertaken for the SAP to ensure that the location of infrastructure can adapt to the impacts of climate change.
Investigate diversification of water supply including rainwater harvesting and WSUD measures and storage options	Hydrogeology Water Demand Sustainability	Y	 The Hydrogeology Water Demand Report prepared by WSP investigated a range of water supply options across the Precinct. Opportunities found to be proximate, high-quality water and have potentially high yields including the: The Southern Recharge groundwater source, located directly under the Precinct. The utilisation of treated stormwater within the Precinct. The recycling of Sewage Treatment Plant effluent. The utilisation of the unused portion of the town water supply allocation. The Sustainability Report prepared by Umwelt identifies opportunities to reduce water demand, increase efficiency and diversify water sources.
Investigate water reuse options	Hydrogeology Water Demand Sustainability	Ŷ	WSP's Hydrogeology Water Demand Report recommended harvesting of stormwater and Sewerage Treatment Plant effluent recycling as the best opportunities for water reuse within the SAP. This is also supported within the Sustainability Report prepared by Umwelt. It is understood that within WSP's report, a 'return to sewer' volume is detailed for each type of industry within the Precinct.
Investigate additional water treatment requirements beyond the chlorination (currently the highest level of treatment)	Hydrogeology Water Demand	Out of Scope	Consideration of additional water treatment is out of scope for this phase and could be considered in the next phase. However, it is noted that salinity was focused on as a water quality measure. It is recommended that this is identified as part of future work undertaken for the SAP to ensure water quality is maintained in response to the impacts of climate change.



Preliminary Finding	Technical Report Addressed by	Addressed Y/N/Partial	Summary of Findings
Ensure water demand calculations consider the impacts of climate change on water demand (i.e., more dry years and high-water demand during warmer weather)	Hydrogeology Water Demand	Out of Scope	The Hydrogeology Water Demand Report. Noted that the consideration of impacts of climate change on water demand is considered during work approvals processes. i.e., DPE Hydro Impact Assessments. It is recommended that this is identified as part of future work undertaken for the SAP to ensure water availability is sustained in response to the impacts of climate change.
Ensure water demand calculations consider the quantity and quality of water required to maintain green infrastructure in the Precinct	Hydrogeology Water Demand	Out of Scope	Consideration of water quality and quantity requirements to maintain green infrastructure are expected to be addressed in the next phase. It is recommended that this is identified as part of future work undertaken for the SAP to ensure water is available to maintain green infrastructure which may be impacted by climate change.
Ensure flood modelling considers the impacts of climate change to flood regimes/levels (i.e., This includes a 30% increase in rainfall activity into 1% AEP flooding modelling outputs.	Hydrogeology Water Demand Flood	Y	The Flood Report prepared by WSP considered the impacts of climate change to flood regimes/levels when completing flood modelling. It is understood that WSP flood models have included an assessment of increased rainfall intensity for the Bohena Creek model, and the 0.05% Annual Exceedance Probability event has also been considered to represent climate change projections for the Naomi River flood model.
Ensure the water balance considers the impacts of climate change on the environmental flow requirements	Hydrogeology Water Demand	N	The Hydrogeology Water Demand Report prepared by WSP did not consider the impacts of climate change on the environmental flow requirements. It is recommended that this is identified as part of future work undertaken for the SAP to ensure water availability is maintained in response to the impacts of climate change.
Ensure consideration of climate change impacts is considered when assessing the impact on groundwater dependent ecosystems (i.e., increased demand due to climate change)	Biodiversity	N	The Biodiversity Report prepared by ERM did not consider the impacts of climate change when assessing potential impacts on groundwater dependent ecosystems. It is recommended that this is identified as part of future work undertaken for the SAP to ensure protection of groundwater dependent ecosystems impacted by climate change.
Minimise clearing of vegetation and maximise retention of existing native woodland and forest vegetation	Biodiversity Structure Plan	Y	The Biodiversity Report prepared by ERM is understood to adopt an avoidance hierarchy and identifies opportunities to minimise clearing of vegetation and maximise opportunities to retain vegetation.



Preliminary Finding	Technical Report Addressed by	Addressed Y/N/Partial	Summary of Findings
Minimise disturbance on riparian corridors	Biodiversity Structure Plan	Y	The land use plan prepared by Hatch Roberts Day identifies Bohena Creek as being excluded from the Precinct and contained within an Environmental buffer.
			The Biodiversity Report prepared by ERM is understood to identify opportunities to minimise disturbance on riparian corridors.
Investigate areas for ecological corridors and refuges	Biodiversity Landscape	Y	The land use plan prepared by Hatch Roberts Day identifies Bohena Creek as being excluded from the Precinct and contained within an Environmental buffer.
	Structure Plan		The Biodiversity Report prepared by ERM is understood to identify opportunities to provide ecological corridors and refuges.
			The Landscape Plan prepared by Moir is understood to include a range of recommendations and opportunities for green infrastructure across the Precinct.
Investigate precinct-based bushfire management strategy considering the	Bushfire Structure Plan	Y	The Bushfire Report prepared by ERM identifies that the bushfire weather conditions in future years are projected to increase in severity for many regions including Narrabri. This will result in:
impacts of increases in FFDI for			An earlier start to the bushfire season.
bushfire safety			Reduced opportunities for fuel reduction burning.
			 Management of fire risk to property, people and biodiversity will become increasingly challenging.
			An increase in the number of extreme fire danger days.
			A Bushfire Emergency Management Plan is recommended. No specific hazard reduction activities such as pre-season burning has been included at this stage.
Include provisions for the adoption of green infrastructure across the	Landscape Structure Plan	Y	The Land Use Plan prepared by Hatch Roberts Day identifies Bohena Creek as being excluded from the Precinct and contained within an Environmental buffer.
Precinct			The Landscape Plan prepared by Moir is understood to include a range of recommendations and
			opportunities for the adoption of green infrastructure across the Precinct supported by landscape level measures to retain water through the concept of an inland sponge.



Preliminary Finding	Technical Report Addressed by	Addressed Y/N/Partial	Summary of Findings
Consider climate ready vegetation and plantings for any green infrastructure and landscape buffers	Landscape Structure Plan	Partial	The Landscape Plan prepared by Moir is understood to recommend endemic species and promote the revegetation of threatened species. Further investigations should be undertaken on the ability of these species to thrive in the future climate conditions for the region.
Prioritise a diverse range of industries and land uses that are adaptive to climate change impacts and do not require large quantities of resources	Economic Structure Pan	Partial	The Land Use Plan supports a diversity of industry and land uses however some of the land uses may require large quantities of resources. The Economics Reports prepared by Aurecon/Nous is understood to consider a diversity of industry and land use types. It is understood that the consideration of climate change within these land uses is based on the extent to which the base information considers climate change i.e., Transport for NSW modelling of rail freight demands.
Consider increased demands for emergency services	Transport Social Infrastructure	N	The Transport Report prepared by WSP did not specifically consider increased demand for emergency services. It is recommended that this is identified as part of future work undertaken for the SAP to ensure adequate emergency evacuation routes and services in response to impacts of climate change.



7.0 Final Considerations

Following review of the Narrabri SAP Investigation Area Land Use Plan, and interviews with authors of technical reports, the following is noted with respect to risks and adaptation considerations for the Special Activation Precinct as outlined in **Table 7.1**.

Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
1	Energy: Increased energy demand for built structures, developments and industry across the investigation area during warmer weather. This considers both increases in mean temperature and heatwaves/extreme temperatures.	Land Use Plan includes an area for solar generation and biogas. Sustainability Report identifies framework to reduce energy demand, maximise onsite renewables and use energy efficiently. Utilities Report identifies infrastructure upgrades to cater for proposed land use.	 Consider/Investigate: Suitability of the size of area allocated for solar generation. Options for prioritisation and promotion of energy efficiency and onsite renewable generation. Additional redundancy requirements in utility capacity during warmer weather. Building design including passive design options. Building design and construction efficiency standards.
4	Energy: Increased pressure across the energy network, critical equipment and services leading to an increase in energy network instability (ongoing elevated demand).	Land Use Plan includes an area for solar generation and biogas. Sustainability Report identifies framework to reduce energy demand, maximise onsite renewables and use energy efficiently. Utilities Report identifies infrastructure upgrades to cater for proposed land use.	 Consider/Investigate: Suitability of the size of area allocated for solar generation. Options for prioritisation and promotion of energy efficiency and onsite renewable generation. Additional redundancy requirements in utility capacity during warmer weather. Building design including passive design options. Building design and construction efficiency standards.
5	Energy: Increased need to cool buildings or work sites and impacts thermal performance of buildings.	Land Use Plan includes an area for solar generation and biogas.	 Consider/Investigate: Suitability of the size of area allocated for solar generation. Options for prioritisation and promotion of energy efficiency and onsite renewable generation.

Table 7.1 Preliminary Climate Change Risk – Responses from work to date



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
		Sustainability Report identifies framework to reduce energy demand, maximise onsite renewables and use energy efficiently. Utilities Report identifies infrastructure upgrades to cater for proposed land use.	 Additional redundancy requirements in utility capacity during warmer weather. Building design including passive design options. Building design and construction efficiency standards.
33	Energy: Emissions intensive land uses unable to transition to low emission operations.	Sustainability Report identifies opportunities for transition to low emission operations i.e., green hydrogen.	 Consider/Investigate: Undertaking secondary risk assessment focusing on transitionary risks associated with policy and legal, technology, market and reputation and how risks may align to existing state and federal commitments to achieve net zero emissions by 2050.
2	Water: Increased water demand for built structures, developments and industry across the investigation area caused by increases in average temperatures.	Hydrogeology Water Demand Report identifies water demands and sources for proposed land use. The report recommends harvesting of stormwater and Sewerage Treatment Plant effluent recycling as the best opportunities for water reuse within the SAP. The Landscape Plan recommends landscape scale water management including WSUD and natural water retention principles.	 Consider/Investigate: Impacts of climate change on water demands for the Precinct. Mechanisms to manage water demand and usage including water restrictions. Impact on groundwater dependent ecosystems. Need for additional aquifer access licences for SAP use. Need for higher level of water treatment, currently chlorination is level of treatment for potable water. Locating bore and extraction infrastructure outside of flood zones to prevent surface water contamination.
3	Water: Increase in water demand across investigation area causing reduced supply of natural water systems.	Hydrogeology Water Demand Report identifies water demands and sources for proposed land use. The report recommends harvesting of stormwater and Sewerage Treatment Plant effluent recycling as the best opportunities for water reuse within the SAP.	 Consider/Investigate: Impacts of climate change on water demands for the Precinct. Mechanisms to manage water demand and usage including water restrictions. Impact on groundwater dependent ecosystems. Need for additional aquifer access licences for SAP use.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
		The Landscape Plan recommends landscape scale water management including WSUD and natural water retention principles.	 Need for higher level of water treatment, currently chlorination is level of treatment for potable water. Locating bore and extraction infrastructure outside of flood zones to prevent surface water contamination.
9	Water: Higher evaporation rates of water storage sites reducing water availability onsite.	Hydrogeology Water Demand Report identifies water demands and sources for proposed land use. The report recommends harvesting of stormwater and Sewerage Treatment Plant effluent recycling as the best opportunities for water reuse within the SAP. The Landscape Plan recommends landscape scale water management including WSUD and natural water retention principles.	 Consider/Investigate: Impacts of climate change on water demands for the Precinct. Mechanisms to manage water demand and usage including water restrictions. Impact on groundwater dependent ecosystems. Need for additional aquifer access licences for SAP use. Need for higher level of water treatment, currently chlorination is level of treatment for potable water. Locating bore and extraction infrastructure outside of flood zones to prevent surface water contamination.
20	Water: Decreased availability of potable water during extended periods of no rainfall.	Hydrogeology Water Demand Report identifies water demands and sources for proposed land use. The report recommends harvesting of stormwater and Sewerage Treatment Plant effluent recycling as the best opportunities for water reuse within the SAP. The Landscape Plan recommends landscape scale water management including WSUD and natural water retention principles.	 Consider/Investigate: Impacts of climate change on water demands for the Precinct. Mechanisms to manage water demand and usage including water restrictions. Impact on groundwater dependent ecosystems. Need for additional aquifer access licences for SAP use. Need for higher level of water treatment, currently chlorination is level of treatment for potable water. Locating bore and extraction infrastructure outside of flood zones to prevent surface water contamination.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
22	Water: Higher levels of water contamination and algae.	Hydrogeology Water Demand Report identifies water demands and sources for proposed land use. The report recommends harvesting of stormwater and Sewerage Treatment Plant effluent recycling as the best opportunities for water reuse within the SAP. The Landscape Plan recommends landscape scale water management including WSUD and natural water retention principles.	 Consider/Investigate: Impacts of climate change on water demands for the Precinct. Mechanisms to manage water demand and usage including water restrictions. Impact on groundwater dependent ecosystems. Need for additional aquifer access licences for SAP use. Need for higher level of water treatment, currently chlorination is level of treatment for potable water. Locating bore and extraction infrastructure outside of flood zones to prevent surface water contamination.
32	Water: Increase in groundwater extraction/decrease in rainfall recharge leading to increase in groundwater salinity.	Hydrogeology Water Demand Report identifies water demands and sources for proposed land use. The report recommends harvesting of stormwater and Sewerage Treatment Plant effluent recycling as the best opportunities for water reuse within the SAP. The Landscape Plan recommends landscape scale water management including WSUD and natural water retention principles.	 Consider/Investigate: Impacts of climate change on water demands for the Precinct. Mechanisms to manage water demand and usage including water restrictions. Impact on groundwater dependent ecosystems. Need for additional aquifer access licences for SAP use. Need for higher level of water treatment, currently chlorination is level of treatment for potable water. Locating bore and extraction infrastructure outside of flood zones to prevent surface water contamination.
6	Health and Wellbeing: Increased instances of heat stress for residential, commercial building and precinct occupants resulting in health impacts or lower productivity.	The Landscape Plan identifies opportunities for green infrastructure. The Sustainability Plan identifies opportunities for building design, efficiency standards and rating tools.	 Consider/Investigate: Water requirements of green infrastructure within the Precinct water demand.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
7	Health and Wellbeing: Increased instances of heat stress for industrial and precinct occupants resulting in health impacts or lower productivity.	The Landscape Plan identifies opportunities for green infrastructure. The Sustainability Plan identifies opportunities for building design, efficiency standards and rating tools.	 Consider/Investigate: Water requirements of green infrastructure within the Precinct water demand.
8	Health and Wellbeing: An increase in the urban heat island effect impacting comfort and amenity of outdoor areas.	The Landscape Plan identifies opportunities for green infrastructure. The Sustainability Plan identifies opportunities for building design, efficiency standards and rating tools.	 Consider/Investigate: Water requirements of green infrastructure within the Precinct water demand.
10	Biodiversity and Environment: Loss of biodiversity and ecosystem function due to increases in average and extreme temperatures and extended periods without rainfall.	The Land Use Plan retains areas of high value native vegetation and a large environmental buffer surrounding Bohena Creek. The Biodiversity Report identifies opportunities to avoid impact and retain vegetation.	 Consider/Investigate: Impacts of changes to bushfire regimes for the ecology within and surrounding the Precinct. Impacts of reduced environmental flows on the biodiversity within and surrounding the Precinct.
19	Biodiversity and Environment: Changes to bushfire regimes leading to shifts in ecology.	The Land Use Plan retains areas of high value native vegetation and a large environmental buffer surrounding Bohena Creek. The Biodiversity Report identifies opportunities to avoid impact and retain vegetation.	 Consider/Investigate: Impacts of changes to bushfire regimes for the ecology within and surrounding the Precinct. Impacts of reduced environmental flows on the biodiversity within and surrounding the Precinct.
21	Biodiversity and Environment: Low runoff impacting environmental flows and biodiversity.	The Land Use Plan retains areas of high value native vegetation and a large environmental buffer surrounding Bohena Creek. The Biodiversity Report identifies opportunities to avoid impact and retain vegetation.	 Consider/Investigate: Impacts of changes to bushfire regimes for the ecology within and surrounding the Precinct. Impacts of reduced environmental flows on the biodiversity within and surrounding the Precinct.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
11	Productivity: Decreased agricultural and regional productivity due to increase in average and extreme temperatures, drought and fire weather.	The Land Use Plan includes a diversity of land use to provide resilience to the impacts of climate change and extreme weather events. The Economics Report identifies the vulnerability of agriculture to the effects of climate change and downstream risks as well as opportunities with changes to growing seasons etc.	Consider as part of future revisions of the Risk Assessment and subsequent updates to Adaptation Report.
12	Productivity: Decreased agricultural and regional productivity due to increase in flooding.	The Land Use Plan includes a diversity of land use to provide resilience to the impacts of climate change and extreme weather events. The Economics Report identifies the vulnerability of agriculture to the effects of climate change and downstream risks as well as opportunities with changes to growing seasons etc.	Consider as part of future revisions of the Risk Assessment and subsequent updates to Adaptation Report.
13	Built Environment: Accelerated carbonation/corrosion of built environment and infrastructure due to increase in average and extreme temperatures.	The Sustainability Report identifies recommendations regarding building design and construction standards.	Consider/Investigate:Climate suitable building materials within the Delivery Plan.
14	Extreme Weather and Natural Disasters: Reduced air quality within both open space and internal areas as a result of fire activity.	 The Bushfire Report identifies that the bushfire weather conditions in future years are projected to increase in severity for many regions including Narrabri. This will result in: An earlier start to the bushfire season. Reduced opportunities for fuel reduction burning. 	 Consider/Investigate: Implementation of precinct-based health and safety management system. System could consider local air quality and associated protection measures when required. Maximising onsite renewable energy generation to remove reliance on the grid/external transmission network.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
		 Management of fire risk to property, people and biodiversity will become increasingly challenging. An increase in the number of extreme fire danger days. The Royal Commission Inquiry into the 2009 Victorian 'Black Saturday' Bushfires has been considered in Section 5.11 in terms of Emergency Management Plans. Utilities Report identifies design criteria for infrastructure to ensure it is located outside of hazard areas including bushfire. 	 Potential increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.
15	Extreme Weather and Natural Disasters: Full or partial fire damage to buildings and public spaces due to bushfire activity.	 The Bushfire Report identifies that the bushfire weather conditions in future years are projected to increase in severity for many regions including Narrabri. This will result in: An earlier start to the bushfire season. Reduced opportunities for fuel reduction burning. Management of fire risk to property, people and biodiversity will become increasingly challenging. An increase in the number of extreme fire danger days. The Royal Commission Inquiry into the 2009 Victorian 'Black Saturday' Bushfires has been considered in Section 5.11 in terms of Emergency Management Plans. 	 Consider/Investigate: Implementation of precinct-based health and safety management system. System could consider local air quality and associated protection measures when required. Maximising onsite renewable energy generation to remove reliance on the grid/external transmission network. Potential increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
		Utilities Report identifies design criteria for infrastructure to ensure it is located outside of hazard areas including bushfire.	
16	Extreme Weather and Natural Disasters: Increased instances of energy and telecommunications network failure or damage impacting housing investigation area, business operations and activities within the precinct due to bushfire activity.	 The Bushfire Report identifies that the bushfire weather conditions in future years are projected to increase in severity for many regions including Narrabri. This will result in: An earlier start to the bushfire season. Reduced opportunities for fuel reduction burning. Management of fire risk to property, people and biodiversity will become increasingly challenging. An increase in the number of extreme fire danger days. The Royal Commission Inquiry into the 2009 Victorian 'Black Saturday' Bushfires has been considered in Section 5.11 in terms of Emergency Management Plans. Utilities Report identifies design criteria for infrastructure to ensure it is located outside of hazard areas including bushfire. 	 Consider/Investigate: Implementation of precinct-based health and safety management system. System could consider local air quality and associated protection measures when required. Maximising onsite renewable energy generation to remove reliance on the grid/external transmission network. Potential increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.
17	Extreme Weather and Natural Disasters: Increase in fire weather causing increased demand on emergency services	 The Bushfire Report identifies that the bushfire weather conditions in future years are projected to increase in severity for many regions including Narrabri. This will result in: An earlier start to the bushfire season. Reduced opportunities for fuel reduction burning. 	 Consider/Investigate: Implementation of precinct-based health and safety management system. System could consider local air quality and associated protection measures when required. Maximising onsite renewable energy generation to remove reliance on the grid/external transmission network.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
		 Management of fire risk to property, people and biodiversity will become increasingly challenging. An increase in the number of extreme fire danger days. The Royal Commission Inquiry into the 2009 Victorian 'Black Saturday' Bushfires has been considered in Section 5.11 in terms of Emergency Management Plans. Utilities Report identifies design criteria for infrastructure to ensure it is located outside of hazard areas including bushfire. 	 Potential increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.
18	Extreme Weather and Natural Disasters: Loss of life/injury and increased hospital presentations	 The Bushfire Report identifies that the bushfire weather conditions in future years are projected to increase in severity for many regions including Narrabri. This will result in: An earlier start to the bushfire season. Reduced opportunities for fuel reduction burning. Management of fire risk to property, people and biodiversity will become increasingly challenging. An increase in the number of extreme fire danger days. The Royal Commission Inquiry into the 2009 Victorian 'Black Saturday' Bushfires has been considered in Section 5.11 in terms of Emergency Management Plans. 	 Consider/Investigate: Implementation of precinct-based health and safety management system. System could consider local air quality and associated protection measures when required. Maximising onsite renewable energy generation to remove reliance on the grid/external transmission network. Potential increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
		Utilities Report identifies design criteria for infrastructure to ensure it is located outside of hazard areas including bushfire.	
31	Extreme Weather and Natural Disasters: Changing seasonal patterns decreasing availability to undertake fire management activities.	 The Bushfire Report identifies that the bushfire weather conditions in future years are projected to increase in severity for many regions including Narrabri. This will result in: An earlier start to the bushfire season. Reduced opportunities for fuel reduction burning. Management of fire risk to property, people and biodiversity will become increasingly challenging. An increase in the number of extreme fire danger days. The Royal Commission Inquiry into the 2009 Victorian 'Black Saturday' Bushfires has been considered in Section 5.11 in terms of Emergency Management Plans. Utilities Report identifies design criteria for infrastructure to ensure it is located outside of hazard areas including bushfire. 	 Consider/Investigate: Implementation of precinct-based health and safety management system. System could consider local air quality and associated protection measures when required. Maximising onsite renewable energy generation to remove reliance on the grid/external transmission network. Potential increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.
23	Extreme Weather and Natural Disasters: Increased levels of localised flooding limiting access and egress.	The Land Use Plan has avoided further development and new development in areas impacted by flood. The Land Use Plan has identified new areas for a range of land use types including residential which will provide resilience for sterilisation of land due to climate change.	 Consider/Investigate: Applying AR&R (2019) guidelines to modelling including a 30% increase in rainfall activity into 1% AEP flooding modelling outputs. Planning controls for land which may be affected by climate change flooding projections across SAP lifetime (identify land which may become sterile due to flood risk). Options to limit land from being sterilised by flood risk.


Risk ID	Risk	Response to Climate Change Risk	Further Recommendations	
		The Flooding and Surface Water Cycle Management Report including flood modelling has considered the impacts of climate change.	 Land uses and asset lifetimes for areas likely to be impacted by flooding. Asset elevation for road corridors with respect to potential flooding risks. Downstream impacts of developing new floodways or exacerbating flood risk downstream (if proposed). 	
24	Extreme Weather and Natural Disasters: Increased levels of localised flooding limiting access and egress, including for emergency services.	The Land Use Plan has avoided further development and new development in areas impacted by flood. The Land Use Plan has identified new areas for a range of land use types including residential which will provide resilience for sterilisation of land due to climate change. The Flooding and Surface Water Cycle Management Report including flood modelling has considered the impacts of climate change.	 Consider/Investigate: Applying AR&R (2019) guidelines to modelling including a 30% increase in rainfall activity into 1% AEP flooding modelling outputs. Planning controls for land which may be affected by climate change flooding projections across SAP lifetime (identify land which may become sterile due to flood risk). Options to limit land from being sterilised by flood risk. Land uses and asset lifetimes for areas likely to be impacted by flooding. Asset elevation for road corridors with respect to potential flooding risks. Downstream impacts of developing new floodways or exacerbating flood risk downstream (if proposed). 	
25	Extreme Weather and Natural Disasters: Increased risk to life/injuries due to increased flood hazard - new floodway.	The Land Use Plan has avoided further development and new development in areas impacted by flood. The Land Use Plan has identified new areas for a range of land use types including residential which will provide resilience for sterilisation of land due to climate change. The Flooding and Surface Water Cycle Management Report including flood modelling has considered the impacts of climate change.	 Consider/Investigate: Applying AR&R (2019) guidelines to modelling including a 30% increase in rainfall activity into 1% AEP flooding modelling outputs. Planning controls for land which may be affected by climate change flooding projections across SAP lifetime (identify land which may become sterile due to flood risk). Options to limit land from being sterilised by flood risk. Land uses and asset lifetimes for areas likely to be impacted by flooding. Asset elevation for road corridors with respect to potential flooding risks. Downstream impacts of developing new floodways or exacerbating flood risk downstream (if proposed). 	



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
26	Extreme Weather and Natural Disasters: Drainage capacity issues for buildings and hard landscaping	The hydrogeology water demand report includes recommendations for capturing rainwater and WSUD. The landscape plan includes recommendations for WSUD and retention of rainwater via natural systems.	N/A.
27	Extreme Weather and Natural Disasters: Damage to infrastructure and assets (e.g., buildings, telecommunications) due to flooding and inundation	The Land Use Plan has avoided further development and new development in areas impacted by flood. Utilities Report identifies design criteria for infrastructure to ensure it is located outside of hazard areas including flood prone land.	 Consider/Investigate: Increase IP ratings of electrical and communication infrastructure to ensure protection from increased water egress and inundation.
28	Extreme Weather and Natural Disasters: Increased or decreased levels of rain/moisture penetration in soils	The Land Use Plan retains areas of high value native vegetation and a large environmental buffer surrounding Bohena Creek. The Hydrogeology and Water Demand report includes recommendations for capturing rainwater and WSUD The landscape plan includes recommendations for WSUD and retention of rainwater via natural systems.	 Consider/Investigate: Maintain permeable areas required for floodways, flood storage, flood fringe, riparian; building footprints. Precinct design to consider impermeable structure only where required.
29	Extreme Weather and Natural Disasters: Extreme heat and other extreme weather (flooding) leading to rail infrastructure damage and failure impacting logistics, safety and reputation	Out of scope. Assumed to be captured by rail track owners and operators.	Consider in more details as part of future revisions of the Risk Assessment and subsequent updates to Adaptation Report.



Risk ID	Risk	Response to Climate Change Risk	Further Recommendations
30	Extreme Weather and Natural Disasters: Impact of extreme weather (heat and drought) on ability to attract workers to the town	The Land Use Plan has identified opportunities to reduce urban heat effects and provide refuge during extreme weather events. These would have an impact on the consequence but not the likelihood of events.	 Consider/Investigate: Further opportunities to manage extreme heat at a local level (cooling, refuges). Consider in more details as part of future revisions of the Risk Assessment and subsequent updates to Adaptation Report.



8.0 Conclusion

8.1 Regular Review

The risks and associated adaptation plan for the Narrabri SAP should be regularly reviewed to consider new and emerging risks. As a result of the current progression and development of the Structure Plan and Master Plan the following elements should be further considered in the next risk assessment:

- Risks associated with changes in regional agricultural productivity.
- Adaptation and management measures for heat stress.

8.2 Recommendations

It is recommended that further consideration is given to the preliminary adaptation findings that have not been addressed or partially addressed (**Table 6.1**) during the finalisation of the Master Plan and/or preparation of the Delivery Plan.

As a result of the Climate Change Risk Assessment process the following recommendations are made with respect to the finalisation of the Narrabri Special Activation Precinct Structure Plan and associated technical reports:

Structure Plan

- Investigate future demands for emergency services as a result of climate change.
- Identify location/s for multipurpose community resilience areas that can provide respite and emergency accommodation during emergencies and extreme weather (heat stress).
- Identify key evacuation routes and ensure adequate capacity is considered on these key transport routes.
- Identify locations where critical infrastructure should be developed underground (i.e., fire prone areas) or areas not suitable for infrastructure (i.e., flood zones).
- Identify suitable locations for water extraction infrastructure including bores to prevent surface water contamination (i.e., outside of flood zones).
- Identify locations where road infrastructure requires asset elevation (i.e., flood zones).
- Minimise clearing of vegetation.
- Protect and enhance riparian vegetation zones.
- Retain existing waterbodies including farm dams within the Precinct.
- Include ecological corridors, wildlife refuges and green infrastructure across the Precinct.
- Plan green infrastructure with consideration of local province and climate ready vegetation.



- Consider locations likely to be impacted by urban heat island effect and include suitable green infrastructure to mitigate this impact.
- Maximise opportunities for renewable energy generation and rainwater harvesting.
- Incorporate water sensitive urban design (WSUD) and water reuse and rainwater harvesting opportunities.

Engineering (Utilities, Hydrogeology, Water Demand, Flood, Traffic and Transport, Renewable Energy)

- Ensure all capacity and demand analysis considers the impacts and influences of climate change.
- Ensure all capacity and demand analysis considers the needs of the environment and precinct wide green infrastructure under climate change.
- Ensure water demand calculations consider the quantity and quality of water required to maintain green infrastructure in the Precinct.
- Investigate additional water treatment requirements beyond the chlorination (currently the highest level of treatment).
- Identify targeted water reuse options for specific land uses.

Environment (Biodiversity, Heritage, Contamination, Bushfire)

- Ensure the water balance considers the impacts of climate change on the environmental flow requirements.
- Investigate impacts on groundwater dependent ecosystems and the impacts of climate change.

Economics

• Investigate how global shifts in low emissions processes and land uses may affect long-term viability of perspective tenants.

Other

• Undertake secondary risk assessment focussing on transitionary risks.

8.3 Performance Criteria

8.3.1 Master Plan

The following performance criteria are recommended for the Narrabri SAP Master Plan:

- Prioritise development that maximises onsite renewable energy generation to remove reliance from the grid and decarbonise energy sources.
- Prioritise development that maximises onsite rainwater harvesting to remove reliance on potable water.



- Include best practice and aspirational building and construction efficiency standards including climate ready materials, energy and water efficiency and passive solar design.
- Adopt precinct wide environmental and health and safety management systems.
- Identify the role of climate change risk and adaptation within the Master Plan vision and/or principles and set ongoing commitment for regular review.
- Acknowledge the role of Aboriginal stakeholders in the management of the environment and climate change adaptation.

8.3.2 Delivery Plan

NOTE: These are preliminary recommendations that should be reviewed and updated following completion of the Structure Plan.

The following performance criteria are recommended for the Narrabri SAP Delivery Plan:

- Include best practice and aspirational energy use and efficiency measures and requirements for all developments.
- Include aspirational passive design requirements to reduce energy input requirements for all developments.
- Include climate resilient material selection requirements for all developments.
- Collaborate with Aboriginal stakeholders to adopt indigenous burning practices into management of the Precinct.
- Assign responsibility for the ongoing management of a climate change risk register:
 - The climate change risk assessment and risk register are designed to be a dynamic register that will require review and refinement as the Precinct is developed and begins operation. At a minimum, it should be consulted, reviewed and revised prior to the commencement of precinct development stages.
- Undertake regular review and audit of efficiency standards.
- Adopt a Precinct wide Environmental Management System.
- Adopt a Precinct wide Health and Safety Management System (air quality, pre warning TARPS).





CLIMATE CHANGE DATA AND PROJECTIONS SUMMARY APPENDIX A

Narrabri Special Activation Precinct

FINAL

November 2022



Climate change data and Projections summary Appendix A

Narrabri Special Activation Precinct

FINAL

Prepared by Umwelt (Australia) Pty Limited on behalf of Hatch Roberts Day

Project Director:Paul DouglassProject Manager:Kai NevilleReport No.R01Date:November 2022





This report was prepared using Umwelt's ISO 9001 certified Quality Management System.



Acknowledgement of Country

Umwelt would like to acknowledge the traditional custodians of the country on which we work and pay respect to their cultural heritage, beliefs, and continuing relationship with the land. We pay our respect to the Elders – past, present, and future.

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Appendices

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1.0 Strategic Context

1.1 International

1.1.1 Paris Agreement

The Paris Agreement is an International agreement within the United Nations Framework on Climate Change (UNFCC) which aims to keep global temperature rise this century within 2 degrees Celsius (°C) of pre-industrial levels and further pursue options to limit the temperature rise to less than 1.5 °C above pre-industrial levels²

1.1.2 2030 Agenda for Sustainable Development

The United Nation's Sustainable Development Goals (UN SDGs) are a set of 17 holistically developed goals intended to drive better outcomes in terms of the health, dignity and equality of people; sustainable management of natural resources (linked to earlier definitions and principles of ecologically sustainable development); economic prosperity; peace and cross regional to global partnerships.

1.2 National

1.2.1 Climate Change Act 2022

The Climate Change Bill 2022 passed through Parliament in September 2022. It provides for an Act to set out Australia's greenhouse gas emissions reduction targets, to provide for annual climate change statements, to confer advisory functions on the Climate Change Authority, and for related purposes.

Australia's greenhouse gas emissions reduction targets are as follows:

- (a) reducing Australia's net greenhouse gas emissions to 43% below 2005 levels by 2030:
 - (i) implemented as a point target; and
 - (ii) implemented as an emissions budget covering the period 2021-2030;
- (b) reducing Australia's net greenhouse gas emissions to zero by 2050.

1.2.2 National Climate Resilience and Adaptation Strategy

The National Climate Resilience and Adaptation Strategy (NCRAS)² outlines that climate impacts are imposing economic costs which will continue to increase along with more intense climate change projections however effective and early action to adapt to climate change can reduce and/or avoid the worst of the impacts.

Adaptation is cross-sectoral and requires an approach which considers a broad range of adaptation considerations. The NCRAS operates across four domains as shown in **Table 1.1** to drive adaptation actions as a result of climate change.



Adaptation considerations included in this document are categorised by NCRAS domains. Climate change will impact each domain differently. There are many interdependencies and relationships between the domains and the climate risks each face, with some risks crossing over into multiple domains to affect whole systems, including the strength of the economy, national security, the resilience of our society and operation of natural systems. It is also important to recognise that within the four domains are a range of stakeholders including but not limited to individuals, businesses, communities, organisations and governments, all facing unique challenges and barriers.

Domain	Description
Natural	Ensuring our natural environment and agricultural industries can adapt to the changing climate to preserve natural capital, improve productivity, and protect heritage. The
	landscapes, seascapes, ecosystems, agricultural lands, and diverse plant and animal life.
Built	Human-made surroundings, structures and any supporting infrastructure created using material, spatial and human resources to facilitate life, health, work and play. The built environment also includes green and urban spaces, cities and towns, and the networks of roads, transport, energy, water and telecommunications infrastructure that connect them.
Social	The social domain includes our people, communities, culture, institutions, support systems, and the interactions between them. This includes families, health and education systems and services, social services and emergency management services.
Economic	The production and consumption of goods. Productivity, financial systems, and the economy. Climate change could impact the productivity and competitiveness of certain industries, the nature of work in those industries, future occupations, and structure of the economy

Table 1.1 NCRAS Domains



2.0 State

2.1 Climate Change Policy Framework

The NSW Climate Change Policy Framework outlines long-term objectives to achieve net-zero emissions by 2050 and to make New South Wales more resilient to a changing climate.

The aim is to maximise the economic, social and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change. The framework:

- defines the NSW Government's role in reducing carbon emissions and adapting to the impacts of climate change
- sets policy directions to guide implementation of the framework
- commits NSW to achieving aspirational long-term objectives of net-zero emissions by 2050 and to help NSW become more resilient to a changing climate
- sets out next steps for implementation.

2.2 Climate Change Adaptation Strategy

The NSW Climate Change Adaptation Strategy³ (CCAS)was released during June 2022. As this is a new document published during the consultation period of this Stage 2 report, a high-level review of the NSW CCAS has only been undertaken. Further alignment between the two documents will be included as part of the Stage 3 works.

The purpose of the NSW CCAS is to make NSW more resilient and adapt to the impacts of climate change. Ambitious and transformative adaptation is critical in the next decade to build resilience, minimise harm from climate change, and maximise opportunity. To enable ambitious action, the strategy has set four key objectives as outlined in **Table 2.1**. These objectives are broadly aligned to the NCRAS domain as also shown in **Table 1.1**.

Objective	Description
Natural Well adapted built environment and infrastructure	Develop and maintain the built environment and infrastructure to prevent, withstand and recover from climate change impacts, while continuing to perform its function and serve the community. This includes developing more resilient infrastructure after disasters.
Well adapted natural environment, biodiversity, ecosystems, and natural resources	Actively manage natural systems to be functional and resilient in the face of climate change by enabling adaptation that protects the environment, sustainably manages different uses and maintains ecosystems and biodiversity so they can be enjoyed.

Table 2.1	NSW (CCAS	Ob	iectives
	-			



Well adapted economy, businesses, industries, and livelihoods	Manage the risks and take advantage of opportunities for our economy, businesses, industries and workers, including the creation of new jobs and industries generated by a climate-resilient future. This includes job opportunities from investment in clean technologies and infrastructure projects.
Well adapted society, government, communities, families and individuals	Society, government, communities, families and individuals have the capacity and resources to adapt to and avoid the worst impacts of climate change and to maintain wellbeing and prosperity.



3.0 Climate

3.1 Climate Data and Projections

Climate change projection data has been informed by the NSW and ACT Regional Climate Modelling (NARCliM) Project Version 1.0. The Project is informed by a single emissions scenario (SRES A2) developed as part of the Intergovernmental Panel on Climate Change (IPCC) fourth Assessment Report ¹ and IPCC Special Report on Emissions Scenarios². The projected warming for SRES A2 for the 2090 to 2099 period, relative to 1980 to 1999, is given by IPCC AR4 as 2.0°C to 5.9°C, with a best estimate of 3.4°C. At the time of development, it was the most likely emissions scenario projected to be experienced and is also generally considered as a high emissions scenario.

The NARCliM Project produced a suit of 12 regional climate projections for across NSW and ACT spanning a range of future changes to the climate. To reduce bias and uncertainty from a single model, the NARCliM Project outputs are aggregated across the 12 models to cover a range of plausible future projections under the SRES A2 climate scenario. Data projections shown in this document display the average as well as the variability of the models.

The NARCliM Project outputs have been summarised into projections across different time scales. For the purposes of this document, Climate change data projections utilised in this document has reviewed data across two time scales, near future (2020-2039 hereafter 2030) and far future (2060-2079 hereafter 2070)³ compared with a baseline (1990-2009 hereafter 2000).

To assist with local and state government planning, AdaptNSW has released climate change projection snapshots across 11 different regions of NSW and ACT⁴. Narrabri is located within the central west area New England North West (NENW) boundary (See **Figure 2.1**). Data presented in this document is tailored to the NENW and Narrabri, where noted. Data projections presented below reference projected changes in climate when compared to the baseline period of 2000.

At a high level and as shown in **Figure 2.1**, the NENW region is projected to experience:

- Increase in average and extreme temperature events
- Increase in number of hot day (above 35°C)
- Increase in rainfall during autumn
- Increase in bushfire risk and intensity
- Decrease in rainfall during winter
- Decrease in number of cold night (below 2°C).

¹ IPCC (2007) Fourth Assessment Report

² IPCC (2007) Special Report on Emissions Scenarios

³ <u>https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW</u>

⁴ https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region





Figure 3.1 New England North West Regional Map

3.2 Rainfall

A summary of NARCliM rainfall projections for the NENW is provided in **Table 3.1** and **Figure 3.2**. Note, data included in Table 2.1 is the average of NARCliM project outputs whilst the variability of model outputs is shown in **Figure 3.2**.

	Near Future (2030)	Far Future (2070)				
Annual						
Mean	+ 1.6%	+ 7.7%				
Seasonal						
Summer	- 3.3%	+ 9.8%				
Autumn	+ 14.9%	+ 16.8%				
Winter	- 7.6%	- 0.7%				
Spring	+ 2.6%	- 0.7%				

Table 3.1 Mean of NARCliM NENW Near and Far Future Rainfall Projections (%)







Data provided in **Table 3.2** includes annual and seasonal rainfall variability across near and far future timescales for the Narrabri locality using the Adapt NSW interactive climate change projections map ⁵. These values are the average NARCliM project outputs as previously described in Section 3.1. Visual NARCliM model representations, which includes the Narrabri locality are provided in **Appendix A**.

	Near Future (2030)	Far Future (2070)
Annual		
Mean	+2.42%	+11.03%
Seasonal		
Summer	-4.78%	+16.15%
Autumn	+23.82%	+20.94%
Winter	-6.5%	+5.52%
Spring	+0.78%	-3.44%

Table 3.2	Mean of NARCliM Narrabri locality	/ Near and Far Future Rainfall Projections ((%)

⁵ https://www.climatechange.environment.nsw.gov.au/projections-map



3.3 Temperature

A summary of temperature projections is provided in **Table 3.3** and **Figure 3.3**. Note, data included in **Table 3.3** is the average of NARCliM project outputs whilst the variability of model outputs is shown in **Figure 3.3**. Data shown in Table 2.4 and Figure 2.3 represents the NENW area as a whole

		Far Future
Annual		
Mean	+ 0.72°C	+ 2.20 °C
Minimum	+ 0.73 °C	+ 2.28 °C
Мах	+ 0.73 °C	+ 2.20 °C
Seasonal		
Summer	+ 0.89 °C	+ 2.40 °C
Autumn	+ 0.72 °C	+ 2.16 °C
Winter	+ 0.48 °C	+ 1.92 °C
Spring	+ 0.80 °C	+ 2.33 °C

 Table 3.3
 Summary of NARCliM NENW Near and Far Future Temperature Projections (°C)



Figure 3.3 Graphical Summary of NARCliM NENW Near and Far Future Temperature Projections



Data provided in **Table 3.4** includes annual and seasonal temperature variability across near and far future timescales for the Narrabri locality using the Adapt NSW interactive climate change projections map ⁶. These values are the average NARCliM project outputs as previously described in **Section 3.1**. Visual NARCliM model representations, which includes the Narrabri locality are provided in **Appendix A**.

	Near Future	Far Future
Annual		
Mean	+0.73°C	+2.22°C
Minimum	+0.74°C	+2.32°C
Max	+0.75°C	+2.21°C
Summer		
Mean	+0.96°C	+2.47°C
Minimum	+0.93°C	+2.60°C
Max	+0.96°C	+2.47°C
Autumn		
Mean	+0.73°C	+2.17°C
Minimum	+0.85°C	+2.43°C
Max	+0.64°C	+1.99°C
Winter		
Mean	+0.45°C	+1.85°C
Minimum	+0.40°C	+1.87°C
Max	+0.49°C	+1.83°C
Spring		
Mean	+0.82°C	+2.39°C
Minimum	+0.81°C	+2.37°C
Max	+0.88°C	+2.54°C

 Table 3.4
 Mean of NARCliM Narrabri locality Near and Far Future Temperature Projections (°C)

⁶ https://www.climatechange.environment.nsw.gov.au/projections-map



3.4 Hot Days and Cold Nights

A summary of hot day and cold night projections is provided in **Table 3.5** and **Table 3.6** and **Figure 3.4** and **Figure 3.5**. Note, data included in **Table 3.5** and **Table 3.6** is the average of NARCliM project outputs whilst the variability of model outputs is shown in **Figure 3.4** and **Figure 3.5**. Data shown in **Table 3.5** and **Table 3.6** and **Figure 3.4** and **Figure 3.4** and **Figure 3.5** and **Table 3.6** and **Figure 3.4** and **Figure 3.5**. Data shown in **Table 3.5** and **Table 3.6** and **Figure 3.4** and **Figure 3.5**.

Hot days are considered days where temperature exceeds 35 $^\circ C$ and cold nights are considered where night temperatures drop below 2 $^\circ C.$

Table 3.5	Summary of NARCliM NENW Near and Far Future number of hot days projections
(number of day	/s)

	Near Future	Far Future
Annual		
Mean	+7.1	+23.4
Seasonal		
Summer	+5.4	+15.2
Autumn	+0.5	+2.2
Winter	+0.0	+0.0
Spring	+1.3	+6.0



Figure 3.4 Graphical Summary of NARCliM NEN Near and Far Future number of days projections



Table 3.6Summary of NARCliM NENW Near and Far Future Number of cold nights (less than 2°C)Projections

	Near Future	Far Future
Annual		
Mean	-8.8	-26.1
Seasonal		
Summer	-0.0	-0.0
Autumn	-1.6	-3.0
Winter	-5.1	-18.2
Spring	-2.1	-4.9



Figure 3.5 Graphical Summary of NARCliM NENW Near and Far Future number of cold nights (less than 2°C) Projections



Data provided in **Table 3.7** includes number of hot days across near and far future timescales for the Narrabri locality using the Adapt NSW interactive climate change projections map ⁷. These values are the average NARCliM project outputs as previously described in **Section 3.1**. Visual NARCliM model representations, which includes the Narrabri locality are provided in **Appendix A**.

Table 3.7	Summary of NARCliM Narrabri locality Near and Far Future number of hot days
projections (nu	imber of days)

	Near Future	Far Future
Annual		
Mean	+13.77	+39.69
Seasonal		
Summer	+9.63	+24.15
Autumn	+1.20	+4.78
Winter	+0.00	+0.01
Spring	+2.94	+10.75

Data provided in **Table 3.8** includes number of cold nights across near and far future timescales for the Narrabri locality using the Adapt NSW interactive climate change projections map⁸. These values are the average NARCliM project outputs as previously described in **Section 3.1**. Visual NARCliM model representations, which includes the Narrabri locality are provided in **Appendix A**.

Table 3.8	Summary of NARCliM Narrabri locality Near and Far Future number of cold nights days
projections (nu	imber of nights)

	Near Future	Far Future
Annual		
Mean	-5.58	-17.48
Seasonal		
Summer	+0.00	+0.00
Autumn	-0.45	-0.83
Winter	-4.44	-14.73
Spring	-0.69	-1.92

 $^{^7\} https://www.climatechange.environment.nsw.gov.au/projections-map$

⁸ https://www.climatechange.environment.nsw.gov.au/projections-map



3.5 Bushfire

The Forest Fire Danger Index is used in NSW to quantify fire weather risk. The FFDI combines observations of temperature, humidity and wind speed. Fire weather is classified as sever when the FFDI is recorded above 50. A summary of fire weather and representative FFDI projections is provided in **Table 3.9** and **Figure 3.6**. Note, data included in **Table 3.9** is the average of NARCliM project outputs whilst the variability of model outputs is shown in **Figure 3.6**. Data shown in **Table 3.9** and **Figure 3.6** represents the NENW area as a whole.

	Near Future	Far Future
Annual		
Mean	+0.2	+0.9
Seasonal		
Summer	+0.1	+0.2
Autumn	-0.0	+0.0
Winter	+0.0	+0.0
Spring	+0.0	+0.7
2020-39 0 2	060-79 0 202	20-39 💿 2060-79
5.0	5.0	
4.0	4.0	
3.0	3.0	
2.0	2.0	
1.0	1.0	
0.0	0.0	
-1.0 Annual Summer Autumn	-1.0 -1.0 -1.0 -	er Autumn Winter Spring

Table 3.9	Summary of NARCliM New England North West Near and Far Future FFDI Projections
(number of day	ys)

Figure 3.6 Graphical Summary of NARCliM NENW Near and Far Future FFDI Projections



Data provided in **Table 3.10** includes changes in number of days a year FFDI is greater than 50 across near and far future timescales for the Narrabri locality using the Adapt NSW interactive climate change projections map⁹. These values are the average NARCliM project outputs as previously described in **Section 3.1**. Visual NARCliM model representations, which includes the Narrabri locality are provided in **Appendix A**.

	Near Future	Far Future
Annual		
Mean	+0.38	1.33
Seasonal		
Summer	+0.29	+0.25
Autumn	-0.00	+0.00
Winter	+0.00	+0.01
Spring	+0.10	+1.07

Table 3.10Summary of NARCliM Narrabri locality Near and Far Future FFDI Projections (number of days)

⁹ https://www.climatechange.environment.nsw.gov.au/projections-map



4.0 Risk Assessment

Risk Assessment material has been prepared to follow guidance from a range of sources including:

- NSW Climate Risk Ready Guide¹⁰
- Climate Change Impact and Risk Management A guide for business and government¹¹
- Australian Standard (AS) 5334-2013: Climate change adaptation for settlements and infrastructure

 A risk based approach¹²
- Climate Compass a climate risk management framework for Commonwealth agencies¹³
- Risk Management Tool Kit for NSW Public Sector Agencies: Volume 1 Guidance for Agencies¹⁴.

The Climate Risk Ready NSW Guide recommends using climate projections that are moderate to high. Moderate to high projections are most relevant as they will assess potential impacts of physical climate change risk to businesses and projects.

4.1 Methodology

The Risk Assessment undertaken has been aligned with Australian Standard 4360: Risk Management as recommended within the Climate change impact and risk management – A guide for business and government^{15.} It adopts a 5 stage process to identify and evaluate risks of climate change to assets, operations and services as shown in **Figure 4.1**.

4.2 Time scale and Scenario

Consistent with data projections and timescales, the risk assessment focuses on assessing risk against a SRES A2 scenario and near (2030) and far (2070) future timescales.

4.3 Risk Register

The Climate Change Risk Assessment utilised the NSW Climate Risk Assessment Tool¹⁶.





Figure 4.1 Risk management steps

4.3.1 Consequence Scale

The consequence scale for the risk assessment has been adopted from Australian Standard (AS) 5334-2013: Climate change adaptation for settlements and infrastructure – A risk based approach¹⁷.

A copy of the consequence scale is provided in **Appendix B**.

4.3.2 Likelihood Scale

The likelihood scale for the risk assessment utilises the default scale within the NSW Climate Risk Assessment Tool. A copy of the likelihood scale is provided in **Appendix B**.

4.3.3 Risk Matrix

The risk assessment utilises the default risk matrix included within the NSW Climate Risk Assessment Tool. A copy of the risk matrix is provided in **Appendix B**.

4.3.4 Control Effectiveness

The risk assessment utilises the default control effectiveness scale included within the NSW Climate Risk Assessment Tool. A copy of the control effectiveness scale is provided in **Appendix B**.

As a large component of the technical studies and work for the precinct is yet to be completed, ratings for control effectiveness have not occurred. Following completion of the Final Risk Assessment, ratings for control effectiveness will be applied.



5.0 Climate Change Adaptation

5.1 Adaptation Considerations

Adaptation considerations identified during the risk assessment workshop are provided in **Table 5.1**. A number of the proposed treatments are not unique to specific risk statements rather some proposed adaptation options are aligned the treatment of multiple risk statements. As a result, column 4 in **Table 5.1** has aligned proposed treatments to relevant risk IDs from the risk register.

There is one risk statement identified as part of the workshop which requires additional input as to how these risks may be proposed to be treated within the SAP Master Plan process. This includes:

• Impact on extreme weather (e.g., heat and drought) on ability to attract workers to the township.

Risk ratings and adaptation options should be re-considered across the duration of the project and following the finalisation of the preferred structure plan option. Following the completion of respective technical studies, treatments and adaptation actions proposed during the master plan process, it is likely the control effectiveness and residual risk levels will become more defined.

Adaption Considerations	When	Who	Risk ID Reference
Investigate options to prioritise energy use and efficiency measures across developments. This may include instigation of additional planning controls within the Delivery Plan. Consider ongoing revision of these requirements through governance framework/commencement of next development horizon.	Incorporate into delivery plan recommendations.	Sustainability/ Structure Plan Renewable Energy / Engineering SAP Concierge	1, 4
Investigate options to maximise onsite renewable energy generation. Plan new developments with energy generation (solar) to remove reliance from the grid	Test via inclusion in scenario options and incorporate into structure plan design (if preferred).	Structure Plan Renewable Energy / Engineering	1, 4, 16, 18
Utility infrastructure capacity requirements to consider additional redundancy requirements for operations during warmer weather. Design networks to accommodate spare capacity that allows for increased resistance in the network in high temperature scenarios.	Investigate for incorporation into final reports	Infrastructure / Engineering	1, 4

Table 5.1 Preliminary Adaptation Considerations



Adaption Considerations	When	Who	Risk ID Reference
Consider passive design options for infrastructure and other developments to reduce energy input requirements.	Incorporate recommendation into delivery plan	Sustainability / Structure Plan	1, 4, 6
Investigate water restriction measures for uptake into the planning processes (e.g., Delivery Plan) at a precinct or housing development level. This would be proposed in addition to existing controls managed as part of water sharing plans etc. This may include water restriction targets for developments during periods of water scarcity. Note: Existing town water supply is not subject to water restrictions.	Investigate for incorporation into delivery plan, if applicable for housing or employment area	Water Demand / Engineering Narrabri Shire Council SAP (Agency) Team	2, 20, 32
Investigate additional water treatment requirements and cost for the precinct based on proposed land uses. Currently chlorination is the highest level of treatment.	Investigate for incorporation into final reports	Water Demand / Engineering	2, 20, 22, 32
Water demand calculations to take increased water demand/take due to climate change influences into consideration. E.g., More dry years, high water demand during warmer weather	Investigate for incorporation into final reports	Water Demand / Engineering	2, 3, 20
Precinct water balance to consider environmental flow requirements. Align biodiversity and water cycle management outcomes to identify recommended runoff flows that consider climate change projections.	Investigate for incorporation into final reports	Water Demand / Engineering Biodiversity / Environment	2, 3, 21
Investigate diversification of water supply across precinct, including rainwater harvesting and WSUD measures.	Investigate for incorporation into final reports	Water Demand / Engineering Sustainability / Structure Plan	2, 32



Adaption Considerations	When	Who	Risk ID Reference
Considerations of local province and climate ready vegetation & plantings across precinct	Investigate species lists and measures for incorporation into structure plan	Ecology / Environment Landscape / Structure Plan	3, 10
Investigate risk of impacting groundwater dependent ecosystems and consider impacts due to increased demand due to climate change. This includes both in times of drought and increase in water demands.	Investigate for incorporation into final report	Water Demand / Engineering	3
Investigate adoption of building efficiency and construction standards that propose design principles above the norm (e.g., external independent rated systems). Incorporate commitment to review and revise building efficiency standards before commencement of each development stage/horizon.	Investigate and incorporate recommendation into delivery plan	Sustainability / Structure Plan	5, 6, 7
Precinct design to include provisions for the adoption green infrastructure across investigation area. This may include adopting measures from the Draft Greener Places Design Guide	Incorporate into final structure plan	Landscape / Structure Plan	6, 7, 8
Precinct to design minimise clearing and maximise retention of existing native woodland and forest vegetation.	Test via inclusion in scenario options and incorporate into structure plan design (if preferred).	Biodiversity / Environment Structure Plan	8, 10
Consider water quantity and quality demands for supporting green infrastructure	Investigate for incorporation into final report	Water Demand / Engineering Landscape / Structure Plan	8
Investigate targeted water reuse options once preliminary land uses are identified	Investigate for incorporation into final report	Waster Demand / Engineering Sustainability / Structure Plan	9



Adaption Considerations	When	Who	Risk ID Reference
Investigate opportunities for underground or large-scale enclosed water storage options including items such as Managed Aquifer Recharge	Investigate for incorporation into final report	Waster Demand / Engineering	9,20
Investigate developing groundwater source and pipeline from other groundwater sources. This may also include investigating options for water from other processes and industries around the area.	Investigate for incorporation into final report	Waster Demand / Engineering	9, 20
Ecological corridor and refuges adopted into masterplan design	Incorporate into final structure plan	Biodiversity / Environment Landscape / Structure	10
Adoption of measures to protect and enhance riparian vegetation zones. Consideration of retaining farm dams and existing water bodies and enhancing for use by native fauna.	Investigate for incorporation into final report Incorporate into final structure plan	Biodiversity / Environment Landscape / Structure	10
Develop revegetation strategies to provide connected refuges for native fauna.	Investigate for incorporation into final report Defer to SAP implementation stage	Biodiversity / Environment Landscape / Structure SAP (Agency) Team	10, 19
Planning process to propose a diverse range of industries to be included within precinct and reduce risk of developments becoming stranded assets. This includes industries that are adaptive to climate change impacts and require no/limited access to large quantities of natural resources such as water.	Test via inclusion in scenario options and incorporate into structure plan design (if preferred).	All Economic Consultants Structure Plan	11, 12
Consider impacts of projected FFDI increases within future Bushfire Assessments.	Investigate for incorporation into final report Incorporate recommendations into delivery plan	Bushfire / Environment	11, 15, 16, 18, 31



Adaption Considerations	When	Who	Risk ID Reference
Consider recent research outcomes being developed following the recent bushfire inquires.	Investigate for incorporation into final report Incorporate recommendations into delivery plan	Bushfire / Environment	11, 15, 16, 18, 31
Review measures to reduce risk of carbonisation/corrosion of built environment assets. This includes consideration of climate resilient construction materials, where applicable.	Defer to detailed design and development stage	SAP (Agency) Team	13
Consider implementation of precinct-based health and safety management system. System could consider local air quality, pre- warning TARPS and other associated protection measures for bushfire events.	Defer to detailed design and development stage	SAP (Agency) Team	14, 18
Consider location of critical infrastructure in fire protected areas (e.g., locating away from high-risk areas or clearing). Undergrounding of critical infrastructure in fire prone areas to protect against damage	Investigate for incorporation into final report	Utilities / Engineering	15
Consider need and increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.	SAP (Agency) Team to consider how to address.	SAP (Agency) Team Narrabri Shire Council	17
Investigate how variation of burning practices, including adoption of indigenous burning practices can be incorporated into precinct management (RFS to review).	Defer to SAP implementation stage	SAP (Agency) Team	19
Investigate need to purchase additional aquifer access licences	Investigate for incorporation into final report	Water Demand / Engineering	20



Adaption Considerations	When	Who	Risk ID Reference
Consider options to maximise rainwater harvesting from rooftops and applicable uses for harvested rainwater. E.g. potable	Investigate for incorporation into final report	Water Demand / Engineering	20, 26
Align biodiversity and water cycle management outcomes to identify recommended runoff flows that consider climate change projections.	Investigate for incorporation into final report	Water Demand / Engineering Biodiversity / Environment	21
Consider location of bores and extraction infrastructure outside of flood zones to prevent surface water contamination.	Investigate for incorporation into final report	Flooding / Engineering	22
Undertake flood modelling to identify how climate change may change flood regime/levels. AR&R (2019) guidelines provide a procedure for climate change flooding risks. This includes a 30% increase in rainfall activity into 1% AEP flooding modelling outputs. Alternatively, there is a NSW Guideline for incorporating ARR2016 into studies.	Investigate for incorporation into final report	Flood / Engineering	23, 24
Road infrastructure corridor planning to consider asset elevation with respect to addition potential flooding risks	Investigate for incorporation into final report	Flood / Engineering	24, 25
Studies to consider downstream impacts of developing new flood ways or exacerbating flood risk down stream of built areas.	Investigate for incorporation into final report	Flood / Engineering	25
Precinct planning process to identify additional areas which may become flood prone and sterilised due to climate change flood projections. This also includes transport infrastructure.	Investigate for incorporation into final report	Flood / Engineering	27, 29



Adaption Considerations	When	Who	Risk ID Reference
Increase IP ratings of electrical and communication infrastructure to ensure protection from increased water egress and inundation.	Defer to construction and implementation stages	SAP (Agency) Team	27
Locate critical infrastructure outside of the flooding zones taking into account worst case climate change scenarios	Investigate for incorporation into final report	Flood / Engineering	27
Develop precinct-based bushfire fire management strategy. Strategy should also consider management options such as pre-season burning and management.	Defer to construction an implementation stages	SAP (Agency) Team	31
Market sounding analysis to consider how global shifts in low emissions processes and land uses may affect long-term viability of perspective tenants	Investigate for incorporation into final report	Economics SAP (Agency) Team	33
Consider undertaking secondary risk assessment focusing on transitionary risks associated with policy and legal, technology, market and reputation and how risks may align to existing state and federal commitments to achieve net zero emissions by 2050.	SAP (Agency) Team to consider	SAP (Agency) Team	33





NARCliM Climate Projection via ADAPT NSW




Figure A.1 New England and North West Change in Days over 35C – Near Future



Figure A.2 New England and North West Change in Days over 35C – Far Future





Figure A.3 New England and North West Change in annual mean FFDI – Near Future



Figure A.4 New England and North West Change in seasonal mean FFDI – Near Future





Figure A.5 New England and North West Change in annual mean FFDI – Far Future



Figure A.6 New England and North West Change in seasonal mean FFDI – Far Future





Figure A.7 New England and North West Change in annual mean number of days with temperatures less than 2 degrees C – Near Future



Figure A.8 New England and North West Change in annual mean number of days with temperatures less than 2 degrees C – Far Future





Figure A.9 New England and North West Change in annual mean number of days with FFDI greater than 50 – Near Future



Figure A.10 New England and North West Change in annual mean number of days with FFDI greater than 50 – Near Future





Figure A.11 New England and North West Change in annual mean number of days with FFDI greater than 50 – Far Future



Figure A.12 New England and North West Change in annual mean number of days with FFDI greater than 50 – Far Future









Figure A.14 New England and North West Change in seasonal mean daily maximum temperature - Near Future









Figure A.16 New England and North West Change in seasonal mean daily maximum temperature - Far Future





Figure A.17 New England and North West Change in annual mean temperature - Near Future



Figure A.18 New England and North West Change in seasonal mean temperature - Near Future





Figure A.19 New England and North West Change in annual mean temperature - Far Future



Figure A.20 New England and North West Change in seasonal mean temperature - Far Future









Figure A.22 New England and North West Change in seasonal mean daily minimum temperature - Near Future









Figure A.24 New England and North West Change in seasonal mean daily minimum temperature - Far Future





Figure A.25 New England and North West Change in annual mean precipitation - Near Future



Figure A.26 New England and North West Change in seasonal mean precipitation - Near Future





Figure A.27 New England and North West Change in seasonal mean precipitation - Far Future



Figure A.28 New England and North West Change in seasonal mean precipitation - Far Future





Table B1 Proposed Risk Assessment Consequence Criteria

	Adaptive Capacity ¹⁰	Infrastructure Service	Social/Cultural	Governance	Financial ¹¹	Environmental and Sustainability ¹²	Economy ¹³
Catastrophic	Capacity destroyed, redesign required when repairing or renewing asset	Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service Loss of infrastructure support and translocation of service to other sites Early renewal of infrastructure by >90%	Severe adverse human health effects, leading to multiple events of total disability or fatalities Total disruptions to employees, customers or neighbours Emergency response at a major level	Major policy shifts Change to legislative requirements Full change of management control	Extreme financial loss >90%	Very significant loss to the environment. May include localized loss of species, habitats or ecosystems Extensive remedial action essential to prevent further degradation. Restoration likely to be required	Major effect on the local, regional and state economies
Major	Major loss in adaptive capacity. Renewal or repair would need new design to improve adaptive capacity	Extensive infrastructure damage requiring major repair Major loss of infrastructure service Early renewal of infrastructure by 50–90%	Permanent physical injuries and fatalities may occur Severe disruptions to employees, customers or neighbours	Notices issued by regulators for corrective actions Changes required in management. Senior management responsibility questionable	Major financial loss 50–90%	Significant effect on the environment and local ecosystems. Remedial action likely to be required	Serious effect on the local economy spreading to the wider economy

¹⁰ Adaptive capacity relates to the ability of the infrastructure element and/or organization to adapt/change/cope with change in the climate change variable.

¹¹ Financial loss will be relative to the infrastructure element being considered (i.e. a single building, coastal town, rail system). Dollar values need to include replacement cost for the infrastructure item and financial loss/costs relating to the loss of the service provided by the infrastructure item.

¹² While the term 'environment' can include both man-made and natural systems, in this Standard 'environment' is limited to the natural environment outside the asset being considered.

¹³ Economy refers to the local economy (e.g. town or region), the state economy, or the economy of Australia as a whole. Significance of this measure will depend on the asset being considered.



	Adaptive Capacity ¹⁰	Infrastructure Service	Social/Cultural	Governance	Financial ¹¹	Environmental and Sustainability ¹²	Economy ¹³
Moderate	Some change in adaptive capacity. Renewal or repair may need new design to improve adaptive capacity	Limited infrastructure damage and loss of service Damage recoverable by maintenance and minor repair Early renewal of infrastructure by 20–50%	Frequent disruptions to employees, customers or neighbours. Adverse human health effects	Investigation by regulators Changes to management actions required	Moderate financial loss 10–50%	Some damage to the environment, including local ecosystems. Some remedial action may be required	High impact on the local economy, with some effect on the wider economy
Minor	Minor decrease to the adaptive capacity of the asset. Capacity easily restored	Localized infrastructure service disruption No permanent damage. Some minor restoration work required Early renewal of infrastructure by 10–20% Need for new/modified ancillary equipment	Short-term disruption to employees, customers or neighbours Slight adverse human health effects or general amenity issues	General concern raised by regulators requiring response action	Additional operational costs Financial loss small,	Minimal effects on the natural environment	Minor effect on the broader economy due to disruption of service provided by the asset
Insignificant	No change to the adaptive capacity	No infrastructure damage, little change to service	No adverse human health effects	No changes to management required	Little financial loss or increase in operating expenses	No adverse effects on natural environment	No effects on the broader economy



Table B2	Proposed Risk Assessment Likelihood Criteria
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	Recurrent Events	Single Events
Almost Certain	Could occur server times per year	More likely than not – probability greater than 50%
Likely	May arise about once per year	As likely as not – 50/50 chance
Possible	May arise once in 10 years	Less likely than not but still appreciable – probability less than 50% but still quite high
Unlikely	May arise once in 10 to 25 years	Unlikely but not negligible – probability low but noticeably greater than zero
Rare	Unlikely during the next 25 years	Negligible – probability very small, close to zero

 Table B3
 Proposed Risk Assessment Matrix

		Consequence						
		Insignificant	Minor	Moderate	Major	Catastrophic		
	Almost certain	Medium	Medium	High	Extreme	Extreme		
poq	Likely	Low	Medium	High	High	Extreme		
eliho	Possible	Low	Medium	Medium	High	High		
Lik	Unlikely	Low	Low	Medium	Medium	Medium		
	Rare	Low	Low	Low	Low	Medium		

Table B4 Proposed Control Effectiveness Schedule

Effectiveness	Description and further action
Substantially effective	Existing controls address risk, are in operation and are applied consistently. Management is confident that the controls are effective and reliable. Ongoing monitoring is required.
Partially effective	Controls are only partially effective, require ongoing monitoring and may need to be redesigned, improved or supplemented.
Largely ineffective	Management cannot be confident that any degree of risk modification is being achieved. Controls need to be redesigned.





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Risk assessment criteria

The below tables are editable to allow you to customise this template with the risk assessment criteria outlined in your organisation's enterprise risk management framework/guidance.

Table 1: Likelihood criteria

Likelihood that a given scenario arises

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

*prefilled based on Table 11 of Climate change impact and risk management - A guide for business and government (Australian Greenhouse Office 2006)

Table 2: Consequence criteria

Consequence and success criteria	Adaptive Capacity	Infrastructure Services	Social/Cultural	Governance	Finanicial	Environmental and Sustainability	Economy
Catastrophic	Capacity destroyed, redesign required when repairing or renewing asset	Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service Loss of infrastructure support and translocation of service to other sites Early renewal of infrastructure by >90%	Severe adverse human health effects, leading to multiple events of total disability or fatalities Total disruptions to employees, customers or neighbours Emergency response at a major level	Major policy shifts Change to legislative requirements Full change of management control	Extreme financial loss >90%	to the environment. May include localized loss of species, habitats or ecosystems Extensive remedial action essential to prevent further degradation. Restoration likely to	Major effect on the local, regional and state economies
Major	Major loss in adaptive capacity. Renewal or repair would need new design to improve adaptive capacity	Extensive infrastructure damage requiring major repair Major loss of infrastructure service Early renewal of infrastructure by 50–90%	Permanent physical injuries and fatalities may occur Severe disruptions to employees, customers or neighbours	Notices issued by regulators for corrective actions Changes required in management. Senior management responsibility guestionable	Major financial loss 50–90%	Significant effect on the environment and local ecosystems. Remedial action likely to be required	Serious effect on the local economy spreading to the wider economy
Moderate	Some change in adaptive capacity. Renewal or repair may need new design to improve adaptive capacity	Limited infrastructure damage and loss of service Damage recoverable by maintenance and minor repair Early renewal of infrastructure by 20–50%	Frequent disruptions to employees, customers or neighbours. Adverse human health effects	Investigation by regulators Changes to management actions required	Moderate financial loss 10–50%	Some damage to the environment, including local ecosystems. Some remedial action may be required	High impact on the local economy, with some effect on the wider economy
Minor	Minor decrease to the adaptive capacity of the asset. Capacity easily restored	Localized infrastructure service disruption No permanent damage. Some minor restoration work required Early renewal of infrastructure by 10–20% Need for new/modified ancillary equipment	Short-term disruption to employees, customers or neighbours Slight adverse human health effects or general amenity issues	General concern raised by regulators requiring response action	Additional operational costs Financial loss small,	Minimal effects on the natural environment	Minor effect on the broader economy due to disruption of service provided by the asset
Insignificant	No change to the adaptive capacity	No infrastructure damage, little change to service	No adverse human health effects	No changes to management required	Little financial loss or increase in operating expenses	No adverse effects on natural environment	No effects on the broader economy

Australian Standard 5334-2013: Climate change adaptation for settlements and infrastructure – A risk based approach

Table 3: Risk matrix

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

*prefilled based on Table 7 of Climate Compass (CSIRO 2018)

Table 4 - Control effectiveness

	Description and further action
Substantially effective	Existing controls address risk, are in operation and are applied consistently. Management is confident that the controls are effective and reliable. Ongoing monitoring is required.
Partially effective	Controls are only partially effective, require ongoing monitoring and may need to be redesigned, improved or supplemented.
Largely ineffective	Management cannot be confident that any degree of risk modification is being achieved. Controls need to be redesigned.

*prefilled based on Table 4.6 of TPP12-03b (NSW Treasury 2012)

Risk ID Unique identifier	Risk description <i>Refer to Guidance for advice on developing a climate risk</i> <i>statement, or refer to the Example Risks tab</i>	Controls & treatments (existing) Current controls	Control effectiveness Select level of effectiveness from drop-down list	Proposed treatments (adaptation actions) Additional control if risk is not acceptable. Refer to Example adaptation actions tab	Residual risk level Expected level of risk remaining after adaptation actions are implemented	Comments Uncertainties or sensitivities; potenital impact on organisational objectives; resources required (financial, physical, human resources, knowledge)
1	Increased energy demand for built structures, developments and industry across the investigation area during warmer weather. This considers both increases in mean temperature and heatwaves/extreme temperatures.	Buildings and development proposals adopt required energy and water efficiency standards. (e.g. NSW BASIX & National Construction Code). Baseline utilities infrastructure analysis compeled. Analysis identifies current capacities and constraints of local energy transmission network and states that the network is likely to reach capacity by 2024. Significant NSW government investment to transition electricty generation away from traditional electricity generation sources, including a number of renewable energy generation developments wthin the surrounding locality. NSW Energy Security Safeguard	Select	 Investigate options to prioritise energy use and efficiency measures across developments. This may include instigation of additional planning controls within the Delivery Plan. Consider ongoing revision of these requirements through governance framework/commencement of next development horizon. Investigate options to maximise onsite renewable energy generation. Plan new developments with energy generation (solar) to remove reliance from the grid Utility infrastructure capacity requirements to consider additional redunancy requirements for operations during warmer weather. Design networks to accomodate spare capacity that to allows for increased resistance in the network in high temperature scenarios. Consider passive design options for infrastructure and other developments to reduce energy input requirements. Investigate option to maximise adoption of onsite energy generation measures. 	Medium	Scenario modelling to take place to understand scenarios of high heat, and increased demand, to ensure networks affected can be upgraded to cater for this
2	Increased water demand for built structures, developments and industry across the investigation area caused by increases in average temperatures.	Annual water determination surface and groundwater for water sharing plans on annual basis. This is in place for all licence allocations except high security licences e.g. town/potable water supplies (which permit use of full allocation). Buildings and development proposals adopt required water efficiency standards (e.g. NSW BASIX and National Construction Code) Baseline water available analysis completed	Select	Investigate water restriction measures for uptake into the planning processes (e.g. Delivery Plan) at a precinct or housing development level. This would be proposed in addition to existing controls managed as part of water sharing plans etc. This may include water restriction targets for deveopments during periods of water scarcity. Discussion noted that increased water use across area may also increase need for additional water treatment before use. Investigate additional water treatment requirements for the precinct based on proposed land uses. Water balance to consider environmental flow requirements. Water demand calculations to take into increased demand due to Climate Change into consideration.	Medium	Note:Groundwater sources do not have typical water restriction targets that other utilities use ie. dam levels, consideration of this.
3	Increase in water demand across investigation area causing reduced supply of natural water systems	Annual water determination surface and groundwater for water sharing plans on annual basis. This is in place for all licence allocations except high security licences e.g. town/potable water supplies (which permit use of full allocation). Baseline water availability analysis completed	Select	Water balance to consider environmental flow requirements. Water demand calculations to take increased demand due to Climate Change into consideration Considerations of local province and climate ready vegetation & plantings across precinct Investiate risk of impacting groundwater dependent ecosystems	High	

4	Increased pressure across the energy network, critical equipment and services leading to an increase in energy network instability (ongoing elevated demand)	Significant NSW government investment to transition electricty generation away from traditional electricity generation sources, including a number of renewable energy generation developments wthin the surrounding locality. Infrastructure Baseline Analysis Report identifies current capacity and constraints of local energy trasmission network (i.e. likely to reach capacity by 2024). NSW Energy Security Safeguard	Select	Investigate options to prioritise energy use and efficiency measures across developments. This may include instigation of additional planning controls within the Delivery Plan. Consider ongoing revision of these requirements through governance framework/commencement of next development horizon. Utility infrastructure capacity requirements to cosnider additional redunancy requirements for operations during warmer weather. Consider passive design options for infrastructure and other developments to reduce energy input requirements. Investigate option to maximise adoption of onsite energy generation measures.	Medium	
5	Increased need to cool buildings or work sites and impacts thermal performance of buildings	Buildings and development proposals adopt required energy and water efficiency standards. (e.g. NSW BASIX & National Construction Code)	Select	Investigate adoption of building efficiency and construction standards which require more stringent design principles (e.g. external rated systems) Investigate and refine opportunities during detailed design, procurement and construction stage of precinct. Implement provision that minimum standards are reviewed before commencement of each development horizon.	Medium	
6	Increased instances of heat stress for residential, commercial building and precicnt occupants resulting in health impacts or lower productivity.	Buildings and development proposals adopt required energy and water efficiency standards. (e.g. NSW BASIX & National Construction Code)	Select	Consideration of passive design measures within precinct infrastructure development Consider adoption of construction standards which require more stringent design principles (e.g. independent external rated systems). This also considers use of alternate building materials, where applicable. Consideration of precinct design to include provisions for green infrastructure	Medium	
7	Increased instances of heat stress for industrial and precinct occupants resulting in health impacts or lower productivity	Buildings and development proposals adopt required energy and water efficiency standards. (e.g. NSW BASIX & National Construction Code)	Select	Consideration of passive design measures within precinct infrastructure development. Consideration of building design and land use proposals across precinct. Consider adoption of construction standards which require more stringent design principles (e.g. independent external rated systems). This also considers use of alternate building materials, where applicable. Consideration of precinct design to include provisions for green infrastructure	Medium	Note: some industrial land uses may require substantial heating requirements. This may reduce potential for risk treatments and adaptatin actions to be implemented
8	An increase in the urban heat island effect impacting comfort and amenity of outdoor areas		Select	Consideration of Draft Greener Places Deisgn Guide in precinct planning Precinct design to include provisions for green infrastructure corridors across precinct. Planning and design should also consider how busihfire risk is affected by this. Precinct to minimise clearing and maximise rentention of existing native woodland and forest vegetation. Masterplan to consider adequate water supply for green infrastructure	Medium	
9	Higher evaporation rates of water storage sites reducing water availability onsite	Existing water sources (groundwater) enclosed	Select	Review outcomes of water balance and demand requirements based on climate change Once landuses are identified, investigate options to feasbily reuse water Investigate opportunities for underground or large scale enclosed water storage options. Investigate Managed Aquifer Recharge Investigate developing groundwater source and pipeline from other groundwater sources. This may also include investigating options for water from other processes and industries around the area.	Medium	

10	Loss of biodiversity and ecosystem function due to increases in average and extreme temperatures and extended periods without rainfall		Select	Retain native vegetation (including native grasslands).Structure plan to minimise woodland and forest (if any) disturbance as much as practicable. Ecological corridor and refuges adopted into Masterplan design. Species plantings lists for green spaces to focus on climate ready species. Adoption of measures to protect and enhance riparian vegetation zones. Consideration of retaining farm dams and existing water bodies and enhancing for use by native fauna. Revegetation strategies to provide connected refugia for native fauna. Protect and enhance areas of native vegetation including riparian vegetation zones.	Medium	Changes in mean temperature of +0.72 degrees unlikley to result in significant impact to biodiversity and ecosystems. Change in mean temperature to +2.2 degrees may start to affect water availability, foragaing resoucres and breeding behaviour of some species. More hot days may also increase chance of unplanned bushfires, with hotter, more destructive fires. Increased number of hot days in the 2070 scenario by 23 can influence biodiversity and ecosytems. Increased evaporation can affect plant health and foraging resources.
11	Decreased agricultural and regional productivity due to increase in average and extreme temperatures, drought and fire weather	Ongoing research from University of Sydney and CSIRO laboratory sites focusing on the agricultural research on climate resilience Diverse economy emables workers to move between industry, on- farm storage assists in mitigating drought risk DPI business planning support and investment in on-farm infrastructure including water storage and feed lots Advancement in cotton and seed technology to be drought tolerant - Uni of Sydney and CSIRO research facilities in Narrabri	Select	Planning process to propose a diverse range of industries to be included within precinct and reduce risk of developments becoming stranded assets. This includes industries that are adaptive to climate change impacts and require no/limited access to large quanities of natural resources such as water. Consider impacts of projected FFDI increases within future Bushfire Assessments. Consider recent research outcomes being developed following the recent bushfire inquires.	High	
12	Decreased agricultural and regional productivity due to increase in flooding	Ongoing research from University of Sydney and CSIRO laboratory sites focusing on the agricultural research on climate resilience Diverse economy emables workers to move between industry, on- farm storage assists in mitigating drought risk DPI business planning support and investment in on-farm infrastructure including water storage and feed lots	Select	Planning process to propose a diverse range of industries to be included within precinct and reduce risk of developments becoming stranded assets. This includes industries that are adaptive to climate change impacts and require no/limited access to large quanities of natural resources such as water.	High	
13	Accelerated carbonation/corrosion of built environment and infrastructure due to increase in average and extreme temperatures	Buildings and development proposals designed constructed to meet current construction guidelines.	Select	Risk to be reviewed during detailed design, procurement and construction stages. Review should take into account proposed age of assets as part of design process. Risk should also be reviewed prior to the commencement of each new development horizon/stage Consider adoption of construction standards which require more stringent design principles (e.g. independent external rated systems). This also considers use of alternate building materials, where applicable.	Medium	
14	Reduced air quality within both open space and internal areas as a result of fire activity	Existing pre-season bushfire management contols. e.g. prescribed burning and approval from RFS. Work Health and Safety Act and Regulation obligations. Development will adopt minimum clearance areas and setbacks consistent with the requirements of NSW RFS Planning for Bushfire Protection Guidelines. These are based on vegetation mapping and slope of the land under the hazard. FDI 80 currently used.	Select	Consider implementation of precinct based health and safety management system. System could consider local air quality and associated protection measures when required. Master Plan to set high level APZs, and additional principles for development within Delivery Plan.	Low	

15	Full or partial fire damage to buildings and public spaces due to bushfire activity	Existing pre-season bushfire management contols. e.g. prescribed burning and approval from RFS Development will adopt minimum clearance areas and setbacks consistent with the requirements of NSW RFS Planning for Bushfire Protection Guidelines. These are based on vegetation mapping and slope of the land under the hazard. FFDI 80 currently used.	Select	Consider impacts of projected FFDI increases within future Bushfire Assessments. Consider recent research outcomes being developed following the recent bushfire inquires. Consider location of critical infrastructure in fire protected areas (e.g. locating away from higk risk areas or clearing). Undergroudning of critical infrastructure in fire prone areas to protect against fire damage. Development to consider adopting review of relevant NSW RFS Planning for Bushfire Protection Guidelines from time to time prior to development of each new planning horizon.	Medium	
16	Increased instances of energy and telecommunications network failure or damage impacting housing investigation area, business operations and activities within the precinct due to bushfire activity	Development will adopt minimum clearance areas and setbacks consistent with the requirements of NSW RFS Planning for Bushfire Protection Guidelines. These are based on vegetation mapping and slope of the land under the hazard. FFDI 80 currently used.	Select	Masterplan to set high level APZs and adopt additional principles within the Delivery Plan. Investigate options to maximise onsite renewable energy generation. Plan new developements with energy generation (e.g. solar) to remove reliance from the grid and external transmission network Investigate projected increases in fire weather/RFID (due to Climate Change) within precinct planning. This will consider recent research that is being undertaken/developed following recent bushfire enquiries.	Medium	
17	Increase in fire weather causing increased demand on emergency services	The masterplan will consider appropriate site access points and design of access roads to enable safe access and egress for residents/site users attempting to leave the area at the same time that emergency service personnel are arriving to undertake firefighting operations. Consistent with NSW RFS Planning for Bushfire Protection Guidelines.	Select	Consideration of the increase in demand for emergency services responding to a bushfire emergency including the need for new stations/ brigades - noting that the fire seasons will extend in duration and the window for hazard reduction will decrease.	Medium	
18	Loss of life/injury and increased hospital presentations	Development will adopt minimum clearance areas and setbacks consistent with the requirements of NSW RFS Planning for Bushfire Protection Guidelines. These are based on vegetation mapping and slope of the land under the hazard. FFDI 80 currently used.	Select	Masterplan to set high level APZs and adopt additional principles within the Delivery Plan. Investigate options to maximise onsite renewable energy generation. Plan new developements with energy generation (e.g. solar) to remove reliance from the grid and external transmission network Investigate projected increases in fire weather/RFID (due to Climate Change) within precinct planning. This will consider recent research that is being undertaken/developed following recent bushfire enquiries.	Medium	Note: Risk of bushfire will always remain within area despite adoption of mitigation measures.
19	Changes to bushfire regimes leading to shifts in ecology	Existing local and regional ecological corridors	Select	Adapive management and monitoring plans. Revegetation strategies to provide connected refugia for native fauna. Protect and enhance areas of native vegetation including riparian vegetation zones. Investigate how variation of burning practices, including adoption of indigenous burniong practices can be incorporated into precinct management (RFS to review).	Medium	
20	Decreased availability of potable water during extended periods of no rainfall	Access licence limit of 3,500ML for potable water services. (high security town water access licence) WSP Baseline report indicates around 2,837ML is used during 'dry years'. Annual water determination surface and groundwater for water sharing plans on annual basis. This is in place for all licence allocations except high security licences e.g. town/potable water supplies (which permit use of full allocation).	Select	Purchase additonal aquifer access licences for SAP use Investigate maximisation of potable drinking water supplies via rooftop harvesting and rainwater tanks. Additional treatment may also be required. Investigate need for higher level of water treatment, currently chlorination is level of treatment for potable water Investigate Managed Aquifer Recharge to increase GW storage Investigate developing groundwater source and pipeline from other groundwater sources	Low	
21	Low runoff impacting environmental flows and biodiversity	User input	Select	Align biodiversity and water cycle management outcomes to identify recommended runoff flows that consider climate change projections.	High	

22	Higher levels of water contamination and algae	Potable: Australian Drinking Water Guidelines Chlorination of existing potable water supply.	Select	Investigate need for higher level of water treatment, currently chlorination is level of treatment for potable water Consideration of bore and extraction infrastructure located outside of flood zones to prevent surface water contamination.	High	
23	Increased levels of localised flooding imiting access and egress	Draft baseline flooding and water cycle management analsyis report has established baseline flooding, stormwater, surface water supply conditions for the SAP investigation area. Existing approved building & infrastructure development controls. Use of flood data to determine historical impacts Emergency management planning controls Narrabri Shire Council Local Emergency Management Plan	Select	 AR&R (2019) guidelines provide a procedure for climate change flooding risks. This includes a 30% increase in rainfall activity into 1% AEP flooding modelling outputs. Also see NSW Guideline Incorporating ARR2016 into studies. Investigate planning controls for land which may be affected by climate change flooding projections across SAP lifetime (identify land which may become sterile due to flood risk). Investigate options to limit land from being sterilised by flood risk. Consider land uses and asset lifetimes for areas likely to be impacted by flooding 	Medium	
24	Increased levels of localised flooding imiting access and egress, including for emergency services.	Draft baseline flooding and water cycle management analsyis report has established baseline flooding, stormwater, surface water supply conditions for the SAP investigation area. Existing approved building & infrastructure development controls. Emergency planning controls Narrabri Shire Council Local Emergency Management Plan	Select	AR&R (2019) guidelines provide a procedure for climate change flooding risks. This includes a 30% increase in rainfall activity into 1% AEP flooding modelling outputs. Also see NSW Guideline Incorporating ARR2016 into studies. Road infrastructure corridor planning to consider asset elevation with respect to potential flooding risks	Medium	
25	Increased risk to life/injuries due to increased flood hazard - new floodway	Emergency planning controls Narrabri Shire Council Local Emergency Management Plan	Select	Studies to consider downstream impacts of developing new floodways or exacerbating flod risk down stream. Road infrastructure corridor planning to consider asset elevation with respect to potential flooding risks	Medium	
26	Drainage capacity issues for buildings and hard landscaping	Existing building, infrastructure development and land use planning controls Water Sensitive Urban Design Guidelines.	Select	Promote measures to capture rainfall from impervious areas	Low	
27	Damage to infrastructure and assets (e.g. buildings, telecommunications) due to flooding and inundation	Existing building, infrastructure development and land use planning controls for local area	Select	Precinct planning process to identfy additional areas which may become flood prone and sterilised due to chaging climate. Increase IP ratings of electrical and communcition infrastructure to ensure protection from increased water egress and innudation. Locate critical infrastructure outside of the flooding zones taking into account worste case climate change scenarios	Low	
28	Increased or decreased levels of rain/moisture penetration in soils	Existing building, infrastructure development and land use planning controls for local area	Select	Maintain permeable areas required for floodways, flood storage, flood fringe, riparian; building footprints. Precinct design to consider impermeable structure only where required.	Low	
29	Extreme heat and other extreme weather (flooding) leading to rail infrastructure damage and failure impacting logistics, safety and reputation	Existing rail corridor near Precinct. Flood and other technical studies undertaken for nearby rail infrastructure developments	Select	Additional rail infrastructure proposed as part of precinct to be designed to standards considering additional flood risk from climate change.	High	Does the scope of the precinct affect controls of the other existing/proposed developments, such as the the inland port?
30	Impact of extreme weather (heat and drought) on ability to attract workers to the town	Diverse economy emables workers to move between industry, on- farm storage assists in mitigating drought risk. DPI business planning support and investment in on-farm infrastructure including water storage and feed lots Advancement in cotton and seed technology to be drought tolerant - Uni of Sydney and CSIRO research facilities in Narrabri Regional NSW grants to moved into region	Select	To be discussed with Regional NSW + RGDC. Measures including those already raised in this document would assist but this is considered a wider reputational item.	High	

31	Changing seasonal patterns decreasing availability to undertake fire management activities.	Development will adopt minimum clearance areas and setbacks consistent with the requirements of NSW RFS Planning for Bushfire Protection Guidelines. These are based on current vegetation mapping and slope of the land under the hazard. FFDI 80 currently used.	Select	Identify areas of investigationn area where extensive ongoing pre-season fire management is likely to be minimal. Consider impacts of projected FFDI increases within assessment (this may result increased setback distances and larger APZ). Consider any recent research or management measures that is being developed following the recent bushfire inquires.	High	
32	Increase in groundwater extraction/decrease in rainfall recharge leading to increase in groundwater salinity	Annual water determination surface and groundwater for water sharing plans on annual basis. This is in place for all licence allocations except high security licences e.g. town/potable water supplies (which permit use of full allocation). Baseline water availability analysis completed.	Select	 Investigate diversification of water supply across precinct, including rainwater harvesting and WSUD measures. Investigate water restriction measures for uptake into the planning processes (e.g. Delivery Plan) at a precinct or housing development level. This would be proposed in addition to existing controls managed as part of water sharing plans etc. This may include water restriction targets for deveopments during periods of water scarcity. Note: existing grundwater licence allocations do not include water restrictions. Investigate options for more intensive water treatment measures across precinct (to manage wider variation of water quality/sources) Investigate water quality requirements for various landuses 	Medium	Agriculture and water users rely on fresh water which may beome unuseable. Decrease in use of water for irrigated agricutlure and commecial activity
33	Emissions intensive land uses unable to transition to low emission operations		Select	Consider undertaking secondary risk assessment focusing on transitionary risks associated with policy and legal, technology, market and reputation and how risks may align to existing state and federal commitments to achieve net zero emissions by 2050.	Extreme	Note: A 2070 is likely inaccurate as transition from existing high emissions industries are expected to occur prior to 2070.



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