Australian Government
Australian Submarine Agency

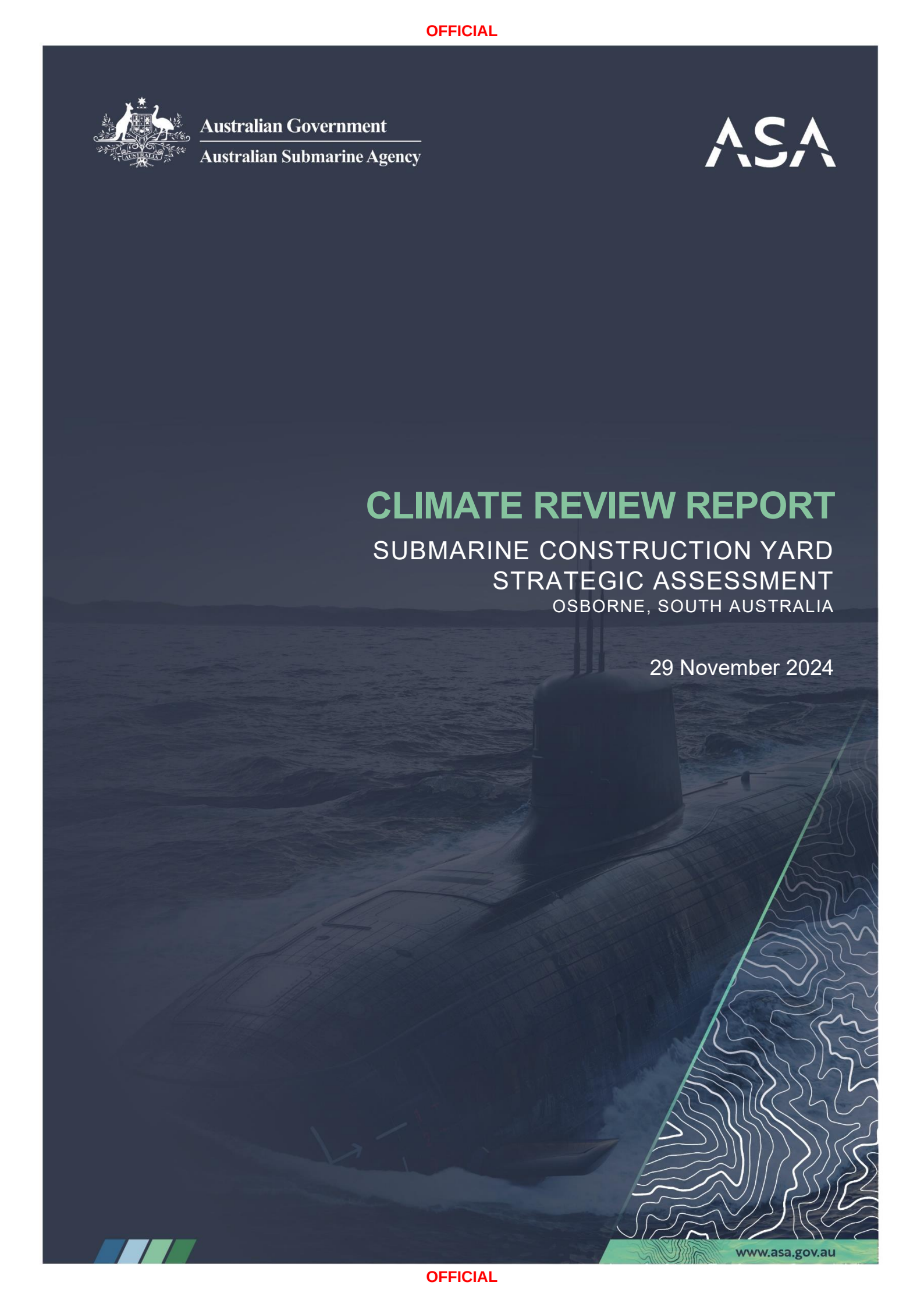
ASA

CLIMATE REVIEW REPORT

SUBMARINE CONSTRUCTION YARD STRATEGIC ASSESSMENT

OSBORNE, SOUTH AUSTRALIA

29 November 2024



www.asa.gov.au

Project name	Submarine Construction Yard Strategic Assessment
Document title	Climate Review Report | Submarine Construction Yard
This document has been prepared by GHD Pty Ltd for the Australian Submarine Agency	

Acknowledgement of Country

The Australian Submarine Agency acknowledges the Kaurna Meyunna people of Kaurna Country, the Traditional Custodians on whose land the Submarine Construction Yard is sited. We recognise their continuing connection to traditional lands and waters and would like to pay respect to their Elders both past and present.

Executive Summary

Overview

The Australian Submarine Agency and the Commonwealth Minister for the Environment and Water ('the Minister') entered into a Strategic Assessment Agreement in November 2023 (the 'Strategic Assessment Agreement'). The pathway for assessment and approvals, agreed upon under the Strategic Assessment Agreement, for the construction and operation of the proposed Submarine Construction Yard, is under Part 10 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The preferred site for the construction and operation of the Submarine Construction Yard (the 'Strategic Assessment Area') is located on the Lefevre Peninsula, approximately 19 km north of Adelaide in South Australia.

The Submarine Construction Yard would be developed to enable the building of nuclear-powered, conventionally armed submarine SSN-AUKUS; and would contain a range of facilities in which the fabrication and manufacturing of submarine parts and components, as well as testing and commissioning of submarines, would occur.

The Lefevre Peninsula has undergone significant alteration and industrial development since 1881; including an area that has been filled historically to depths of approximately 3.3 m below the ground level, within the Strategic Assessment Area. Additionally, the Port Adelaide River has been subject to dredging operations since the onset of industrialisation in the region.

This climate review considers the climatic hazards that are predicted to impact the Strategic Assessment Area and surrounding region; which would affect the functioning of the Submarine Construction Yard in the future. These hazards include sea level rise, extreme temperatures and heatwaves, drought, extreme rainfall and flooding, and bushfires.

This report also considers climatic hazards that have the potential to impact matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* ('Protected Matters'). This includes unique plants, animals, habitats, and places that hold ecological or cultural significance to people and communities. This climate review provides an overview of potential future climate change related impacts on Protected Matters within the Strategic Assessment Area and the surrounding region, including:

– Listed threatened species habitats within the Strategic Assessment Area and surrounding area
– Listed migratory species habitats within the Strategic Assessment Area and surrounding area
– The environment

Approach

Representative Concentration Pathways (RCPs) are the internationally agreed, scientific climate models. This climate review assessed high emission (RCP8.5) and moderate emission (RCP4.5) scenarios to project future climatic conditions in the Strategic Assessment Area and surrounding region. It also considered Shared Socioeconomic Pathways (SSPs) to refine models; accounting for future developments in society, economy, and environment. RCPS and SSPs are internationally agreed-upon standard for climate modelling set by the Intergovernmental Panel on Climate Change (IPCC).

The climate review considered the RCP4.5 and SSP2-4.5 (intermediate scenario), and RCP8.5 and SSP5-8.5 (worst-case climate change scenarios), over mid-term (2050) and long-term (2100) timeframes.

A summary of the climate change projections for the intermediate and worst-case scenarios is found in Table E.1. While the area is very likely to be affected by climate change, it should not impact the function of the Submarine Construction Yard.

Table E.1 Comparing climate projection data (1986-2005) against RCPs to understand potential climate outcomes in 2100

Climatic hazard	Intermediate scenario (RCP4.5)	Worst-case scenario (RCP 8.5)
Sea level	Sea level rise of up to +0.57 m by 2100 (SSP2-4.5)	Sea level rise of up to +0.73 m by 2100 (SSP5-8.5)
Temperature	Higher temperatures, with 27.5 days over 35°C by 2100	Higher temperatures, with 36.2 days over 35°C by 2100
Drought	Precipitation levels decrease by an average of 6.7 mm	Precipitation levels decrease by an average of 9.3mm
Extreme rainfall / flooding	Percentage change of extreme rainfall events increase by an average of 9.1%	Percentage change of extreme rainfall events increase by an average of 22.9%
Bushfire risk	Increase in bushfire risk to 2.9 severe fire danger days per annum by 2100	Increase in bushfire risk to 5.4 severe fire danger days per annum by 2100

The Protected Matters in the region are vulnerable to inundation from rising sea levels and erosion of coastal areas, shifts in species distributions, and exacerbation of habitat loss and fragmentation.

Document navigation

This report is an Appendix to the Biodiversity Values Report, which provides a review of the predicted climate conditions within the Strategic Assessment Area and the surrounding region. An assessment of the impact of the construction and operation of the Submarine Construction Yard on matters protected under the EPBC Act, is provided in the Strategic Impact Assessment Report.

Acronyms and Abbreviations

Acronym / abbreviation	Meaning
AR5	Assessment Report 5
AR6	Assessment Report 6
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
IPCC	Intergovernmental Panel on Climate Change
RCP	Representative Concentration Pathway
SSN	Submersible Ship Nuclear
SSP	Shared Socioeconomic Pathway

Glossary

Term or phrase	Meaning
Assessment Report 5	Assessment Report 5 (AR5) – the fifth assessment report on global climate science and projections released in released in 2014 by the International Panel on Climate Change.
Assessment Report 6	Assessment Report 6 (AR6) – the sixth assessment report on global climate science and projections released in released in 2021 by the International Panel on Climate Change.
AUKUS	Trilateral security partnership between Australia, the United Kingdom, and the United States of America.
Baseline climate trends	A specific time interval in the past against which current and future climate data are compared. This period is used as a reference point to measure and assess changes in climate variables, such as temperature, precipitation, sea level, and atmospheric concentrations of greenhouse gases.
Climate impact	A threat or an opportunity that may arise as a result of either the weather or climate change both in the short and long-term.
Climate projection	The simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases and aerosols, derived using climate models.
Climate variable	Commonly measured meteorological trends. For example, temperature, rainfall, wind, humidity.
Emissions scenario	Representative estimates of future emissions of greenhouse gases, aerosols, and other pollutants. Emissions scenarios are used in combination with climate models to produce future climate projections. See also Representative Concentration Pathways.
the Environment	Means 'environment' as defined in Section 528 of the EPBC Act. It includes: a. Ecosystems and their constituent parts including people and communities ('ecosystem' is defined in the EPBC Act as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functioning unit'); and b. Natural and physical resources; and c. The qualities and characteristics of locations, places and areas; and d. Heritage values of places ('heritage value' is defined in the EPBC Act as including 'the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians.' 'Indigenous heritage value' is defined as meaning 'a heritage value of the place that is of significance to Indigenous persons in accordance with their practices, observances, customs, traditions, beliefs or history'); and e. The social, economic and cultural aspects of a thing mentioned in paragraph a), b), c) or d).
Intergovernmental Panel on Climate Change (IPCC)	The United Nations body for assessing the science related to climate change.
Long-term timeframe	The year 2100, which refers to projections from the period between 2081-2100
Mid-term timeframe	The year 2050, which refers to projections from the period between 2041 and 2060
The Plan	The Strategic Assessment Plan which describes: – The Actions and Classes of Actions that are to be undertaken to construct and operate the Submarine Construction Yard in the Strategic Assessment Area. – The outcomes that will be achieved for Protected Matters, to which Actions proposed under The Plan relate, in accordance with the requirements of the EPBC Act.
Protected Matter	Means a matter protected by a provision of Part 3 of the EPBC Act. The specific matter protected by each provision is set out in Section 34 of the EPBC Act.
The Report	The Impact Assessment Report assesses the potential environmental impacts associated with the development of the Submarine Construction Yard, and includes: – A description of the environment to which Actions proposed under The Plan relate – An assessment of the potential impacts of implementing The Plan on Protected Matters – Details of how likely or potential impacts will be avoided, mitigated and offset (where necessary or appropriate) to make sure that Protected Matters are protected and managed in the long-term.

Term or phrase	Meaning
Representative Concentration Pathway (RCP)	An emissions scenario that includes concentrations of the full suite of greenhouse gases and land use over time. These are used as inputs to climate models.
Strategic Assessment Area	Means the area displayed within the Strategic Assessment Area in Attachment 1 of the Agreement.
Surrounding region	The Strategic Assessment Area is surrounded by a variety of natural and manmade infrastructure. It sits in the greater context of the Lefevre Peninsula in Adelaide, South Australia. – North: natural reserves and ecosystems line the coast. This includes the Adelaide International Bird Sanctuary National Park, and Torrens Island – South: The Osborne Naval Shipyard and residential areas – East: Torrens Island, Barker Inlet and St Kilda – West: industrial zoning, and Gulf St Vincent
Shared Socioeconomic Pathway (SSP)	An emissions scenario that describes possible future developments in society, economy, and environment. There are five shared socioeconomic pathways endorsed by the International Panel on Climate Change associated with five emissions scenarios that reflect ways in which the world may evolve with different climate policies (mitigation scenarios) in place.
Vulnerable	The propensity or predisposition to be adversely affected. The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.

Contents

Table index

Figure index

Appendices

1. Introduction

1.1 Overview

Australia, the United Kingdom, and the United States announced the AUKUS trilateral security partnership in September 2021. The AUKUS partners agreed to support Australia to construct conventionally-armed nuclear-powered submarines (known as 'submersible ship nuclear', or SSN) in South Australia. The conventionally-armed nuclear-powered submarines built under AUKUS will meet Australia's defence requirements in future decades.

The approach for Australia to develop a conventionally-armed nuclear-submarine capability (the 'Optimal Pathway') was announced on 13 March 2023. Under AUKUS, it is planned to build up to five conventionally-armed nuclear-powered submarines in Australia (to be known as SSN-AUKUS), by the early 2040s.

The preferred site for construction of SSN-AUKUS submarines (the 'Submarine Construction Yard') is located at Osborne on the Lefevre Peninsula, approximately 19 km north of Adelaide, in South Australia. The Submarine Construction Yard would be developed to contain a range of facilities in which the fabrication and manufacturing of submarine parts and components, as well as testing and commissioning of submarines, would occur (

Figure 1).

The Australian Submarine Agency and the Commonwealth Minister for the Environment and Water ('the Minister') entered into a Strategic Assessment Agreement in November 2023 (the 'Strategic Assessment Agreement'). This Section 146 agreement, made under Part 10 of the EPBC Act, sets out the content that is required for inclusion within the Strategic Assessment Plan for the construction and operation of the Submarine Construction Yard ('The Plan'), as well as the requirement to develop relevant Terms of Reference for a Strategic Impact Assessment Report ('The Report').

The area agreed to be designated as the 'Strategic Assessment Area', in which Actions and Classes of Actions outlined under the Plan can be endorsed and approved by the Minister, is shown in

Figure 1.

1.2 Purpose of this report

The purpose of this report is to provide a review of the predicted climate conditions within the Strategic Assessment Area and the surrounding region. The predicted climate conditions have been based upon two plausible, but conservative, future climate scenarios (RCP4.5 and RCP8.5). This report is designed to support The Report, and address the Terms of Reference relating to future climatic conditions, as summarised in Table 1-1.

Table 1-1 Terms of Reference from The Report

Terms of Reference clause	Section of Climate Review Report
5.6. The Report must detail the plausible future climatic conditions of the Strategic Assessment Area in the assessment of impacts on Protected Matters of implementing The Plan (where such data exists). This should include, but not be limited to:	
a) How changes in climate would affect the impacts of implementing the Plan on Protected Matters over time, and what (if any) effect this would have on the outcome for Protected Matters.	Section 4
b) Discussion of loss, fragmentation, or drying of potential climate refugia for threatened species or communities as a result of the proposed Plan – consider the potential impacts of removing or otherwise impacting this climate refugia for the long-term survival of the species in the region.	Section 4
c) Discussion of increased risk of fire as a result of The Plan under drier conditions and periods of extreme heat.	Section 3.2
d) Discussion of changes in the frequency and intensity of extreme weather events that may exacerbate impacts to Protected Matters within and downstream of the Strategic Assessment Area.	Section 3.2
e) Inclusion of different climate scenarios in any site water management modelling, including flooding, storm surge events and sea level rise.	Section 3.2 Section 3.2.1

STRATEGIC ASSESSMENT AREA

Legend

- Railway
- Strategic assessment area
- Marine area
- Onshore area

Australian Government
Australian Submarine Agency

GHD

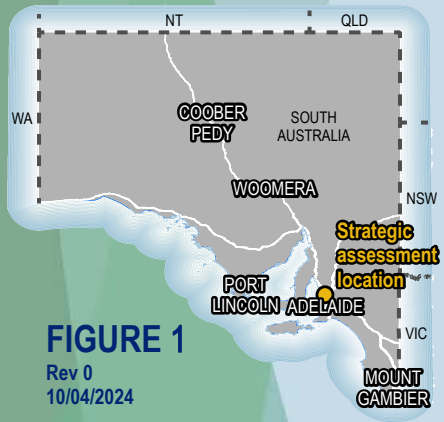


FIGURE 1
Rev 0
10/04/2024

0 150 300 450 600
Metres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

12621796_301_AssessmentAreasAgreement

Data source: GA - Roads, place names, rail, waterways, State boundaries (2015). GHD - Strategic assessment area (2023). nearmap.com:

1.3 Understanding uncertainties in climate projections

Uncertainties in predictive scenarios of future climate change stem from several sources, and pose challenges to the precise projection of future climate change.

There are typically three main sources of uncertainty in climate projections:

- **Natural climate variability**. This includes local variability in daily weather, seasonal climate, and climate differences over decades. This is the primary source of uncertainty over the next 10 years
- **How regional weather and climate respond to changing greenhouse gas and aerosols concentrations**. This information is derived from climate models, each of which provides a different simulation of future weather and climate at a given location
- **How greenhouse gas and aerosol concentrations may change in response to socio-economic change, technological change, energy transitions, and land use change**. This is the largest source of long-term uncertainty.

These uncertainties in projecting future climate variables also extend to more specific environmental metrics, such as sea level projections. In sea level projections, the likely sea level ranges are evaluated by considering uncertainties related to temperature changes associated with emissions scenarios. Uncertainties exist in the relationships between temperature and the factors driving projected sea level changes, including thermal expansion, ocean dynamics, and glacier and ice sheet loss (Fox-Kemper *et al.* 2021).

Because of the uncertainties inherent in projections of future climate, scenarios should be regarded as representations of a plausible future (what **may** happen in the future) and not as forecasts or predictions (what **will** happen in the future). Many forms of uncertainty exist in climate modelling, including uncertainty in future emission scenarios and within global climate models themselves.

2. Approach

2.1 Overview

This Climate Review Report includes a review of projected climate trends and is based on current practices from the International Panel on Climate Change (IPCC). It considers how the climate is expected to change over time and what the implications could be to Protected Matters within the Strategic Assessment Area and the surrounding region.

2.1.1 What is the IPCC?

The IPCC is an intergovernmental body of the United Nations. It focuses on furthering the scientific understanding on how climate change is influenced by human activities. The IPCC releases reports outlining global climate projections, climate change impacts and future risks (IPCC 2014). The Fifth Assessment Report (AR5) included four scenarios for global climate projections, each a different interpretation of how the world may respond to the challenge of a changing climate, the need to continue to produce and use energy and resources, and the global greenhouse gas emissions that may occur given alternative economic, globalisation and environmental pathways (IPCC 2014). These factors are named as 'Representative Concentration Pathways' (RCPs) in AR5, and other subsequent reports. A high RCP represents future climate conditions, if a small amount of effort was made to reduce emissions; and a low RCP represents future climate conditions, if a significant amount of effort was made to reduce emissions, and have a generally less severe outcome.

It should be noted that the IPCC released the Sixth Assessment Report (AR6) in 2021, to provide an overview of the state of knowledge on the science of climate change and updated data since the publication of AR5; however, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BOM) climate projection data has not yet been updated to reflect AR6 (Lee et al. 2021).

2.2 Climate parameters

2.2.1 Timeframe

Climate models provide an output of potential future climate states over several timeframes. To reduce variation in the models' data outputs, timeframes are commonly presented as an average over a 20-year period; for example 2050 which encompasses 2041-2060, and 2100 which encompasses 2081-2100.

The timeframes selected for this climate review are:

– Mid-term timeframe of 2050
– Long-term timeframe of 2100.

These timeframes are considered to be appropriate, as the Submarine Construction Yard is proposed to be operational by the mid-term timeframe, with the infrastructure anticipated to remain in place beyond the long-term timeframe.

2.2.2 Climate scenarios

This Climate Review Report has utilised climate scenarios from two different pathways from the IPCC's Fifth and Sixth Assessment Reports. Representative Concentration Pathways (RCPs) provide plausible descriptions for potential future climate states, whereas Shared Socioeconomic Pathways (SSPs) further refine the RCP emission scenarios; referring to scenarios in the context of potential future developments in society, economy, and the environment.

RCP 8.5 is often recommended for climate projection assessments to account for a worst-case, but plausible, scenario (Schwalm *et al.* 2020); and ensures that our analysis considers the upper bounds of potential climatic conditions. RCP 4.5 provides a comparison to this worst-case scenario; representing a stabilisation of greenhouse gas concentrations by 2100, if moderate global action is taken towards mitigating greenhouse gas emissions (Climate Change in Australia 2019).

The two RCPs comply with the Terms of Reference for this assessment. Details of each climate scenario are provided in Table 2-1.

Table 2-1 Details of climate scenarios

Scenario	IPCC report	Purpose	Assessment / description
RCP4.5	Assessment Report 5	Including both RCP scenarios allows a conservative assessment of how climatic conditions might impact the execution of The Plan on Protected Matters and assess the potential outcomes under different climate futures.	Assumes a stabilisation scenario where global emissions peak around 2040 and then decline.
RCP8.5			Represents a high-emission pathway where emissions continue to rise throughout the 21st century.
SPP5-8.5	Assessment Report 6	SPP scenarios were used to provide different climate projections for water management modelling that might affect the impacts of implanting The Plan on Protected Matters. This includes projected sea-level rise scenarios for the Strategic Assessment Area and surrounding region.	Society prioritises rapid and unconstrained growth in economic output and energy use.
SPP2-4.5			Represents a more stable scenario where development and emissions levels continue throughout the 21st century.

3. Climate change projections

3.1 Baseline climate trends – 1986 to 2005

Weather data from the period between 1986 to 2005 (BOM 2024) was obtained from the Bureau of Meteorology Parafield Airport (Station number 023013) and Torrens Island (Station number 023018) weather stations for the following parameters:

– 9 am and 3 pm wind data
– Rainfall
– Minimum and maximum daily temperature
– Prevailing wind and other wind data

The data was reviewed and used as the basis for the baseline data for the Strategic Assessment Area, typical trends for this period are summarised in Figure 2.The baseline weather data is provided in Appendix A.

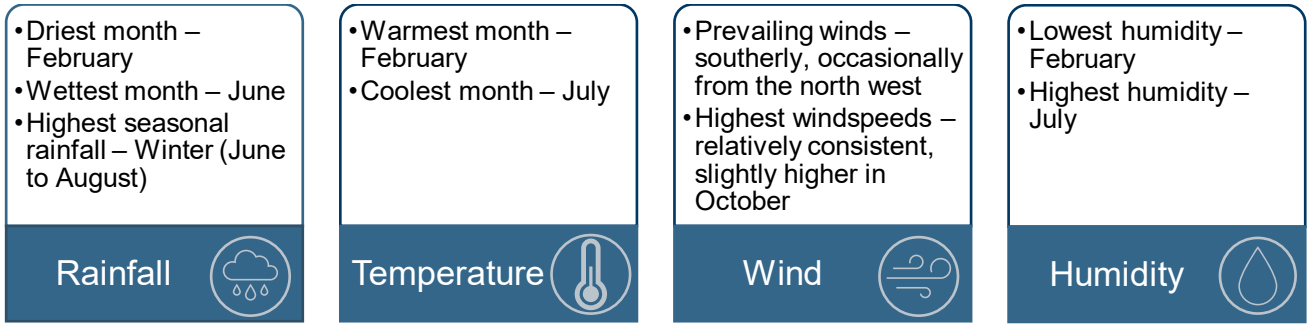


Figure 2 Baseline climate trends – Adelaide

3.2 Projected climate change trends – 2050 and 2100

Projected climate change trends for the Adelaide region under the RCP4.5 and RCP 8.5 scenarios are summarised below.

1. Sea level: Continued increase in sea level is projected for the Adelaide region.
2. Extreme temperature: By 2050, the Adelaide region is expected to experience warmer temperatures across all seasons. Spring is projected to experience the greatest warming.
3. Rainfall: Rainfall is projected to decline, especially in spring. This rainfall decline may lead to more prolonged drought periods. Despite a predicted overall decline in rainfall, the intensity of rainfall during extreme weather events is projected to increase.
4. Drought: The Strategic Assessment Area and surrounding region is likely to continue to get drier in the future.
5. Bushfires: The frequency of hot days (days over 35°C and 40°C) and heatwaves is expected to increase. This will increase harsher bushfire risk to the surrounding region. Frosts are projected to decrease over time.

The climate projection data under RCP4.5 and RCP8.5 scenarios for the Strategic Assessment Area are detailed in Appendix A.

3.2.1 Projected sea level rise

Indicative sea level rise under the RCP4.5 scenario for the Strategic Assessment Area and surrounding region is shown in Figure 3. The mapping shows the projected inundation of 0.21 m (shaded in light blue) for the 2050 timeframe, and 0.57 m (shaded in dark blue) for the 2100 timeframe.

Figure 4 shows the indicative sea level rise under the RCP8.5 emission scenario. The mapping shows the projected inundation of 0.23 m (shaded in light blue) for the 2050 timeframe and 0.73 m (shaded in dark blue) for the 2100 timeframe.

3.2.2 Extreme temperatures and heatwaves

Climate modelling for the Strategic Assessment Area and surrounding region suggests that the climate will continues to warm, with maximum and minimum temperatures increases over this century. In the long-term higher temperatures will tend to prevent frost leading to a decrease in their occurrence.

Under scenario RCP4.5, by 2050, average temperatures in the region are projected to increase between 0.8°C and 1.6°C when compared with to 1986-2005, by 2100 the increase may be between 1.1°C and 2.2°C. The increase in average temperatures also translates to an increase in extreme temperatures and more frequent hot days (days of over 35°C and 40°C), average hot days could increase by 25 days over 35°C and 6.5 days over 40°C by 2050 and increase to 27.5 days over 35°C and 7.5 days over 40°C by 2100. In the long-term higher temperatures will tend to prevent frost leading to a decrease in their occurrence.

Under scenario RCP8.5, by 2050, average temperatures in the region are projected to increase between 1.2°C and 2°C when compared to 1986-2005, by 2100 the increase may be between 2.6°C and 4.1°C. The increase in average temperatures also translates to an increase in extreme temperatures and more frequent hot days (days of over 35°C and 40°C), average hot days could increase by 26.8 and 7.4 days by 2050 and increase to 36.2 and 12.9 days by 2100.

Climate extremes are rare events, so accurately determining their current and future frequency and intensity is difficult and highly dependent on having a long record of climate observations.

Urban heat Island effect

Annual average temperatures in South Australia are increasing and so are the number and duration of extreme hot weather events. Higher temperatures are observed in large cities than compared to rural areas. The severity of heat experienced in cities during hot weather varies across the urban landscape. Areas with hard surface such as bitumen and concrete which absorb more heat compared to vegetated areas or parklands. This phenomenon is called the urban heat island effect (Seed Consulting Services 2017).

The South Australia's trend and condition report card for 2023 states that urban heat intensity in metropolitan Adelaide has increased by 0.2°C between 2014 and 2023 (Government of South Australia 2023a). There is significant variation within Local Government Areas, showing localised areas of warming and cooling between 2014 and 2023 (Figure 5). The Strategic Assessment Area is located with the Port Adelaide Enfield Local Government Area and depicts an increase of 0.5-1°C between 2014 and 2023 (Government of South Australia 2023b).The greatest warming occurred in Local Government Areas of Campbelltown and Norwood (Government of South Australia 2023a).

The Strategic Assessment Area is located in an industrial zone with extensive land use, resulting in an increase in hard surfaces when compared to rural South Australia. The construction of the Submarine Construction Yard is expected to lead to an expansion of hard surface areas within the Strategic Assessment Area. These hard surfaces include roads, pavements and carparks. Temperatures in the region are likely to increase as described in Section 3.2.2.

3.2.3 Extreme rainfall/flooding

While the Strategic Assessment Area and surrounding region is projected to likely receive less overall total rainfall in the future, extreme rainfall events and flash flooding events are projected to increase. By 2050 the percentage change of extreme rainfall events in projected to increase by an average of 11.8% under RCP4.5 and 7.2% under RCP8.5, when compared with 1986-2005.

By 2100 the percentage change of extreme rainfall events is projected to increase by an average of 9.1% under RCP4.5 and 22.9% under RCP8.5.

3.2.4 Drought

The Strategic Assessment Area and surrounding region is likely to continue to get drier in the future. The mid-term 2050 projections suggest that rainfall is projected to continue to decline under both RCP4.5 and RCP8.5 scenarios when compared with 1986-2005. Precipitation levels are projected to decrease by an average of 4.2 mm under RCP4.5 and 5.9 mm under RCP8.5.

By 2100 precipitation levels are projected to decrease even further, precipitation levels are projected to decrease by an average of 6.7 mm under RCP4.5 and 9.3 mm under RCP8.5.

3.2.5 Bushfires

The number of high fire danger days (bushfire days) in the region surrounding the Strategic Assessment Area is expected to increase in the future. By 2050 under RCP4.5 the surrounding region is likely to observe an increase in bushfire days by 1.9 to 3.5 days. Under RCP8.5 bushfire days will increase by 1.9 to 2.3 days, when compared with 1986-2005.

By 2100 under RCP4.5 bushfire days are likely to increase by 2.2 to 2.9 days and 2.3 to 5.4 days under RCP8.5. Figure 6 depicts the risk rating for properties as indicated by the South Australian Planning and Design Code and the Country Fire Service South Australia (Government of South Australia 2024, Country Fire Service South Australia 2024). As noted, the Strategic Assessment Area and surrounding suburbs is graded as low risk (safer place, shaded in pink) from bushfires.

INDICATIVE SEA-LEVEL RISE SCENARIO (2050, 2100) (SSP2-4.5)

Legend

- Railway
- Strategic assessment area
- Moderate (SSP2-4.5) sea-level rise scenario - 2050
- Moderate (SSP2-4.5) sea-level rise scenario - 2100

Australian Government
Australian Submarine Agency

GHD

FIGURE 3
Rev 0
6/11/2024

0 150 300 450 600
Metres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

12621796_304_SeaLevelRise2_45

Gulf St Vincent
Torrens Island Conservation Park
Port Adelaide River
Pelican Point
Power Stations
Container Terminal
Grain Terminal
Snapper Point
Lefevre Peninsula
Pelican Point Road
Mutton Cove
Falie Reserve
Oliver Rogers Road
North Haven Golf Course
Biodiversity Park
Victoria Road
Power Station
Lady Ruthven Drive
Port Adelaide
Osborne Naval Shipyard
North Haven Marina
Osborne Road

Data source: GA - Roads, place names, rail, waterways, State boundaries (2015). GHD - Strategic assessment area (2023). NASA/GHD - Indicative sea-levels rises (2024) nearmap.com

INDICATIVE SEA-LEVEL RISE SCENARIO (2050, 2100) (SSP5-8.5)

Legend

- Railway
- Strategic assessment area
- Moderate (SSP5-8.5) sea-level rise scenario - 2050
- Moderate (SSP5-8.5) sea-level rise scenario - 2100

Australian Government
Australian Submarine Agency

GHD

FIGURE 4
Rev 0
6/11/2024

0 150 300 450 600
Metres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

12621796_305_SeaLevelRise5_85

Gulf St Vincent
Torrens Island Conservation Park
Port Adelaide River
Pelican Point
Power Stations
Container Terminal
Grain Terminal
Snapper Point
Lefevre Peninsula
Mutton Cove
Pelican Point Road
Falie Reserve
Oliver Rogers Road
North Haven Golf Course
Biodiversity Park
Victoria Road
Power Station
Lady Ruthven Drive
Port Adelaide
Osborne Naval Shipyard
North Haven Marina
Osborne Road

TREND RESULTS SHOWING CHANGE IN URBAN HEAT INTENSITY (FROM 1 JANUARY 2014 TO 1 JANUARY 2023) FOR EACH LGA

Legend

- Strategic assessment area
- Local Government Area

Change in heat intensity

- 1.0 - 1.5 ^{0}C decrease
- 0.5 - 1.0 ^{0}C decrease
- 0.0 - 0.5 ^{0}C decrease
- No change
- 0.0 - 0.5 ^{0}C increase
- 0.5 - 1.0 ^{0}C increase
- 1.0 - 1.5 ^{0}C increase
- 1.5 - 2.0 ^{0}C increase

Australian Government
Australian Submarine Agency

GHD

FIGURE 5
Rev 0
30/08/2024

0 2.5 5 7.5 10
Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

12621796_302_UrbanHeatMapping

TWO WELLS
GAWLER
LYNDOCH
TOWN OF GAWLER
ANGLE VALE
VIRGINIA
CITY OF PLAYFORD
WILLIAMSTOWN
SPRINGTON
MOUNT PLEASANT
CITY OF SALISBURY
CITY OF TEA TREE GULLY
KERSBROOK
Gulf St Vincent
CITY OF PORT ADELAIDE ENFIELD
HOUGHTON
GUMERACHA
BIRDWOOD
CAMPBELLTOWN CITY COUNCIL
MOUNT TORRENS
CITY OF CHARLES STURT
THE CORPORATION OF THE TOWN OF WALKERVILLE
LOBETHAL
THE CITY OF NORWOOD PAYNEHAM AND ST PETERS
CITY OF PROSPECT
CITY OF WEST TORRENS
ADELAIDE
WOODSIDE
CITY OF BURNSIDE
CITY OF HOLDFAST BAY
CITY OF UNLEY
OAKBANK
CITY OF MITCHAM
STIRLING
HAHNDORF
NAIRNE
CITY OF MARION
ECHUNGA
CALLINGTON
MACCLESFIELD
CITY OF ONKAPARINGA
MEADOWS
MASLIN BEACH
MCLAREN VALE
STRATHALBYN
WILLUNGA
ALDINGA BEACH
SELLICKS BEACH
MOUNT COMPASS

Data source: GA - Roads, place names, State boundaries (2015). DE - Heat Intensity (2023). GHD - Strategic assessment area (2023). World Imagery: Earthstar

BUSHFIRE RISK FOR THE STRATEGIC ASSESSMENT AREA

Legend

- Railway
- Strategic assessment area
- Bushfire - General
- Bushfire - Urban Interface
- Bushfire - Safer Places

Australian Government
Australian Submarine Agency

GHD

FIGURE 6
Rev 0
27/08/2024

0 0.5 1 1.5 2
Kilometres

N

Map Projection: Transverse Mercator
Horizontal Datum: GDA2020
Grid: GDA2020 MGA Zone 54

12621796_303_BushfireMapping

Bolivar
St Kilda
Port Adelaide River
Outer Harbor
Yerlo
North Haven
Lefevre Peninsula
Midlunga
Taperoo
Draper

4. Protected Matters vulnerable to climate impacts

Based upon the projected climate change impacts described in Section 3.2, Protected Matters in and around the Strategic Assessment Area are vulnerable from the following climate change-related hazards and extreme weather events:

- Sea level rise
- Extreme temperatures and heatwaves
- Severe storms (including lightning strike)
- Extreme rainfall/flood
- Drought and earth movement
- Bushfire.

Table 4-1 outlines the Protected Matters within the Strategic Assessment Area and surrounding region that are more vulnerable to climate change impacts. A summary of the potential climate impacts on Protected Matters within the Strategic Assessment Area and surrounding region are summarised in Table 4-2.

Table 4-1 Protected Matters summary

Protected Matter	Description
Listed threatened species	The Strategic Assessment Area contains areas of habitat suitable for listed threatened species. Observations from field surveys conducted within in the Strategic Assessment Area (**Chapter 5 of The Impact Assessment Report**) included: – Three EPBC Act listed threatened species Habitat types included low open shrubland, tidal flats, seagrass meadows, mangrove shrubland and constructed wetlands.
Migratory species	The Strategic Assessment Area contains areas of habitat suitable for migratory species. Observations from migratory shorebird surveys conducted within the Strategic Assessment Area (**Chapter 5 of The Impact Assessment Report)** included: – Seven EPBC Act listed migratory species Habitat types included tidal flats and constructed wetlands.
The environment	Climate change impacts have the potential to affect environmental, social and economic values within the Strategic Assessment Area. Factors of the environment have been grouped into the following: – Physical environment – Biological environment – Social environment. Further detail on these environmental factors is described in **Chapter 5 of The Impact Assessment Report**.

Table 4-2 Potential climate impacts on Protected Matters within the Strategic Assessment Area

Climate impact	Protected Matter		
	Threatened species	Migratory species	The environment
Sea level rise	– **Loss** of intertidal feeding habitat for birds due to inundation, affecting shorebird populations – Habitat fragmentation and loss of potential climate refugia	– **Loss** of intertidal feeding habitat for birds due to inundation, affecting shorebird populations and their migratory patterns – Habitat fragmentation and loss of potential climate refugia	– Increase in erosion and flooding of important foreshore areas and affect water quality as salt water is pushed further upstream into freshwater ecosystems – Increase in damage costs to infrastructure – Habitat fragmentation and loss of potential climate refugia
Extreme temperature	– Increased risk of mortality – Habitat fragmentation and loss of potential climate refugia – Disruption of food cycle	– Increased risk of mortality. Change in migratory patterns – Habitat fragmentation and loss of potential climate refugia – Disruption of food cycle	– Increasing temperatures lead to increased health risks, especially in vulnerable populations, including heat stress and heat-related illnesses resulting in ill-health and or death.
Extreme rainfall / flooding	– Flooding from extreme rainfall events disrupts nesting sites and reduces food availability leading to loss of population	– Flooding from extreme rainfall events disrupts nesting sites and reduces food availability leading to loss of population	– Increase in damage costs to infrastructure – Temporary decrease in water quality – Disturbance to vulnerable habitats
Drought	– Drought may lead to the drying of wetlands and mudflats causing habitat fragmentation and loss of critical feeding and breeding areas reducing the population of threatened species.	– Drought may lead to the drying of wetlands and mudflats causing habitat fragmentation and loss of critical feeding and resting areas, reducing the population of migratory species.	– Decrease in water supply due to drought conditions leads to economic hardships – Drying of potential climate refugia – Disruption of food cycle
Bushfire	– Increased risk of mortality – Loss of potential climate refugia	– Increased risk of mortality – Loss of potential climate refugia	– Decrease in air quality – Loss of potential climate refugia – Increased risk of mortality – Increase in damage costs to infrastructure – Long term disturbance to soil and water quality

5. References

Bureau of Meteorology (BOM) (2024). Weather station (WS) Parafield Airport 023013 and WS Torrens Island 023018 for both 9am and 3pm wind data, rainfall, and minimum and maximum daily temperature data. WS Parafield Airport 023013 for 9am and 3pm relative humidity and WS Torrens Island 023018 for daily solar data. For wind gusts, WS Parafield Airport 023013, WS RAAF Edinburgh 023083, and WS Adelaide Airport 023034 were integrated.

Commonwealth Science Industrial Research Organisation (CSIRO) (2019) *ESCI Climate Risk Assessment Framework: User Guide*, Step 3: Analyse future climate risk – quantified scenarios [Online]. Electricity Sector Climate Information Project. Available from: https://www.climatechangeinaustralia.gov.au/media/ccia/2.2/cms_page_media/687/ESCI_User_Guide_Pt4a_Step_3_1.pdf (Accessed June 2024).

Country Fire Service South Australia (CFS SA) (2024). Bushfire safer places [Online]. Available from: https://www.cfs.sa.gov.au/plan-prepare/before-a-fire-be-prepared/bushfire-safer-places/ (Accessed May 2024).

Commonwealth Science Industrial Research Organisation (CSIRO) (2015a). Extremes Data Explorer: Southern and South-Western Flatlands (East) Sub-Cluster Projections. Climate Change in Australia.

Commonwealth Science Industrial Research Organisation (CSIRO) (2015b). Projections Cluster Report: Southern and South-Western Flatlands, Appendix Table 1, p 50. Climate Change in Australia.

Commonwealth Science Industrial Research Organisation (CSIRO) (2015c). Projections Cluster Report: Southern and South-Western Flatlands, Appendix Table 2. Climate Change in Australia.

Commonwealth Science Industrial Research Organisation (CSIRO) (2015d). Projections Cluster Report: Southern and South-Western Flatlands, Figure 4.5.2, p 31. Climate Change in Australia.

Commonwealth Science Industrial Research Organisation (CSIRO) (2015e). Projections Cluster Report: Southern and South-Western Flatlands, Appendix Table 3. Climate Change in Australia.

Commonwealth Science Industrial Research Organisation (CSIRO) (2015f). Summary Data Explorer: Southern and SW Flatlands (East) Sub-Cluster Projections. Climate Change in Australia.

Department for Trade and Investment (DTI) (2022). Bushfire regulations [Online]. Government of South Australia. Available from: https://www.sa.gov.au/topics/business-and-trade/building-industry/building-rules-regulations-and-information/bushfire (Accessed May 2024).

Department for Environment and Water (DEW) (2023a). Tracking changes in South Australia's environment: 51 trend and condition report cards [Online]. Government of South Australia. Available from: https://data.environment.sa.gov.au/Content/Publications/SA_2023_ReportCards_FullReport.pdf (Accessed May 2024).

Department for Environment and Water (2023b). Technical information supporting the 2023 Urban heat environmental trend and condition report card, DEW Technical report 2023/57 [Online]. Government of South Australia, Department for Environment and Water, Adelaide. Available from: https://data.environment.sa.gov.au/Content/Publications/RC2023_TechReport_LIV_UR_UrbanHeat.pdf (Accessed July 2024).

Fox-Kemper, B., Hewitt, H.T., Xiao, C., Aðalgeirsdóttir, G., Drijfhout, S.S., Edwards, T.L. & Yu, Y. (2021). Ocean, Cryosphere and Sea Level Change. In Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Zhou, B. (Eds.) (2021): The Physical Science Basis. *Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, pp 1211–1362. Cambridge University Press. Available from: https://doi.org/10.1017/9781009157896.011 (Accessed May 2024).

Intergovernmental Panel on Climate Change (IPCC) (2014). Climate Change: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 151.

Lee, J.-Y., J. Marotzke, G. Bala, L. Cao, S. Corti, J.P. Dunne, F. Engelbrecht, E. Fischer, J.C. Fyfe, C. Jones, A. Maycock, J. Mutemi, O. Ndiaye, S. Panickal, and T. Zhou (2021). Future Global Climate: Scenario-Based Projections and Near-Term Information. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 553–672, Doi: 10.1017/9781009157896.006.

Schwalm, C. R., Glendon, S., & Duffy, P. B (2020). RCP8. 5 tracks cumulative CO_2 emissions. Proceedings of the National Academy of Sciences, 117(33), 19656-19657.

Seed Consulting Services (2017). Western Adelaide Urban Heat Mapping Project Report. Cities of West Torrens, Charles Sturt, and Port Adelaide Enfield, and the Adelaide Mount Lofty Ranges Natural Resources Management Board.

Appendices

Appendix A

Climate projection data

Table 1 Climate projection data for the Strategic Assessment Area and surrounding region under RCP 8.5 (2050 and 2090-2100)

Variable		Current climate		Climate change projections			
	Climate variable	Annual historical trend Parafield Airport (023013) and Torrens Island (023018) (from site)	Baseline period	General trend	Mid-century, very high scenario 2050, RCP 8.5	Late century, very high scenario 2090, RCP 8.5	Source
Temperature	Mean maximum daily temperature (°C) - Annual	22.6	1986 to 2005	↑	+1.5°C (1.2 to 2) i.e. 24.1°C (23.8 to 24.6)	+3.3°C (2.6 to 4.1) i.e. 26°C (25.2 to 26.7)	2,7
	Days p.a. over 35 °C	19.4	1986 to 2005	↑	26.8 days	36.2 days	2,7
	Days p.a. over 40 °C	3.9	1986 to 2005	↑	7.4 days	12.9 days	2,7
Rainfall	Mean Rainfall (mm) - Annual	446.5	1986 to 2005	↑↓ Seasonal variation	-5.9% (-17.8 to 4.4) i.e. 420 mm (367.2 to 466.3)	-9.3% (-36.9 to 5.8) i.e. 404.8 mm (281.5 to 472.5)	2,7
	Mean Rainfall (mm) - Spring (SON)	117.6	1986 to 2005	↓	-7.6% (-34.9 to 14.2) i.e. 108.7 mm (76.6 to 134.4)	-18.9% (-49.9 to 8.5) i.e. 95.5 mm (59 to 127.6)	2,7
	Mean Rainfall (mm) - Summer (DJF)	62.6	1986 to 2005	↓	-5.8% (-22.8 to 16.6) i.e. 59 mm (48.3 to 73)	-3.3% (-26 to 22.3) i.e. 60.6 mm (46.4 to 76.6)	2,7
	Mean Rainfall (mm) - Autumn (MAM)	90.1	1986 to 2005	↑	+0.3% (-22.7 to 18.1) i.e. 90.4 mm (69.7 to 106.5)	+1.7% (-33.3 to 33.1) i.e. 91.7 mm (60.1 to 120)	2,7
	Mean Rainfall (mm) - Winter (JJA)	176.1	1986 to 2005	↓	-9.2% (-19.3 to 4.3) i.e. 159.8 mm (142.1 to 183.7)	-19.1% (-42.8 to -2.6) i.e. 142.5 mm (100.8 to 171.5)	2,7
	Maximum 1 day rainfall for a 20 year ARI event	n/a	n/a	↑	+7.2% (-10.5 to 34.5)	+22.9% (-2.8 to 42)	3
Extreme events	Severe fire danger days per year	1.7	1981-2010	↑	1.9 to 2.3 days	2.3 to 5.4 days	4
Sea conditions	Sea level rise (m)	n/a	1986-2005	↑	+0.22 m (0.18 to 0.31)	+0.73 m (0.56 to 1.00)	NASA AR6

Table 2 Climate projection data for the Strategic Assessment Area and surrounding region under RCP 4.5 (2050 and 2090-2100)

Variable		Current climate		Climate change projections			
Climate variable		Annual historical trend Parafield Airport (023013) and Torrens Island (023018) (from site)	Baseline period	General trend	Mid century, moderate scenario 2050, RCP 4.5	Late century, moderate scenario 2090, RCP 4.5	Source
Temperature	Mean maximum daily temperature (°C) - Annual	22.6	1986 to 2005	↑	+1.2°C (0.8 to 1.5) i.e. 23.8°C (23.4 to 24.2)	+1.7°C (1.1 to 2.2) i.e. 24.3°C (23.7 to 24.8)	2,7
	Days p.a. over 35 °C	19.4	1986 to 2005	↑	25 days	27.5 days	2,7
	Days p.a. over 40 °C	3.9	1986 to 2005	↑	6.5 days	7.5 days	2,7
Rainfall	Mean Rainfall (mm) - Annual	446.5	1986 to 2005	↓	-4.2% (-16.8 to 2.4) i.e. 427.9 mm (371.7 to 457.3)	-6.7% (-18.3 to 2.6) i.e. 416.8 mm (364.8 to 458)	2,7
	Mean Rainfall (mm) - Spring (SON)	117.6	1986 to 2005	↓	-6.4% (-23.1 to 4.9) i.e. 110.1 mm (90.5 to 123.4)	-13.6% (-26.3 to 2.9) i.e. 101.7 mm (86.7 to 121)	2,7
	Mean Rainfall (mm) - Summer (DJF)	62.6	1986 to 2005	↓	-2% (-18.7 to 16) i.e. 61.3 mm (50.9 to 72.6)	-2.7% (-19.6 to 13.3) i.e. 60.9 mm (50.3 to 71)	2,7
	Mean Rainfall (mm) - Autumn (MAM)	90.1	1986 to 2005	↓	-1.4% (-20 to 23) i.e. 88.9 mm (72.1 to 110.8)	-1.8% (-26.4 to 16.5) i.e. 88.5 mm (66.4 to 105)	2,7
	Mean Rainfall (mm) - Winter (JJA)	176.1	1986 to 2005	↓	-9.4% (-18.9 to 3.4) i.e. 159.5 mm (142.8 to 182.1)	-9.4% (-24 to 2.2) i.e. 159.6 mm (133.9 to 180)	2,7
	Maximum 1 day rainfall for a 20 year ARI event	n/a	n/a	↑	+11.8% (-7.3 to 22)	+9.1% (-4.4 to 39.3)	3
Extreme events	Severe fire danger days per year	1.7	1981-2010	↑	1.9 to 3.5 days	2.2 to 2.9 days	4
Sea conditions	Sea level rise (m) (2100 not 2090)	n/a	1986-2005	↑	+0.22 m (0.18 to 0.31)	+0.73 m (0.56 to 1.00)	NASA AR6

Source references:
1. CSIRO BOM (2015). Climate Change in Australia Projections Cluster Report - Southern and South-Western Flatlands, Appendix Table 1, pg 50 SSWF East (2050 projection not available, 2030 scenario used in place)
2. CSIRO BOM (2015). Climate Change in Australia Summary Data Explorer, Southern and SW Flatlands (East) Sub-Cluster Projections
3. CSIRO BOM (2015). Climate Change in Australia Extremes Data Explorer, Southern and SW Flatlands (East) Sub-Cluster Projections
4. CSIRO BOM (2015). Climate Change in Australia Projections Cluster Report - Southern and South-Western Flatlands, Appendix Table 2, Adelaide (SSWFE) Station - Projections and baseline (2050 projection not available, 2030 scenario used in place)
5. CSIRO BOM (2015). Climate Change in Australia Projections Cluster Report - Southern and South-Western Flatlands, Figure 4.5.2 , pg 31 (2050 projection not available, 2090 scenario used in place)
6. CSIRO BOM (2015). Climate Change in Australia Projections Cluster Report - Southern and South-Western Flatlands, Appendix Table 3, Port Adelaide Projections, (2050 projection not available, 2030 scenario used in place)
7. Bureau of Meteorology. (2024). (1986-2005) Weather station (WS) Parafield Airport 023013 and WS Torrens Island 023018 for both 9am and 3pm wind data, rainfall, and minimum and maximum daily temperature data. WS Parafield Airport 023013 for 9am and 3pm relative humidity and WS Torrens Island 023018 for daily solar data.

Australian Government

Australian Submarine Agency

ASA

www.asa.gov.au