Project Name: @ type here

Climate Change and Natural Hazards Risk Assessment

June 2024

* Square brackets = Guidance for completing this form. Delete as required.
* @ = project specific information input required.
* Delete this table when document finalised.

Document Control

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| Branch |  |
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Endorsement and Approval

**Sponsor**

I agree to the project proceeding as proposed in this document.

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Contents

[Document Control i](#_Toc168570636)

[Version history i](#_Toc168570637)

[Endorsement and Approval i](#_Toc168570638)

[Glossary iii](#_Toc168570639)

[1 Introduction 1](#_Toc168570640)

[1.1 Background 1](#_Toc168570641)

[1.1.1 Climate risk workshop or process 1](#_Toc168570642)

[2 Climate change projections 1](#_Toc168570643)

[2.1 Projected climate future 1](#_Toc168570644)

[2.2 Climate modelling 2](#_Toc168570645)

[2.2.1 Representative Concentration Pathways 2](#_Toc168570646)

[2.2.2 Timescales 2](#_Toc168570647)

[2.3 Climate change projections 3](#_Toc168570648)

[3 Potential Likelihood 4](#_Toc168570649)

[4 Potential climate change and natural hazards consequences 4](#_Toc168570650)

[4.1 Sea level rise and coastal inundation 4](#_Toc168570651)

[4.2 Mean temperature 4](#_Toc168570652)

[4.3 Extreme temperature and heatwaves 5](#_Toc168570653)

[4.4 Mean rainfall and drought 5](#_Toc168570654)

[4.5 Extreme rainfall and flooding 5](#_Toc168570655)

[4.6 Bushfire weather 6](#_Toc168570656)

[4.7 Extreme storms (including wind, lightning and hail) 6](#_Toc168570657)

[4.8 Water shortages 6](#_Toc168570658)

[4.9 Natural hazard consequences 7](#_Toc168570659)

[4.10 Electricity supply disruptions 7](#_Toc168570660)

[5 Climate Change and Natural Hazards Risks 7](#_Toc168570661)

[6 Network considerations 9](#_Toc168570662)

[7 Project Treatment and Residual Risk Assessment 9](#_Toc168570663)

[8 Conclusions 12](#_Toc168570664)

# Glossary

| Terms, abbreviations and acronyms | Meaning |
| --- | --- |
| BoM | Bureau of Meteorology |
| CCNHRA | Climate Change and Natural Hazard Risk Assessment |
| Climate Change Adaptation | The planning, design and construction (including retrofitting) of infrastructure and services in order to avoid failure or impact from the weather. |
| Climate Change Mitigation | The actions taken to avoid or reduce release of greenhouse gas emissions including reduction of carbon footprint of construction materials. |
| Climate hazard | The potential occurrence of a [climate-related] natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. |
| Climate variable | A variable that contributes to the characterization of Earth’s climate e.g., sea level, temperature, wind, precipitation.  |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation  |
| Design Rating | An Infrastructure Sustainability rating type assessed at the end of detailed design (as applicable to the Contract). Assessed based on the inclusion of design elements and construction requirements for sustainability in the project documentation. |
| Infrastructure Sustainability (IS) | Infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes over the long term. |
| Infrastructure Sustainability Accredited Professional (ISAP) | A person who has completed the ISCA Infrastructure Sustainability for Professionals training and successfully passed the examination. |
| ISC | Infrastructure Sustainability Council  |
| Natural hazard | The potential occurrence of a natural event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. Natural hazards include extreme events arising from heatwaves, bushfires, droughts, cyclones, severe storms, flooding, etc. |
| Physical risk | The physical consequence and outcomes on infrastructure and communities resulting from climate hazards, including direct damage to assets and networks, impacts to livelihoods and wellbeing, or liability due to failure to foresee and mitigate losses from any physical risks. |
| RCP (Representative Concentration Pathways) | The predicted concentrations of CO2 in the atmosphere over the 21st century depending on different levels of global action to reduce greenhouse gas emissions. |
| Resilience | The planning, design, management or construction of infrastructure and/or services to plan for failures to ensure services are not interrupted or are able to be quickly re-established following failure (planning for failure). |
| Shocks | Large-scale high-impact events and catastrophes such as human-made and natural disasters. Examples of shocks include cyber-attack; digital network failure; terrorist attack; war and conflict, collapse of financial systems; natural disasters such as earthquakes and floods; widespread pandemics; and diseases. |
| SSP (Shared Socioeconomic Pathway) |  The SSPs represent pathways of various hypothetical global socio-economic and political futures that result in various outcomes in the physical state of the climate. |
| Stresses | Often defined as the underlying ‘slow burn’ issues that have the potential to exacerbate a shock. Examples of stresses in the context of infrastructure may include social cohesion; housing affordability; access to transport; increased energy costs; and ageing population. |
| Transition risk | Uncertainties driven by policy, legal, technological or market changes that influence supply and demand, customer expectations and reputation, as global and local systems transition to a low carbon economy. |
| Treatment options | Treatment measures associated with climate and natural hazard risks can include:* Structural measures, such as physical changes to the infrastructure to achieve or facilitate adaptation
* Non-structural’ measures, such as changes to maintenance contracts or the implementation of an emergency management plan. Treatment can be undertaken immediately, or at timescales when the risk occurs.
 |

# Introduction

## Background

This document provides the Climate Change and Natural Hazards Risk Assessment for Click or tap here to enter text Project.

The Climate Change and Natural Hazards Risk Assessment has been undertaken in accordance with the engineering policy EP170 Climate Change and Natural Hazards Risk Assessment and the Climate Change and Natural Hazards Risk Assessment Guideline.

[If the project is preparing this report to address IS rating requirements (i.e., v2.1 Res 1 credit), provide this context and confirm the project’s Res 1 target.]

The background policy context and process is outlined in these technical documents.

### Climate risk workshop or process

Assessing climate change and natural hazards risks for a project or asset involves a rigorous and comprehensive approach, and consideration and inclusion of important factors such as design life and stakeholder involvement are essential in identifying accurate climate and natural hazards risks and potential mitigation measures. In alignment with this, a preliminary desktop risk assessment was undertaken based on a review of project documentation, local hazard mapping and in consideration of future climate projections. These hazards and risks were presented, refined and agreed for the project through a [multidisciplinary workshop / socialisation process] with representatives of Transport and Main Roads and the consultant’s team [confirm if this was one or a series of workshops, separate meetings with individual disciplines or discipline sub-groups, a combination of the above, etc].

The multidisciplinary process reviewed the [amend as required]:

* validation of preliminary climate change and natural hazards risks informed by a desktop assessment
* identification of new climate change and natural hazards risks
* allocation of preliminary risk ratings, and
* identification of potential treatment options.

Staff involved in the process included:

[Add: List staff attendance, including organisation and role / discipline.]

# Climate change projections

## Projected climate future

In accordance with the Climate Change and Natural Hazards Risk Assessment Guideline, the projected changes in local climate and natural hazards were identified and considered over a variety of timeframes. The hazards (shock and stress variables) that were considered are listed below in Table 2.1.

Local Governments have also undertaken a variety of climate change risk assessments and produced hazard mapping for their respective jurisdictions. Local hazard mapping commonly relates to sea level inundation and riverine flooding. The Town Planning Scheme for [add text] Council was referenced for this project.

Table 2.1 – The minimum climate and natural hazards considered as part of the risk assessment

|  |  |
| --- | --- |
| Primary variables (stresses) | Secondary variables (shocks) |
| * Air temperature
* Humidity
* Sea surface temperature
* Precipitation
* Sea level rise
* Wind and hail
* Coastal inundation
* Drought
* Frost
 | * Precipitation
* Wind and hail
* Bushfire
* Coastal inundation
* Cyclones/storms
* Flooding
* Heatwave
* Earthquake
* Tsunami
 |

## Climate modelling

The climate of Queensland, as with global climate trends, is naturally variable. Climate change, however, will lead to shifts beyond this natural variability.

Risk assessment based on climate change requires an understanding of the current climate using historical data for comparison with future climate scenarios.

Future climate scenarios are generated and prepared using data from Global Climate Models (GCM). GCMs are tools used for understanding how the climate will respond to changes in greenhouse gas (GHG) emission levels.

### Representative Concentration Pathways

The representative concentration pathways (RCPs) that were selected for this project climate change risk assessment are Click or tap here to enter text.

### Timescales

Roadway infrastructure has a varied expected design life depending on the component or system (e.g., pavement versus electrical). Minimum design lives provided in Table 2.2.2 are indicative for the purposes of the climate change assessment and may be subject to change through project design development.

|  |
| --- |
| Guidance: Refer Table 3 of the Climate Change and Natural Hazards Risk Assessment Guideline for standard design lives of Transport and Main Roads elements. |

For the Click or tap here to enter text Project, the projections for timescales Click or tap here to enter text and Click or tap here to enter text have been selected. This is based on Click or tap here to enter text.

## Climate change projections

The [Queensland Climate Futures Dashboard](https://www.longpaddock.qld.gov.au/qld-future-climate/dashboard/) provides an interactive tool that can be used to identify the varying changes to climate across geographical areas, timeframes and climate projections. The Regional Climate Summaries are based on Global Climate Models (GCMs) and show climate change projections for the years 2030, 2050, 2070 and 2090 at a state-wide scale for Queensland and for 13 Queensland regions. As the forecast useful life for the asset is over 20 years, 20xx and 20xx were selected for the detailed climate change projections. 20xx [identify the longest projection selected] represents the [select correct option / update wording to reflect decision] final expected operating year of the asset or beyond / the longest projection available. Table 2.3 below provides the detailed climate change projections for the applicable region for the project, Click or tap here to enter text.

|  |
| --- |
| Guidance: A level of sensitivity analysis is considered best practice when completing climate and natural hazard risk assessments as projects can often see large differences in the numbers (e.g., for flooding and rainfall) under RCP 8.5 vs RCP 4.5. Assessing the risk under both scenarios can better inform decision making and the risk profile the asset owner and stakeholders are prepared to tolerate. Sensitivity analysis responds to the inherent uncertainty associated with far future projections (say 2070 and beyond) so that unnecessary costs are not incurred or alternatively under-design is avoided.Sensitivity analysis for projections is required as part of the v2.1 IS rating credit Res-1 Level 2. |

[Add: Discussion on sensitivity analysis here.]

Table 2.3 – Detailed climate change projections for the project region Click or tap here to enter text.

|  | Short timescale | Long timescale |
| --- | --- | --- |
| Climate Variable | 20xx¹ | 20xx² | 20xx³ | 20xx⁴ |
| Mean Temperature (°C)(Annual) |  |  |  |  |
| Maximum Temperature (°C)(Annual) |  |  |  |  |
| Minimum Temperature (°C)(Annual) |  |  |  |  |
| Days above 40°C |  |  |  |  |
| Hot Days (days above 35°C) |  |  |  |  |
| Bushfire (Days) |  |  |  |  |
| Precipitation (%) |  |  |  |  |
| Surface Wind (%) |  |  |  |  |
| Solar Radiation (%) |  |  |  |  |
| Duration of Drought (change in months) |  |  |  |  |
| Duration of floods (change in months) |  |  |  |  |
| Sea level rise (metres) |  |  |  |  |
| Thunderstorms (days per year) |  |  |  |  |

1 & 3 – Future Climate Dashboard Click or tap here to enter text, Region:

<https://app.longpaddock.qld.gov.au/dashboard>

2& 4 – CSIRO & BOM Climate Futures Tool: Click or tap here to enter text.

# Potential Likelihood

The likelihood of particular climate hazards impacting on an asset are largely dependent on:

* Location of the asset
* Local climate projections

# Potential climate change and natural hazards consequences

## Sea level rise and coastal inundation

The Queensland Government has adopted a projected sea-level rise of 0.8 m by the year 2100. This is based on the climate modelling for probable scenarios presented at the Intergovernmental Panel on Climate Change Fifth Assessment Report 2014.

[Add: Project region specific comment for sea level risk and coastal inundation.]

There are some concerns that this may be a low estimate. With a high emissions projection (RCP 8.5), modelling potential sea level rise is 2 m by 2100 as shown by the National Oceanic and Atmospheric Administration (NOAA) of the United States of America in Figure 4.1.

Figure 4.1 – Projected sea level rise (NOAA, 2017)



## Mean temperature

There is strong agreement on the direction and magnitude of temperature changes among GCMs and downscaling results and as a result, there is very high confidence in substantial warming for the annual and seasonal projections for daily mean, maximum and minimum surface air temperature for a range of emissions scenarios.

[Add: Project region specific projection for mean temperature.]

Changes in mean temperature that can affect road infrastructure occur at the extremes, for instance increasing the duration of bushfire seasons and impacting heatwaves and days over 35ºC. While mean temperature can influence most elements of the roadway, it is the extremes that could result in the greatest impact to the project, both from a construction and operational perspective, including prolonged bushfire seasons impacting roadside infrastructure, motorists, cyclists, pedestrians and operations personnel. Prolonged heat exposure can also impact on the materials and infrastructure as well as personnel working along the corridor.

## Extreme temperature and heatwaves

Heat related extremes are projected to increase at the same rate as projected mean temperature with a substantial increase in the number of warm spell days. An increased frequency and duration of hot days and heatwaves is projected for the proposed works area in general with very high confidence under both RCP 4.5 and RCP 8.5 scenarios (CSIRO and BOM, 2015).

[Add: Project region specific projection for extreme temperatures and heatwaves.]

As noted above, extreme temperatures and heatwaves have the potential to reduce the efficiency of electrical infrastructure and impact on operations and maintenance activities (both personnel and rate of infrastructure renewal).

## Mean rainfall and drought

Projected changes in rainfall tend to be location specific. Generally speaking, all sources suggest an increase in the variability of rainfall for all projects. Projected changes to meteorological drought share much of the uncertainty of mean rainfall change, and there is no clear indication on changes to drought conditions.

[Add: Project region specific projection for mean rainfall and drought.]

Changes in precipitation and increased duration of drought can impact on the longer-life elements of the proposed works including drainage infrastructure, road base and bridges. Soil cracking and subsidence based on these changes in patterns can lead to instability and more frequent maintenance over the life of the project.

## Extreme rainfall and flooding

In a warming climate, heavy rainfall events are expected to increase in magnitude mainly due to a warmer atmosphere being able to hold more moisture (Sherwood et al., 2010).

[Add: Project region specific projection for bushfire weather.]

The CSIRO and BOM (2015) indicate with high confidence a future increase in the intensity of extreme rainfall events across the proposed works area. However, given the natural variability of rainfall the frequency and magnitude of increases in extreme rainfall cannot be confidently projected.

Extreme rainfall can result in severe flooding which can directly impact the road, including inundation of drainage infrastructure, damage/malfunctioning of electrical infrastructure and sheet flows resulting in aquaplaning. In addition, flooding can impact the surrounding local road network, potentially restricting emergency access and/or driving additional users onto the road.

## Bushfire weather

Studies suggest that climate change will have a significant impact on future fire weather (e.g. Williams et al, 2009; Clarke et al, 2011; Grose et al, 2014). Suitable weather conditions (hot, dry and windy) must generally exist for fires to spread. Given the combination of factors required for increased bushfire conditions, the potential increase in the future will rely heavily on projected changes in the weather.

There is high confidence that climate change will result in harsher fire weather in the future. This is seen in the mean changes and when examining individual models and scenarios. However, there is low confidence in the magnitude of the change, as this is strongly dependent on the rainfall projection. It is also recognised that the actual variability of fire weather across Queensland may be underestimated as the baseline fire climate is poorly sampled due to the small number of stations.

[Add: Project region specific projection for bushfire weather.]

Increased incidence of bushfire weather and the number of severe fire weather days could result in damage to electrical equipment and other roadside infrastructure (e.g., noise walls) as well as increased smoke impacting on the visibility for motorists and health of cyclists and pedestrians using the active transport network.

## Extreme storms (including wind, lightning and hail)

Projections indicate a decrease in the formation of tropical cyclones; however it is anticipated that the proportion of the most intense cyclones will increase over the century while the intensity of associated rainfall may increase further.

Thunderstorms can also be hazardous, bringing accompanying winds hail, tornados, flash flooding and lightning. While uncertainty exists with the projected changes in terms of number of additional thunderstorms, global models agree that the intensity of storms is predicted to increase.

[Add: Project region specific projection for extreme storms.]

As the intensity of cyclones and thunderstorms increase, potential impacts to transport infrastructure include damage to electrical infrastructure from high winds and hail as well as from debris blowing onto the corridor and adversely impacting vehicle safety.

## Water shortages

Related to mean rainfall and drought trends, water shortages may be a more common indirect consequence to QTRIP in future. This could present particular challenges for network operations and maintenance, particularly on gravel roads.

[Add: Project region specific information on water shortages. Are existing shortages occurring? What impact could this have on the project construction phase and asset during operation?]

## Natural hazard consequences

Natural hazards such as landslides, earthquakes and tsunamis can be disastrous and cause structural damages to transport infrastructure. Landslides are generally caused when heavy rain saturates soil on a hillside, and can result in damage to land, vehicles, roads or highways. Earthquakes have potential to severely disrupt transportation networks and infrastructure, causing structural damage, casualties and injuries in the past. Following an earthquake, for example, some vulnerable transportation infrastructures such as bridges can be severely damaged, resulting in extensive repairs that may take months or years to finish. In the event of a tsunami, coastal highways and road networks can be badly damaged and unpaved roads are easily washed away.

## Electricity supply disruptions

Increase in the frequency and intensity of extreme weather events may also have an indirect impact to the road network through disruption to electricity supply. Again, this primarily has potential consequences for future network operations and impacts the level of service for the network.

[Add: Project specific comment on the impacts from electricity supply disruptions.]

# Climate Change and Natural Hazards Risks

The climate change and natural hazards risks identified and assessed for the Click or tap here to enter text Project are listed in Table 5 below.

Table 5 - Click or tap here to enter text Project Climate Change Risk Assessment

[Action – Complete Project Climate Change Risk Assessment Matrix and copy and paste into document.]

# Network considerations

|  |
| --- |
| Guidance: For the below, consider whether there are broader network considerations in relation to climate change and natural hazards risks, such as:* Whether the project asset is dependent on other sections of the network being climate resilient, and as such, benefits of adaptation may not be realised.
* Whether the asset is the weakest link for a network and therefore benefits of risk treatment are magnified.
* Whether the asset provides the sole access point for communities or critical infrastructure.

Delete this box upon completion of this section. |

[Add: Project specific comment on the impacts from electricity supply disruptions.]

# Project Treatment and Residual Risk Assessment

|  |
| --- |
| Guidance: The final steps in completing the assessment are to identify and implement treatment options to reduce risk levels, then assessing the level of residual risk based on implementation of the selected treatment options.The Climate Change and Natural Hazards Risk Assessment Guideline outlines common treatment options that could be applied to address and mitigate identified risks. Both current and potential treatment options are included, including designation of which variable the treatment applies to and the responsibility for implementation. Some options can be used to treat and reduce multiple risks while others are specific to a single risk.Any use of generic treatment options from the Guideline should be modified within the residual risk assessment to:* use project-specific or other official document references where possible
* clarify the intent of the treatment, and whether it has been implemented as part of the project, or if it is a process that exists to guarantee future implementation, and
* be specific to the shock or stress variable it is addressing.

For example, instead of the generic “update emergency response plans”, a project-specific treatment may be “implement risk mitigation activities in accordance with the District Fire Management Plan. This was reviewed and updated in 20XX [insert evidence] and a process exists to update these every X years [insert evidence].”Note for any projects submitting IS Design or As Built ratings, the report and residual risk assessment should generally only document treatment options that have been confirmed for implementation at the time of submission, and can be evidenced (management plans, policies, project drawings/reports/specifications). If unconfirmed / “proposed” treatment options are still included in an IS rating submission report (e.g., as handover items to the construction contractor for further investigation and resolution during Construction), they should be listed separately from the list of confirmed treatments, accompanied by a statement confirming that they have not factored into the residual risk assessment.For projects in earlier stages, e.g., during Planning phase or early Design, unconfirmed treatment options can still be documented with the intent to refine the list in future updates.Delete this box upon completion of this section. |

Table 8 outlines proposed / confirmed treatment options [select as appropriate for current level of progress] to address all extreme and high priority direct and indirect risks [or other treated risk levels as applicable] in accordance with IS Rating Scheme v2.1 Res-1 credit requirements [delete if not applicable], along with the residual risk rating assessed based on implementation of those treatments. Confirm if the necessary risks have been downgraded to an acceptable level as per Res-1 requirements, if applicable to the project.

Risk statements that have been rated as low or medium are not required to have treatment options identified and have not been considered further in the residual risk assessment [delete or amend as applicable].

Table 8 – Click or tap here to enter text Project Residual Risk Assessment

[Action – Complete the Residual Risk Register in the Climate Change and Natural Hazards Risk Assessment Template and copy and paste into this document.]

# Conclusions

[Add: Project-specific conclusions and actions to be taken forward to subsequent project phases. Where climate change and natural hazards risk assessments are completed as part of options analysis, discuss points of difference between risk assessments for each option.]