AIRPORT AND SURROUNDS

B18 CLIMATE CHANGE AND NATURAL HAZARDS

CONTENTS

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TABLES

18.1 INTRODUCTION

This chapter describes the climatic conditions and natural hazards that may affect the design, construction and operation of the Sunshine Coast Airport (SCA) Expansion Project (the Project) and provides a risk assessment of potential hazard and climate-related threats to the Project.

The baseline component of the chapter defines current climate conditions and how climate is expected to change in the Sunshine Coast region through the identification of key climate change parameters and predictions. This detail provides the basis for assessing what aspects of the Project may be affected.

The impact assessment component of this chapter provides a risk register related to design and operational elements of the Project in order to undertake a risk analysis, evaluation and treatment process for climate change risks.

18.2 Methodology and assumptions

18.2.1 Methodology

The objective of this chapter is to assess the risks to the Project associated with changing climate patterns, in accordance with Sections 5.4 and 8.1 of the Project's Terms of Reference (TOR) dated May 2012.

As the TOR require a risk assessment, the chapter methodology is based around the risk management process outlined in ISO (AS/NZS) 31000 *Risk Management* and also draws from more recent and relevant guidance within Risk Standard AS 5334-2013, *Climate Change Adaptation for Settlements and Infrastructure*. As shown in **Figure 18.2a**, both risk standards identify a six-step risk management process that includes:

1. Establishing the context
2. Risk identification
3. Risk analysis
4. Risk evaluation
5. Risk treatment (adaptation
6. Implementation of management strategies, monitoring and review.

Using the risk management framework as a foundation, this chapter involves the following methodological tasks:

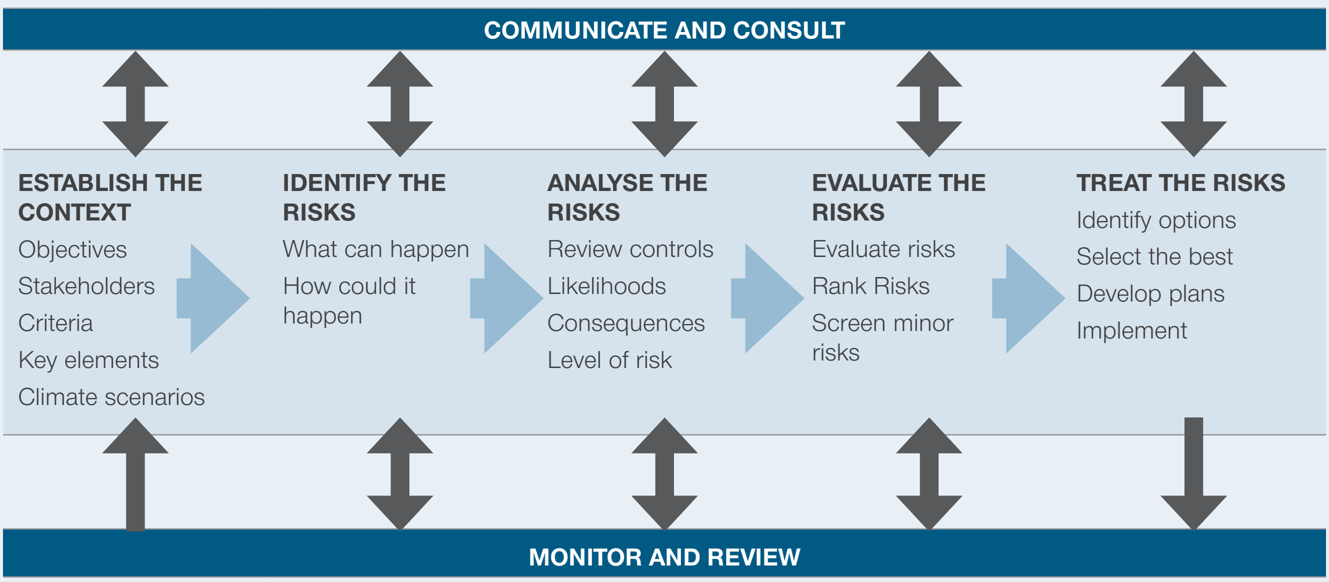
1) An initial data and information collection exercise (including consultation with relevant Sunshine Coast Council (SCC) business units) including a gap analysis
2) Identification and description of the climate change baseline to establish the context of the chapter including relevant climate change parameters and predictions
3) Identification, analysis and evaluation of potential risks from future climate change on the Project separated into key project stages of design, construction and operations
4) Identification and recommendations about risk treatment measures and monitoring measures that should be committed to avoid or minimise impact from future climate change.

The baseline component of this chapter addresses items 1 and 2 of the tasks listed previously. The impact assessment component of this chapter addresses tasks 3 and 4, and includes proposed treatment (adaptation) measures for identified risks.

18.2.2 Assumptions

In this chapter, state and regional climate change predictions for various climate parameters have been drawn from existing national and global projections. It should be recognised that these climate change projections contain various levels of uncertainty due to complexities of the global

Figure 18.2a: Risk management framework (from DEH 2006)



climate, limitations in modelling and variations in future emissions. As such, scientific evidence from local, national and international studies may modify projected climate change scenarios, and any such changes would need to be considered and reflected in future planning for the Project.

As this chapter is a largely qualitative risk assessment of future climate change impacts on the Project to guide climate change adaptation actions, there has not been a technical review of climate change science or sensitivity analysis between different climate change emissions scenarios. Instead, predictions of future climate change for the Sunshine Coast Region are based on information in other documents (including, but not limited to, other chapters of the EIS including Chapter B5 and the SCC's Climate Change and Peak Oil Strategy 2010-2020).

Refer below and to **Section 18.8, References** for a complete list of information sources. Acknowledging there is a degree of uncertainty with long-term projections, long-term local climate change projections for 2050, 2075 and 2100 were determined, relative to 1990 by SCC (2010c). Projections were based on the outputs from IPCC GCM's using SimCLIM. Where data was not available, projections from CSIRO (2007) and other levels of government were used for the purposes of the SCC strategy. Projections would be reviewed in future iterations of the strategy to accommodate improved modelling outputs, changes to IPCC scenarios and any shifts in greenhouse gas mitigation approaches (SCC, 2010c).

Potential impacts from climate change on infrastructure assets and more generally in terms of airports and aviation are based on a review of relevant desktop literature from relevant organisations including the International Civil Aviation Organisation (ICAO).

18.2.3 Policy context and legislative framework

The following sections describe climate change policy relevant to the Project, including a description of the national framework, and State and local government policy actions specific to climate change adaptation. In addition, Australian standards that relate to climate change risk assessments are discussed.

18.2.3.1 National framework for climate change adaptation

Government actions specifically focused on climate change adaptation to date are as follows:

- *The National Climate Change Adaptation Framework* (COAG, 2007) endorsed by SCC for Australian Governments (COAG) recognises that climate change adaptation is a long-term agenda. The framework establishes strategies, including climate change projections and regional scenarios, to guide actions by governments from 2007 to 2014. The strategies aim to assist in informed decisions on climate change adaptation and to identify sectors and regions, particularly the coast, which is particularly vulnerable to the impacts of climate change
- The (former) Department of Climate Change's (DCC) *Climate Change Risks to Australia's Coast: a first pass national assessment* (DCC, 2009) is one of the key actions identified in the *National Climate Change Adaptation Framework*. The assessment identifies areas at high risk to climate change impacts and identifies national priorities for adaptation to reduce climate change risk in the coastal zone
- The House of Representatives Standing Committee on Climate Change, Water, Environment and the Arts released *Managing our coastal zones in a changing climate: the time to act is now* (Australian Government, 2010). This inquiry made recommendations with regard to managing the coastal zone in response to climate change and included 14 recommendations relating to climate change adaptation
- The *Adapting to Climate Change in Australia* (DCC, 2010) paper sets out the Australian Government's vision for adapting to the impacts of climate change. The Australian Government proposes to work through COAG to develop a national adaptation agenda for adapting to the impacts of climate change
- *Developing a national coastal adaptation agenda: a report on the national climate change forum* (DCCEE, 2010) publishes details from the forum addressing the national coastal adaptation agenda
- The (former) Department of *Climate Change and Energy Efficiency's* (DCCEE) Climate Change Adaptation Actions for Local Government (DCCEE, 2010) considers climate change adaptation in the context of local government planning and development approvals. This publication is the second update of the original edition published by the Australian Greenhouse Office in 2007. The report complements *Climate Change Impacts and Risk Management – A Guide for Business and Government* released by the Australian Greenhouse Office (DEH) in 2006. A risk assessment and treatment process (based on AS/NZ 4360) has been identified as the preferred method of assessing the extent to which local government should consider and implement adaptation options, based on likely climate change scenarios at the regional/local scale.

18.2.3.2 State-level climate change policies and regional plan

The Queensland Government addresses climate change adaptation through state planning policies, action plans and planning schemes. Those relevant to the Project include:

- *ClimateQ: toward a greener Queensland* (DERM, 2009) consolidates and updates the policy approach outlined in the *ClimateSmart 2050* (OCC, 2007) and *ClimateSmart Adaptation Plan 2007-2012* (OCC, 2007). It takes into account the latest national and international science and policy and presents a range of strategies for managing the impacts of climate change. This policy is no longer in force but the regional summaries, including *Climate change in the SEQ Region*, remain in force

- *State Planning Policy (SPP) 1/03: Mitigating the Adverse Impacts of Flood, Bushfire and Landslide* (DES and DLGP, 2003) required the likely impacts of climate change on natural hazards to be incorporated in hazard assessment studies. Note that this Policy has now been replaced by the new single State Planning Policy (SPP). The new SPP (Queensland Government, December 2013) outlines that development addresses the natural hazard and associated risks to people, property, economic activity, social wellbeing and the environment by achieving a series of performance outcomes. These include:
  (a) The development is compatible with the level of risk associated with the natural hazard
  (b) The development siting, layout and access responds to a potential natural hazard and minimises risk to personal safety
  (c) The development is resilient to natural hazard events by ensuring siting and design accounts for the potential risks of natural hazards to property
  (d) The development directly, indirectly and cumulatively avoids an unacceptable increase in the severity of the natural hazard and does not significantly increase the potential for damage on the site or to other properties
  (e) The development avoids the release of hazardous materials as a result of a natural hazard event
  (f) Natural processes and the protective function of landforms and/or vegetation are maintained in natural hazard areas.
- *The South East Queensland (SEQ) Regional Plan 2009-2031* (DIP, 2009) provides a framework for managing growth, land use and development in SEQ. Climate change is included in the plan through two key climate change approaches: reducing greenhouse gas emissions and climate change adaptation. Development and implementation of an *SEQ Climate Change Management Plan* (2009) was a key initiative of the Plan which identifies a range of initiatives which the State Government would use to increase resilience to climate change across SEQ.
- The Queensland Coastal Plan (DERM, 2012b) was prepared under the *Coastal Protection and Management Act 1995*. It replaced the State Coastal Management Plan (2001) and associated regional coastal management plans, including, the SEQ Regional Coastal Management Plan (2006). The Coastal Plan consists of the State Policy for Coastal Management, containing policies and guidance for coastal land managers on managing and maintaining coastal land.
- The Coastal Protection State Planning Regulatory Provision (the SPRP) took effect on 26 April 2013. The SPRP suspends the operation of the State Planning Policy 3/11: Coastal Protection and parts 1.4.3 and 2.4 of the SEQ Regional Plan. The SPRP is a statutory instrument under the *Sustainable Planning Act 2009*, applies to all local government areas in Queensland that contain areas within the coastal zone and has effect for up to 12 months from the day it took effect. The SPRP has, in turn, now been superseded by the single State Planning Policy (SPP) which took effect on 2 December 2013 but retains the essential policy elements of the SPRP.
- A Draft Coastal Management Plan was released by the Queensland Government in September 2013 for public comment. The Draft Plan has been prepared under the *Coastal Protection and Management Act 1995* and is due to replace the State Policy for Coastal Management upon approval. While the Draft Plan provides a simplified approach to coastal management, climate change impacts on the coast and related management reflect the existing elements of the State Policy.
- Coastal hazard sections of the single SPP and Draft Coastal Management Plan are underpinned by specific mapping of coastal hazard areas.

Current coastal hazard areas[1] mapped for the SCA and surrounding lands are shown in **Figure 18.2b, Figure 18.2c** and **Figure 18.2d** indicating the position of the following:

- Erosion prone areas
- Areas subject to permanent inundation
- Areas subject to temporary storm tide inundation defined as either a high hazard area (greater than 1 m of inundation depth) or medium hazard area (less than 1 m of inundation depth).

18.2.3.3 SCC climate change policies

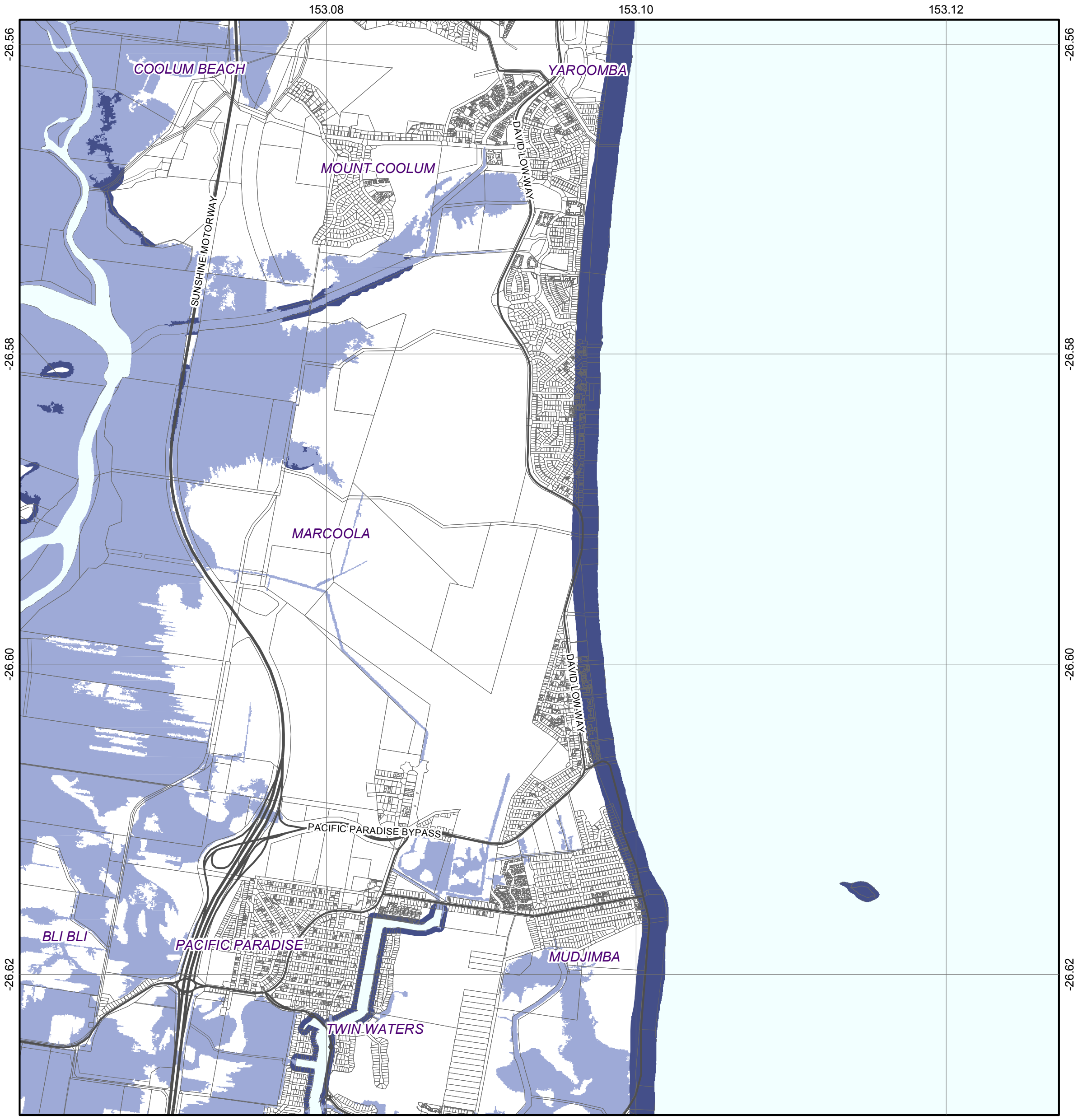
The Sunshine Coast was identified as a climate change ‘hotspot’ by IPCC (SCC, 2010). Exposure to climate change and peak oil threats is heightened by this region’s coastal location, population growth, development pressures, dispersed settlement pattern and reliance on climate sensitive economies (SCC, 2010).

In response to these threats, the SCC prepared the *Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020* (the Strategy) and Action Plan to help provide environmental, social and economic resilience to these issues. The Strategy is backed by SCC’s *Corporate Plan 2009-2014* which acknowledges the need to address climate change.

The Strategy identifies risks, challenges and opportunities associated with climate change and peak oil for the Sunshine Coast. The Strategy recognises climate change risks have the potential to impact on the local transport system including increased frequency, depth and duration of flooding at airports. The SCC owns the SCA and it is recognised as an important strategic asset that generates

1 *The maps allow for a sea level rise of 0.8 metre and a (10) ten per cent increase in the maximum potential intensity of cyclones at the year 2100. Please note that at the time of preparation of the EIS, these mapping products were under Departmental review.*

Figure 18.2b: Coastal hazard mapping (erosion prone areas)



Notes
1. The areas shown on this map are indicative of the extent of erosion and permanent inundation defined by the declared erosion prone area plans. Only the declared erosion prone area plans should be used for development assessment. To determine the actual position of the erosion prone area a registered surveyor or geotechnical consultant may be required if there is any doubt. Erosion prone area plans for each local government area and a comprehensive description of their determination are available from the Department of Environment and Resource Management website at www.derm.qld.gov.au
2. The erosion prone area includes the impact of climate change to 2100 including a sea level rise of 0.8m

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September 26, 2011

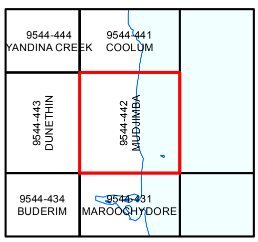
Queensland Government

0 0.5 1
Kilometres
Scale at A4: 1:40,000

Coastal Hazard Areas Map Erosion Prone Area Indicative Footprint[1]

9544-442 MUDJIMBA

- Erosion risk due to storm impact and long term trends of sediment loss and channel migration
- Permanent inundation of land due to sea level rise[2]



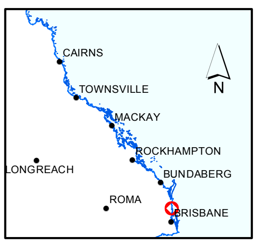
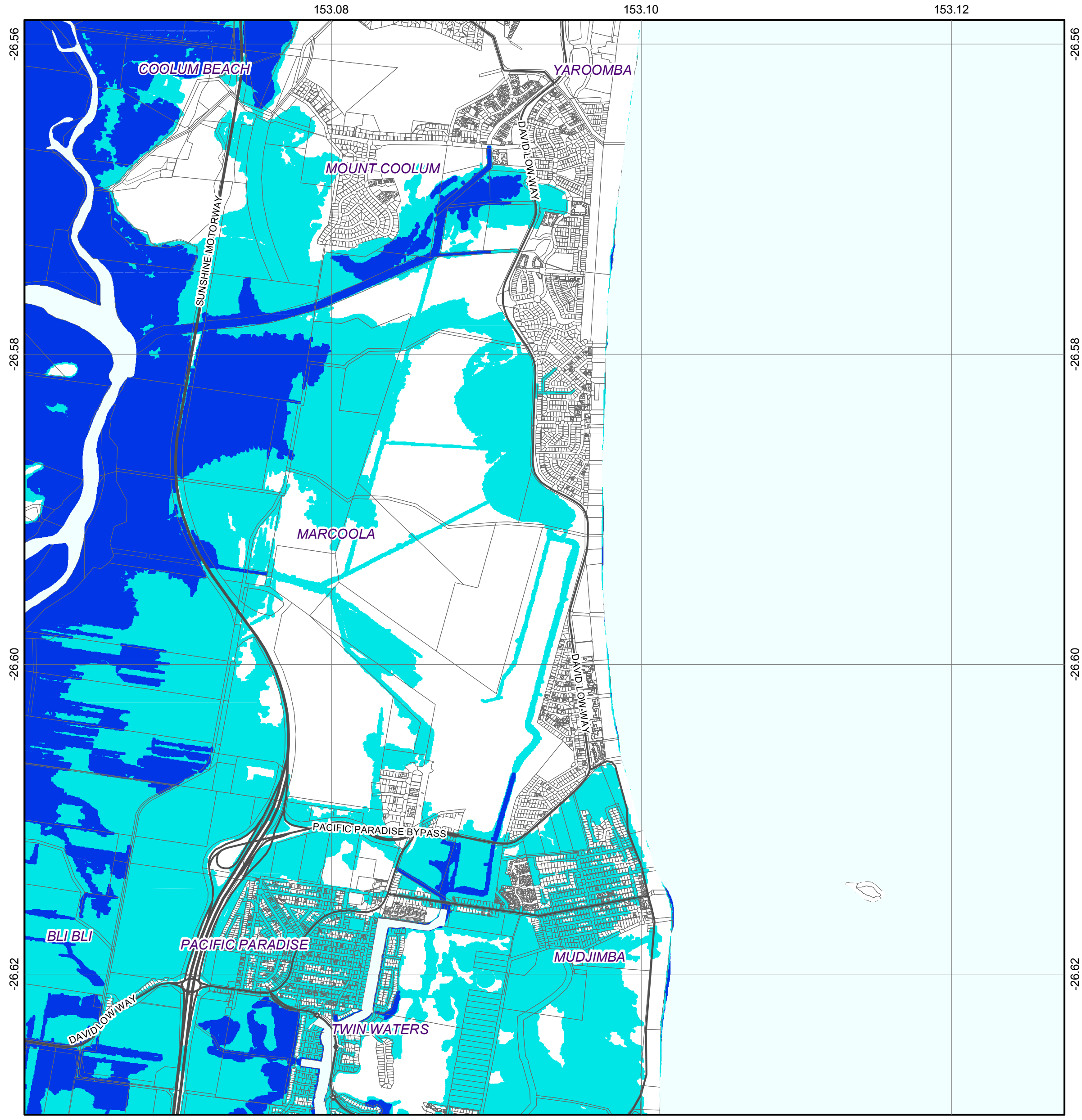


Figure 18.2c: Coastal hazard mapping (storm tide inundation)



Notes

1. A default storm tide inundation level of 1.5 m HAT in South East Queensland regional planning area and 2.0 m HAT for the remainder of Queensland is used where storm tide inundation levels including climate change have not been determined locally. The default level uses a sea level rise factor of 0.8m to 2100.

2. The high hazard area may be subject to permanent inundation by sea level rise - refer to the Erosion Prone Area map.

3. The map should be used as a guide only. Field surveys are recommended to verify feature boundaries.

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September 26, 2011

Queensland Government

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Kilometres
Scale at A4: 1:40,000

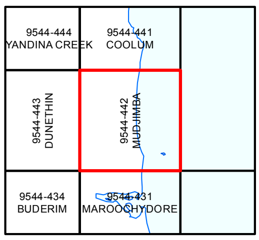
Coastal Hazard Areas Map
Storm Tide Inundation Areas

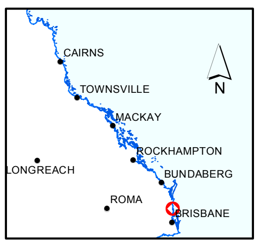
9544-442 MUDJIMBA

Storm Tide Inundation Area (including projected climate change impacts to 2100)

High hazard area
(greater than 1.0 m water depth)

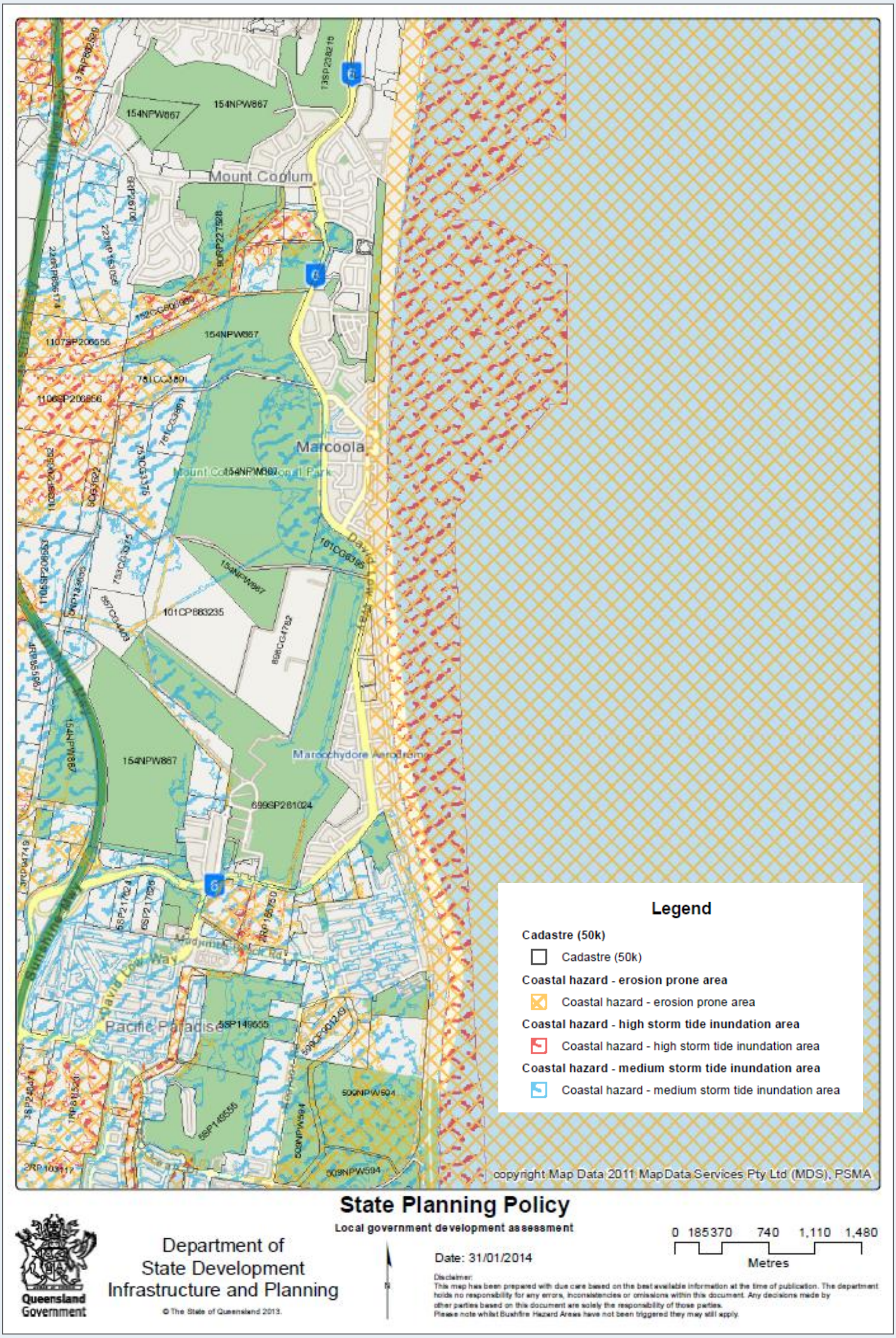
Medium hazard area
(less than 1.0 m water depth)





CLIMATE CHANGE AND NATURAL HAZARDS

Figure 18.2d: Coastal hazard mapping (State Planning Policy, 2013)



significant revenue. It is also a significant contributor to the Sunshine Coast tourism sector and the regional economy as a whole.

In accordance with the 'precautionary principle' the Strategy takes a risk avoidance and management approach to tackle climate change through four key themes; leadership, mitigation, adaptation and energy transition to:

- Reduce greenhouse gas emissions
- Cut oil dependency
- Help the Sunshine Coast transition to alternative energy sources
- Adapt to the prospect of climate change
- Build business capacity for SCC and the region.

To implement the Strategy a strategic framework has been developed which provides a roadmap for the next decade through a set of eight objectives and an Action Plan. The Action Plan includes two objectives addressing climate change; to identify and plan for climate change risks; and to adapt to the impacts of climate change.

18.2.3.4 Australian standards

Key risk standards which are relevant to the climate change assessment of the Project include:

- ISO (AS/NZS) 31000 Risk Management
- Risk Standard AS 5334-2013, Climate Change Adaptation for Settlements and Infrastructure.

18.2.3.5 Other data

Other climate change information sources include:

- *Storm Tide Threat in Queensland: History, Prediction and Relative Risks, Brisbane: Department of Environment and Heritage*, (Harper, 1998)
- *Queensland Climate Change and Community Vulnerability to Tropical Cyclones: Ocean Hazards Assessment: Synthesis Report, Brisbane*. (Queensland Government, 2004)
- *Queensland Coastal Processes and Climate Change, Brisbane*. DERM, 2011
- *Queensland Coastal Plan Coastal Hazards Guide* (DERM, 2012c), Brisbane: Queensland Government, Department of Environment and Resource Management
- *Coastal Hazards Technical Guide* (DEHP, 2013) provides information about coastal hazards (storm-tide inundation and coastal erosion), and guidance for determining areas at risk from coastal hazards, including future risks linked to projected sea level rise and an increase in cyclone intensity
- Increasing Queensland's resilience to inland flooding in a changing climate: Final report on the Inland Flooding Study, Brisbane: State of Queensland. (DERM, 2010). Provides data on rainfall intensity and temperature
- Increasing Queensland's resilience to inland flooding in a changing climate: Final report on the Inland Flooding Study, Brisbane. (ERM, DIP, LGAQ, 2010). Provides data on rainfall intensity and temperature.

18.3 EXISTING CLIMATE

The project area is located at Mudjimba, on the Sunshine Coast in SEQ. This region has a subtropical climate with wet, hot and humid summers, and dry, mild winters. Summer weather patterns in the region are mainly influenced by its position with the south-east trade wind belt. The frequency of storms is higher in summer due to unstable atmospheric conditions. Tropical cyclones and lows occur infrequently in the region during the late summer months. Stable atmospheric conditions in the winter months are influenced by the northward migration of the subtropical anticyclonic belt.

The existing climate of the region is variable. Causes of long-term climate variability include the El Nino-Southern Oscillation (ENSO) cycle, which repeats every two to eight years, and the Pacific Decadal Oscillation, which influences decadal and inter-decadal climate variability.

Information presented in the sections below on the long-term climate for the project area has been sourced from the Australian Bureau of Meteorology (BOM) SCA weather station (site number 040861), located at Latitude 26.60°S and Longitude 153.09°E, at 3 m elevation. The weather station was established in 1994 and current climate data is available to May 2012 http://www.bom.gov.au/climate/averages/tables/cw_040861.shtml. Values shown in the data tables as blue are the lowest values in the data set whilst values shown in red are the highest values.

18.3.1 Rainfall

Mean rainfall data (see **Table 18.3a**) shows a typical sub-tropical monsoonal pattern with highest mean rainfall occurring in February (183.5 mm) and lowest mean rainfall occurring in September (56.1 mm). The mean number of days with rain ≥1 mm occur most frequently from December to April (roughly 10 to 11 days per month). Some of the wettest months on record have been recorded over the past three years with 588 mm of rainfall recorded in December 2010 and 557 mm recorded in January 2011.

18.3.2 Temperature

Mean temperature data shows highest maximum temperatures generally occur in January and February (28.6°C and 28.7°C respectively) with the lowest mean minimum temperatures in July (9.4°C) (refer **Table 18.3b**).

The number of hot days (that is days over a certain temperature) are also shown in Table 18.3c. On average, there are about 22 days per year over 30°C, 1.6 days over 35°C and 0 days over 40°C.

18.3.3 Humidity

Humidity data is collected at the SCA weather station during morning (9am) and afternoon (3pm) conditions. Mean humidity has fairly minor variation throughout the year (ranging from 65 – 76 per cent in morning conditions and 59 – 71 per cent in the afternoon conditions), noting that afternoon periods tend to be less humid than mornings (refer **Table 18.3d**).

18.3.4 Wind

Wind speeds are generally greater in the summer months compared to winter months with mean wind speeds of 19.3 km/hr in January and only 14.9 km/hr in July in morning conditions. Given the airport's location close to the coast, afternoon wind speeds increase compared to morning conditions, with mean speeds over 20 km/hr from August to April. Winds are generally from the south-east, which is indicative of the alignment for the new runway (refer **Table 18.3e**).

18.3.5 Evaporation

Mean daily evaporation is not collected for the SCA weather station. Data from the nearby Nambour DPI weather station correlate strongly with temperature and is therefore considered an appropriate substitute for the SCA station. The data from Nambour indicates greatest evaporation in the summer months (November to January) and least evaporation in the winter months (May to August) (refer **Table 18.3f**).

18.3.6 Extreme weather events

The Sunshine Coast currently experiences a range of extreme weather events including flooding during large rainfall and storm events, beach erosion, and bushfire (particularly during periods of prolonged drought and high winds).

Inland flooding of the region's waterways, creeks, rivers and low-lying plains is a regular occurrence. Although rain is usually confined to the wet season, flooding on the Sunshine Coast can occur any time of year. Historically, there have been significant flood events every few years on the Sunshine Coast.

Table 18.3a: Rainfall data SCA weather station (BOM, 2012)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall													
Mean rainfall (mm)	150.4	**183.5**	161.3	160.3	164.5	118.5	68.8	80.6	**56.1**	78.9	87.8	165.0	1476.2
Decile 5 (median) rainfall (mm)	119.0	**178.2**	122.2	174.2	142.7	103.3	55.8	46.2	**28.3**	75.5	72.5	131.4	1392.6
Mean number of days of rain ≥ 1 mm	10.9	10.9	11.3	**11.5**	9.8	9.2	6.6	5.9	**5.6**	7.1	6.8	10.2	105.8

Table 18.3b: Mean temperature data SCA weather station (BOM, 2012)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean maximum temperature (°C)	28.6	**28.7**	27.6	25.8	23.3	21.2	**20.8**	21.8	24.1	25.4	26.8	28.0	25.2
Mean minimum temperature (°C)	21.2	**21.3**	19.9	17.0	13.6	11.3	**9.4**	9.9	12.9	15.6	17.9	19.8	15.8

Table 18.3c Temperature data SCA weather station (BOM, 2012)

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean number of days ≥ 30 °C	4.9	4.7	1.7	0.5	**0.0**	**0.0**	**0.0**	0.2	0.9	1.8	2.4	**5.3**	22.4
Mean number of days ≥ 35 °C	0.2	0.2	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	0.1	**0.0**	**0.4**	0.3	**0.4**	1.6
Mean number of days ≥ 40 °C	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	0.0

Table 18.3d: Humidity data SCA weather station (BOM, 2012)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9 am conditions													
Mean 9am relative humidity (per cent)	73	73	74	75	75	**76**	73	68	**65**	66	67	69	71
3 pm conditions													
Mean 3pm relative humidity (per cent)	70	**71**	69	68	65	63	**59**	**59**	63	66	67	69	66

Table 18.3e Wind data SCA weather station (BOM, 2012)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9 am conditions													
Mean 9am wind speed (km/h)	**19.3**	18.8	18.3	17.3	15.8	15.0	**14.9**	15.8	16.7	18.2	18.9	18.5	17.3
3 pm conditions													
Mean 3pm wind speed (km/h)	24.1	23.5	23.1	21.2	19.1	**18.2**	18.9	21.2	23.5	24.2	**24.5**	24.3	22.1

Table 18.3f Evaporation data SCA weather station (BOM, 2012)

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Other daily elements													
Mean daily evaporation (mm)	5.2	4.8	4.2	3.3	2.6	**2.3**	2.5	3.1	4.0	4.6	5.1	**5.3**	3.9

The last significant flood events on the Sunshine Coast were in January to March of 2012. There were three flood events, roughly a month apart. Each event had rainfall that exceeded a 1 in 100 year event probability at certain durations for local areas. These events affected most parts of the Coast at different times including Caloundra, Nambour, Cooroy, Cooran, Pomona, Noosaville, Tewantin, Maroochydore and Mooloolaba (source http://www.sunshinecoast.qld.gov.au/). Major regional flooding of the Maroochy River did not occur.

The wet season usually starts on the Sunshine Coast with thunderstorms in November. Cyclones can occur from December to April. Unlike North Queensland, the risk of a category 4 or 5 cyclone is rated as very low. Winter storms are usually associated with fast moving east coast lows.

The Sunshine Coast's bushfire season starts in the dry season at the beginning of August and runs through until the beginning of the wet season over summer. However, there may be a bushfire risk at other times, depending on local conditions.

18.4 CLIMATE PROJECTIONS

The climate change projections described for the project area are largely based on the future scenarios of climate change detailed in the *Climate Change Background Study assessed for the Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020* (SCC, 2010). Where local projections are not available, climate change estimates draw upon the Queensland Government's strategy *Climate Q toward a greener Qld* (DERM, 2009). The *Climate Q* report references the projections of the *Climate Change in Australia* report (CSIRO, 2007), which in turn are based on the results of climate modelling undertaken as part of the Intergovernmental Panel on Climate Change (IPCC) Projections Fourth Assessment Report (AR4) (IPCC, 2007).

It should be noted at the time of preparation of this chapter that the Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020 is intended to remain in force with no changes to the sea level rise estimates following AR5.

Likewise, the Regional Summaries and CSIRO model scenarios remain valid, though the remainder of Climate Q has been repealed by the State Government. CSIRO has also released the Climate Change: Science and Solutions for Australia (2011) which upholds the previous modelling. The Climate Commission's The Critical Decade: Queensland climate impacts and opportunities (2012) also affirms the Regional Summaries.

18.4.1 Regional summary

The IPCC AR4 recommends the use of regionally specific estimates of climate change to inform climate change strategy and policy. The CSIRO has undertaken projections at national, state and regional levels. Queensland climate change projections for 2030, 2050 and 2070 were produced by CSIRO (2007) based on the results from 23 Global Climate Models (GCM's). Projections for the SEQ region include a decline in rainfall, with increasing temperature and evaporation, in conjunction with more extreme climate events such as sea-level rise and cyclonic weather. Key findings from the models outlined in *Climate Q toward a greener Qld*, include:

Temperature:

- Average annual temperature in SEQ increased 0.4 °C from 19.4 °C to 19.8 °C
- Projections indicate an increase of up to 4 °C by 2070; leading to annual temperatures well beyond those experienced over the last 50 years
- By 2070, Tewantin may have nearly four times the number of days over 35 °C, increasing from an average of three per year to an average of 11 per year by 2070.

Rainfall:

- Average annual rainfall fell nearly 16 per cent compared with the previous 30 years. This is generally consistent with natural variability experienced over the last 110 years, which makes it difficult to detect any influence of climate change at this stage
- Models have projected a range of rainfall changes from an annual increase of 17 per cent to a decrease of 30 per cent by 2070
- The 'best estimate' of projected rainfall change shows a decrease under low, medium and high emissions scenarios.

Evaporation:

- Projections indicate annual potential evaporation could increase 6–16 per cent by 2070.

18.4.2 SCC local area

To provide a local context to inform the *Sunshine Coast Climate Change and Peak Oil Strategy 2010-2020* (SCC, 2010), climate change projections for the Sunshine Coast have been undertaken by SCC through the University of the Sunshine Coast. Acknowledging there is a degree of uncertainty with long-term projections (SCC, 2010), long-term local climate change projections for 2050, 2075 and 2100 were determined, relative to 1990. Projections made by the SCC through the University of the Sunshine Coast were based on the outputs from IPCC GCM's using the climate change simulation model SimCLIM. Where data was not available, projections from CSIRO (2007) and other levels of government were used for the purposes of the Strategy.

The modelling assumes a 'business as usual' approach where there is no significant reduction in global greenhouse gas emissions (SCC, 2010). These projections are to be reviewed in future iterations of the strategy to accommodate improved modelling outputs, changes to IPCC scenarios and any shifts in greenhouse gas mitigation approaches (SCC, 2010).

18.4.2.1 Temperature

The IPCC has identified that there is evidence of increasing temperatures across the globe. Analysis of local data from a number of weather stations on the Sunshine Coast indicates that annual mean temperatures have been increasing across the region when compared to the IPCC baseline period from 1961 to 1990 (SCC, 2010).

Based on projections modelled for mean annual temperatures for the Sunshine Coast, fewer cold days and more hot days are expected as a result of climate change, with associated shifts in annual and seasonal means and extremes (SCC, 2010). It is predicted that by 2100, there would be an extra 30 days experiencing temperatures over 35°C and warming across the region, with annual mean temperatures expected to increase by (SCC, 2010):

- Up to 1 °C by 2020
- Up to 2 °C by 2050
- Up to 4 °C by 2075
- Up to 6.5 °C by 2100.

18.4.2.2 Rainfall

The Sunshine Coast is expected to experience a change in rainfall patterns as a result of climate change as follows (SCC, 2010):

- Reductions in annual average rainfall
- Fewer days per annum when rainfall can be expected to occur
- Shifts in mean seasonal rainfall
- Shifts in mean monthly rainfall
- Changes in the intensity and frequency of extreme rainfall events.

The IPCC (2007) has identified that there is evidence of decreasing rainfall across the globe. Rainfall is projected to decline across the Sunshine Coast consistent with the CSIRO (2007) projections for changes in rainfall for SEQ. In the last decade in SEQ, the average annual rainfall fell nearly 16 per cent compared with the previous 30 years (SCC, 2010). However, this is generally consistent with natural variability experienced over the last 110 years, so it is difficult to attribute this decrease to climate change at present.

SimCLIM modelling indicates seasonal shifts, with rainfall increasing in winter but decreasing in other seasons (SCC, 2010). Consistent with CSIRO projections, it is also projected that climate change would impact on the frequency and intensity of extreme rainfall events, with fewer but larger rainfall events expected (SCC, 2010). More intense rainfall events increase the potential for flooding which would be further complicated by sea level rise.

18.4.2.3 Sea level rise

In Queensland, climate change is predicted to cause sea level rise (DERM, 2011). CSIRO (2007) has developed three scenarios for sea-level rise (relative to 1990). Scenario 3 considers the possible high-end risk identified in AR4 and includes some new evidence on icesheet dynamics. In this context, the SCC Climate Change Strategy advocates the 'high end' scenario from the DCC *Climate Change Risks to Australia's Coast: a first pass national assessment* (2009) report for planning for future sea level rise for the Sunshine Coast including a 1.1 m sea level rise projection by 2100 (SCC, 2010).

These projections have been considered as part of the initial design and layout of infrastructure elements associated with the Project and further evaluated in the context of current guidance from the State Government about sea level rise as well as published reference documents relevant to climate change and sea level rise benchmarks.

As outlined in Chapter A4, a sea-level rise projection of 0.8 m by 2100 has been adopted for the design of the runway infrastructure. This is based on previous State Government guidance on coastal erosion and storm tide inundation risk as well as current guidance from Engineers Australia (Engineers Australia, 2013) and evaluation of sea level rise benchmarks used in other states and territories.

18.4.2.4 Storm surges and flooding

An increase in mean sea level is expected to result in an associated increase in tidal extremes such as storm surges and king tides (Hunter, 2008). In Australia, the frequency of extremes generally increases 10 fold for every 0.2 metres sea-level rise (Hunter, 2008). On the Sunshine Coast, higher storm surges and larger spring tides are predicted with increased risk of flooding in the region (SCC, 2010).

As outlined in Chapter B5 (Flooding), a 2050 scenario was modelled to investigate the potential implications of climate change on the design of the Project and the potential flood impacts of the project in the future. A 2050 scenario was chosen as it is close to the Project design year (2040).

A sea level rise of 0.3 m was adopted for the model for the 2050 climate change scenario, as described in the Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering (Engineers Australia, 2013). Consequently, a constant tailwater level of 1.8 m AHD was adopted for climate change scenarios.

In accordance with recommendations from the Office of Climate Change report Increasing Queensland's Resilience to Inland Flooding in a Changing Climate (DERM, DIP, LGAQ, 2010), a 10% increase in rainfall intensity was adopted for the 2050 scenario. This corresponds to a 2°C increase in average temperatures by 2050 (DERM, DIP, LGAQ, 2010).

18.4.2.5 Wind

It is anticipated that wind speeds would increase along the east coast of Australia and dominant synoptic systems would intensify, generating stronger winds (CSIRO, 2007). Although the extent of the projected changes in wind speeds have not yet been quantified, even modest changes in wind speed can have a major impact on coastal erosion by altering the wave climate (CSIRO, 2007). Changes in the frequency and intensity of severe winds have the potential to generate storm surges and large waves, causing coastal inundation and erosion (CSIRO, 2007).

18.4.2.6 Evaporation

Potential evaporation is a measure of the evaporative power of the atmosphere. Networks to measure potential evaporation are not as well developed as those that measure temperature and rainfall and there are insufficient data available to indicate changes over time. However, SimCLIM modelling indicates annual potential evaporation at the Sunshine Coast could increase 6–16 per cent by 2070 (SCC, 2010).

18.4.2.7 Extreme events

Tropical cyclones

As a result of climate change, the total number of cyclones in Australia is expected to decrease but the proportion of cyclones in the more intense categories are expected to increase. *The Queensland Coastal Plan* (DERM, 2012a) projected an increase in the maximum cyclone intensity of 10 per cent by 2100. Currently the project area is to the south of the main area of tropical cyclone formation.

However, cyclone activity could have a greater tendency to track southwards with increasing global temperatures. It has been projected that cyclone tracks could shift 130 kilometres southwards (DERM, 2009). As a result, the Sunshine Coast may experience increased impacts from cyclones.

The CSIRO has modelled the potential shifts in cyclone characteristics for the Queensland coastline for 2030 and 2070. Based on the CSIRO models, the following changes in tropical cyclone characteristics are expected to include (SCC, 2010):

- A nine per cent decrease in tropical cyclone numbers
- An increase in the number of long-lived tropical cyclones (potentially several days to a week)
- Storms tending to move further south (average of 3 degrees latitude)
- Lower central pressures
- Stronger winds (mostly in the Pacific)
- A 60 per cent increase in the number of the most severe storms by 2030
- A 140 per cent increase in the number of the most severe storms by 2070.

Storm tides and wave set up

A storm tide is a higher-than-normal sea level that occurs due to the presence of a storm or cyclone. As well as storm tides, wave action causes a local rise in water level at the coast, known as wave set up. A more detailed assessment of storm tide and wave set up as a result of climate change would be required for the Sunshine Coast. However, based on the *Queensland Climate Change and Community Vulnerability to Tropical Cyclones: Oceans Hazard Assessment Stage 3 Report* (DNRM, DES, EPA, BOM and JCU, 2004), a potential 10 per cent increase in cyclone intensity and frequency including a southward shift in cyclone track may increase the 1 per cent storm tide levels in the project area by 0.30 m. This would be in addition to mean sea level rise.

Hail storms

CSIRO (2007) has projected a change in large hail risk for SEQ with both the 2030 and 2070 projections indicating increased risks of large hail storms for the Sunshine Coast.

Droughts and bushfires

As a result of increasing temperature, reduced average rainfall and increased evaporation, it is expected that the frequency and duration of droughts would increase on the Sunshine Coast (CSIRO 2007).

Bushfires are expected to become more frequent and more intense as a result of (SCC, 2010):

- Vegetation growth resulting from more intense rainfall events
- Hotter and longer dry periods associated with increasing temperature and declining rainfall
- Increased wind speeds which would intensify and spread bushfires.

18.4.3 Climate change prediction summary – Sunshine Coast area

As outlined above, the manifestations of climate change relevant to the Project include: increased temperature, sea level rise and a projected increase in extreme events, including storm surge, flooding, stronger winds and bushfires.

The timeframe adopted for the study is to 2100 (88 years) unless otherwise identified. Based on current data, the following climate changes are projected for the Project area, relative to 1990 are shown in **Table 18.4a**.

18.5 VULNERABILITY OF THE PROJECT TO FUTURE CLIMATE CHANGE

The vulnerability of the Project to future climate change is a function of the exposure and sensitivity of project elements and components to the various aspects of climate change discussed in the previous sections of this chapter.

In general, the geographic setting and location of the Airport increases its exposure to impacts from coastal climate change and flooding (as a result of more intense rainfall and storm events) as a result of surrounding low lying land. Inversely, as large areas of the airport are cleared, grassed and maintained for aviation navigational safety purposes, there is lower exposure to risks such as bushfire damage to existing and future infrastructure.

In defining the sensitivity of the Project to future climate change, the Project has been broken down into two distinct phases:

1) Design and location of infrastructure
2) Activities undertaken once the infrastructure (that is the new runway and taxiway) is operational.

Construction activities may be affected by extreme weather events but are not expected to be affected by longer term climate change implications such as sea level rise assuming the Project is built within a reasonable period following approval.

Table 18.5a provides an overview of the aspects of the Project that may be sensitive to future climate change impacts. This table forms the basis for identification of risks taken forward in the next section for analysis, evaluation and treatment.

Table 18.4a: Projected future changes in climate considered as part of the Project

Projected future changes in climate for the Project
Temperature • Temperature increase of up to 6.5oC by 2100 • Extra 30 days over 35oC per annum by 2100.
Rainfall and evaporation • Reduction in average annual rainfall by 2100 • Rainfall events becoming more intense • Increased potential for flooding, to be further exacerbated by sea level rise • Potential evaporation increase of 6–16 per cent by 2070 • Frequency and duration of droughts expected to increase.
Sea level rise and storm surges • For runway design – projected sea-level rise factor of 0.8m by 2100 • For flooding assessments – projected sea-level rise factor of 0.3m by 2050 • Expected increase in storm surges and king tides and associated increase in flooding.
Wind • Wind speeds to increase • Resulting alteration in wave climate • Potential for increased storm surges, large waves, coastal inundation and erosion.
Tropical cyclones • Potential increase in impacts from cyclones due to southward shift along Queensland coastline • Increase in cyclone severity and longevity.
Storms • Increase in number of severe storms with increased risks of large hail storms for the Sunshine Coast.
Droughts and bushfires • Frequency and duration of droughts expected to increase • Bushfires expected to become more frequent and intense as a result of vegetation thickening, increased temperature, declining rainfall and increased wind speeds.

The table headings within the columns of **Table 18.5a** should be interpreted as follows:

- 'Sea level rise' includes the associated increased risk from permanent and temporary storm tide inundation (that is, flooding from the sea)
- 'Increased storminess' refers to increasingly intense storm events (including possible cyclonic activity) leading to flooding, erosion, or other processes that could damage infrastructure
- 'Decreased water supply' refers to increased drought conditions and increased evaporation and their effects on both natural and built systems.
- 'Increased temperature' includes increases in mean temperature as well as increases in the number of hot days over 35°C
- 'Increased bushfire' refers to more frequent or intense bushfire events.

As shown in **Table 18.5a**, key aspects of the design and layout of the Project in the context of future climate change impacts include the location and fill elevation of the proposed runway and taxiways, vulnerability of associated aviation infrastructure and services and the capacity of the site drainage system.

Depending on the location and final design of this infrastructure, factors such as flash flooding or increased storminess (lightning, wind, dust, smoke from bushfire) could also affect the operational useability of the proposed runway. Likewise, without adequate consideration in the design, a combination of impacts (intense storms, increased temperatures, higher evaporation rates, saltwater intrusion) could give rise to the need for greater maintenance, repair and/or replacement of infrastructure.

Given the timeframes proposed for development, construction stage activities are likely to be subject to current (as opposed to predicted future) climatic conditions but still may need to take into account extreme weather.

Table 18.5a: Project elements that may be sensitive to future climate change

Project element	Sea level rise	Increased storminess	Decreased water supply	Increased temperature	Increased bushfire
Design and layout considerations					
Runway and taxiway footprint and elevation/vulnerability	✗	✗			
Site drainage system (on site and off site flooding impacts on built and natural environment)	✗	✗	✗		
New underground services	✗	✗	✗		
Location of radar, lighting and other navigational equipment	✗	✗			
Operational stage considerations					
Runway operations and useability	✗	✗			✗
Maintenance and repair/ replacement of runway and taxiway infrastructure	✗	✗		✗	
Aircraft safety/useability/noise	✗			✗	✗

Broader impacts from climate change on aircraft operation and the aviation industry are generally outside of the scope of this assessment and will need to be addressed by the industry more broadly in the future. Specific issues that may be relevant to airport operation include predicted reductions in aircraft payload and slow climb rates during extreme hot weather and possible delays or reduction in useability of the runway infrastructure as a result of more frequent extreme weather events (lightning, dust storms, smoke from fire, etc.).

18.6 IMPACT ASSESSMENT – RISK REGISTER AND ASSESSMENT

The following section sets out a risk register detailing potential hazards and risks to the Project that may be associated with climate change.

For the purpose of this chapter, risk is defined as the likelihood of the Project being affected as a result of climate change and the varying degrees of consequence. This methodology is consistent with the risk management framework in AS/NZS 31000 Risk Management.

In accordance with the Standard, each identified risk has then been assessed in terms of its consequence and likelihood, evaluated in the context of existing controls (such as the proposed design of the new infrastructure) and an overall risk rating provided. Risk treatment measures (in the form of current and future mitigation commitments) are then proposed where risk levels can be further reduced.

18.6.1 Methodology

The publication *Climate Change Impacts and Risk Management: A Guide for Business and Government* (DEH 2006) has been used as the basis of the methodology to determine likelihood and consequence to create a risk matrix. The standard consequence and likelihood scales from that document have been augmented by more recent advice provided as part of the Risk Standard AS 5334 for *Climate Change for Settlements and Infrastructure*, and have been adopted here.

18.6.1.1 Consequence scales

The consequence scale used in this risk assessment is presented in **Table 18.6a**.

18.6.1.2 Likelihood scales

The likelihood scale used in this risk assessment is presented in **Table 18.6b**.

18.6.1.3 Risk matrix

In order to define the level of priority associated with each combination of consequence and likelihood, the following risk matrix developed by DEH (2006) has been adopted (**Table 18.6c**).

The general interpretation of the priority of risk from this table is as follows (DEH, 2006):

- **Extreme** risks demand urgent attention at the most senior level and cannot be simply accepted as a part of routine operations without executive sanction. These risks are *unacceptable* and should be eliminated or reduced through control measures.
- **High** risks are the most severe that can be accepted as a part of routine operations without executive sanction but they would be the responsibility of the most senior operational management and reported upon at the executive level. These risks are *undesirable* and should be eliminated or reduced through control measures.
- **Medium** risks can be expected to form part of routine operations but they would be explicitly assigned to relevant managers for action, maintained under review and reported upon at senior management level. These risks are *acceptable with formal review* but should be managed through control measures where practical to do so.
- **Low** risks would be maintained under review but it is expected that existing controls would be sufficient and no further action would be required to treat them unless they become more severe. These risks are *generally acceptable* but should be reviewed from time to time to ensure they remain classified as low.

18.6.1.4: Relationship with significance criteria

The Project EIS impact assessment methodology adopts a similar risk-based approach for characterising the significance and likelihood of impacts on receiving environmental values. This methodology has been modified slightly for the purpose of ensuring the climate change assessment presented in this chapter is consistent with the requirements of the Terms of Reference and to ensure close alignment with ISO 31000 and AS 5334.

18.6.1.5: Risk identification and register

The sensitivity and exposure of various project elements to future climate change is summarised in **Table 18.5c**. Based on this initial grouping, a more definitive list of risk statements has been developed which form the basis for more formal analysis and evaluation.

<u>Design and layout</u>

Note that these risk statements should be interpreted in the context of the proposed design and layout of the Project as outlined in Chapter A4 – Project Description of the EIS:

DL1 Sea level rise, increased storms and flooding lead to damage/increased maintenance of the new runway and taxiway system.

DL2 Sea level rise, increased storms and flooding in combination with changes to surface water hydrology from the Project lead to drainage or hydrology impacts to the natural environment within or adjacent to the site.

DL3 Sea level rise, increased storms and flooding in combination with changes to surface water hydrology from the Project, lead to drainage or hydrology impacts to the built environment within or adjacent to the site.

DL4 Decreased rainfall, increased temperature and evaporation in combination with changes to surface and ground water hydrology from the Project lead to impacts on the natural environment within or adjacent to the site (e.g. desiccation and/or changes to natural wetting or drying regime in key habitats).

DL5 New underground services are vulnerable to sea level rise (saltwater intrusion) impacts or by impacts from increased storms and flooding.

<u>Operational stage</u>

Note that these risk statements should be interpreted in the context that the proposed design and layout of the Project has been built in accordance with Chapter A4 – Project Description of the EIS and operational phase environmental management plans (EMP) as outlined in Chapter E3 of the EIS have been implemented.

O1 Sea level rise, increased storms and flooding lead to decreased useability of the runway.

O2 Sea level rise, increased storms and flooding and increased temperature lead to increased requirements for maintenance and/or repair of runway and taxiway infrastructure.

O3 There is a reduction in the useability of the new runway due to aircraft safety issues related to any of the following issues: increased standing water (bird hazard), increased bushfires (smoke hazard), increased temperatures (dust storms, reduction in aircraft payload and/or noise restrictions on operations), increased storminess (lightning, etc.).

As outlined above, the risk analysis and evaluation step for each risk identified above includes an assessment of the consequence (**Table 18.6a**) and likelihood (**Table 18.6b**) of the impact from the risk occurring from which to assign an overall risk rating (low, medium, high or extreme) in accordance with **Table 18.6c**.

In accordance with ISO 31000, the risk rating needs to take into account existing controls – that is measures within the adopted design and proposed layout of the Project, construction environmental management plans and any guidance that can be provided on how operational phase activities would be managed in accordance with Airport operational plans and procedures. These measures are generally outlined in other chapters of the EIS, with the key design aspects summarised in **Section 18.6.3**.

18.6.2 Existing controls – Project design

As outlined in Chapter A4 of the EIS, the following points are relevant in considering how the design of the Project has taken into account impacts from future climate change:

- The overall philosophy for determining the level of adaptation to climate change was based on:
  - A risk assessment of the infrastructure taking into consideration public safety and potential financial loss
  - The potential for the infrastructure to be modified in the future to adapt to climate change when the likely conditions are more certain
- The airfield and taxiway infrastructure were identified as needing to be developed in full consideration of climate change given the difficulty of modifying the facilities in the future, and the high potential loss should the infrastructure be damaged
- The runway and main parallel taxiway would be filled using sand from Moreton Bay to a level that makes the infrastructure immune to flooding based on a Q100 at 2100 flood scenario with a 0.8 m sea level rise. This scenario was developed using the climate change benchmarks from the former Queensland Coastal Plan 2011 (DERM 2011a and b) and other relevant guidelines (Engineers Australia, 2013)
- As outlined in Chapter B5, the results of the 2050 flood modelling scenario indicate a widespread increase in predicted flood levels across the catchment from climate change alone. With the inclusion of the new runway, the forecast flood levels are predicted to increase to a minor extent north and east of existing Runway 18/36. Chapter B5, further notes that this increase in forecast flood levels are indicative of the need for a regional climate change mitigation strategy for the Maroochy River catchment and such a mitigation strategy will be prepared and implemented by the appropriate authorities (including SCC) as it become required
- In the context of more localised drainage issues on the site, existing and proposed drainage channels have been designed to deal with a range of historical stormwater events. Further design of the drainage system would be considered following the EIS as part of the detailed design process. The performance of the local drainage system would be monitored over time, noting that there are a range of remedial works (widening and deepening of drainage channels) that could be undertaken in the future to accommodate changes in rainfall patterns (greater intensity, greater frequency) associated with climate change or where localised flooding was observed
- Changes to local drainage from the Project that could affect natural values within or adjacent to the site (such as retained habitat for threatened species and the adjacent National Park areas) relate to ecosystem processes such as groundwater recharge, wetting and drying cycles, and the duration and frequency of inundation. These matters have been assessed in the EIS chapters related to Terrestrial Flora (B7), Terrestrial Fauna (B8) and Aquatic Flora and Fauna (B9). These assessments include consideration of future climate change implications on these habitats and areas
- The most effective strategy for mitigating longer-term climate change impacts on natural systems would be through reducing anthropogenic impacts and building the resilience of these habitats through appropriate management regimes over time. Such mitigation and monitoring measures are outlined in Volume E of the EIS in the context of the construction and operational environmental management plan for the Project and through broader environmental strategies implemented by the SCC and adjacent conservation land owners
- While the runway itself will be designed to be immune from permanent inundation impacts, long term predictions of sea level rise indicate that the area to the north of the north-western end of the runway may be subject to more permanent inundation by 2100 based on the State Government's coastal hazard mapping (refer **Figure 18.2b**). More regular inundation of this area may attract avifauna and as a result has the potential to increase risk of bird strike during runway operation. At this stage, a design solution to this potential issue has not been developed, with the level of risk to be monitored over time and noting the risk of impacts are uncertain and long term. Remedial measures that could be taken to control this risk over time include increased on-ground management (bird scaring by Airport Operations Staff) or changes to the local drainage, such as flood flaps beneath the Sunshine Motorway to prevent backflow from the Maroochy River during normal flow (whilst still providing for backflow during flood events).

*Table 18.6a: Qualitative measures of consequence**

Consequence descriptor	Adaptive capacity	Infrastructure, Service	Social/Cultural	Governance	Financial	Environmental	Economy
Insignificant	No change to the adaptive capacity.	No infrastructure damage, little change to service.	No adverse human health effects.	No change to management required.	Little financial loss or increase in operating expenses.	No adverse effects on natural environment.	No effects on the broader economy.
Minor	Minor decrease to the adaptive capacity of the asset. Capacity easily restored.	Localised infrastructure service disruption. No permanent damage. Some minor restoration work required. Early renewal of infrastructure by 10-20 per cent. 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, <10 per cent.	Minimal effects on the natural environment	Minor effect on the broader economy due to disruption of service provided by the asset.
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 per cent.	Frequent disruption to employees, customers or neighbours. Adverse human health effects.	Investigation by regulators. Changes to management actions required.	Moderate financial loss 10 - 50 per cent.	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.
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 per cent.	Permanent physical injuries and fatalities may occur. Sever 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 per cent.	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.

Consequence descriptor	Adaptive capacity	Infrastructure, Service	Social/Cultural	Governance	Financial	Environmental	Economy
Catastrophic	Capacity destroyed, redesign required when repairing or renewing asset.	Significant permanent damage and/or complete loss of the infrastructure service. Loss of infrastructure support and translocation of service to other sites. Early renewal of infrastructure by >90 per cent.	Sever adverse human health effects, leading to multiple events of total disability or fatalities.	Major policy shifts. Change to legislative requirements. Full change of management control.	Extreme financial loss >90 per cent	Very significant loss to the environment. May include localised 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.

**Source: Risk Standard AS 5334 for Climate Change for Settlements and Infrastructure*

Table 18.6b: Qualitative measures of likelihood

Rating	Descriptor	Recurrent or event risks	Long-term risks
Almost certain	Could occur several times per year.	Has happened several times in the past year and in each of the previous 5 years. OR Could occur several times per year.	Has a greater than 90 per cent chance of occurring in the identified time period if the risk is not mitigated.
Likely	May arise about once per year.	Has happened several times in the past year and in each of the previous 5 years. OR Could occur several times per year.	Has a 60 – 90 per cent chance of occurring in the identified time period if the risk is not mitigated.
Possible	Maybe a couple of times in a generation.	Has happened during the past 5 years but not in every year. OR May arise once in 25 years.	Has a 40 – 60 per cent chance of occurring in the identified time period if the risk is not mitigated.
Unlikely	Maybe once in a generation.	May have occurred once in the last 5 years. OR May arise once in 25 to 50 years.	Has a 10 – 30 per cent chance of occurring in the future if the risk is not mitigated.
Rare	Maybe once in a lifetime.	Has not occurred in the past 5 years. OR Unlikely during the next 50 years.	May occur in exceptional circumstances, i.e. less than 10 per cent chance of occurring in the identified time period if the risk is not mitigated.

Table 18.6c: Risk matrix

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

18.6.3 Risk ratings and treatment – summary

Table 18.6d provides the risk analysis and evaluation for each risk identified above. This risk register includes consideration of existing controls and a subsequent assessment of the consequence and likelihood of the impact to generate an overall risk rating (low, medium, high or extreme) in accordance with **Table 18.6c**.

Risk treatment is then based on additional controls or actions that are justified to further treat/reduce the risk. This can occur either through a reduction in the likelihood of impact or the consequence of impact (e.g. its severity, duration, etc.). In general, if assessed risk levels are medium, high or extreme, they would be subject to consideration of additional treatment options through adaptation whereas low risks are considered acceptable.

18.7 CONCLUSION

Based on the outputs of the risk assessment, relevant climate change risks that have been identified can be reduced to a low residual risk levels through a mix of existing controls (associated with the design of key infrastructure elements of the Project) and through the proposed implementation of risk treatment measures.

As there is considerable scientific uncertainty to the timing and magnitude of climate change impacts at a local scale, the risk register developed for the Project as outlined in this chapter, should be reviewed prior to commencing works and then periodically reviewed (every five years) throughout the operation of the new runway and associated infrastructure to ensure assessed risk levels are accurate and proposed treatment measures are being implemented and are effective.

Where practicable, it is recommended this review of risk be integrated within and done in combination with planned reviews of the Sunshine Coast Climate Change and Peak Oil Strategy (SCC 2010c).

Table 18.6d: Risk register

ID	Risk statement	Existing controls	Likeli-hood	Conse-quence	Risk rating	Additional mitigation	Residual
DL1		Consequence	Rare	Major	Low	None Proposed; Design considered appropriate to manage the risk	Low
DL2		Risk Rating	Additional Mitigation	Residual	Low	The considerable increase in forecast flood levels across the catchment caused by climate change indicates a requirement for regional climate change mitigation for the Maroochy River catchment regardless of development at SCA. A regional mitigation strategy would be prepared and implemented by cooperation between appropriate government planning authorities at Federal, State and Local government level as it becomes required. SCA would work with the relevant authorities to ensure that the potential impacts associated with the new runway are accommodated in the regional strategy.	Low
DL3	Sea level rise, increased storms and flooding in combination with changes to surface water hydrology from the Project, lead to drainage or hydrology impacts to the built environment within or adjacent to the site.	The design of the new runway includes significant mitigation infrastructure including new large scale drainage channels (north, south and west of the runway) to assist in flood mitigation and minimise flood impacts for events up to the 100-year ARI flood, including for a 2050 climate change scenario. Flood modelling indicates that without development of the Project, climate change would cause a widespread increase in predicted flood levels across the catchment, with peak flood levels forecast to be approximately 200 mm to 350 mm higher than current day flood levels for the 100-year ARI flood. With the inclusion of the new runway, the forecast flood levels are predicted to increase to a minor extent (between 20 mm and 35 mm north and east of the existing RWY 18/36).	Rare	Moderate	Low	SCA would monitor performance of drainage systems on the airport over time and undertake remedial works as required (clearing of drains and culverts to maintain flow capacity). As discussed above, a regional mitigation strategy would be prepared and implemented by cooperation between appropriate government planning authorities at Federal, State and Local government level as it becomes required. SCA would work with the relevant authorities to ensure that the potential impacts associated with the new runway are accommodated in the regional strategy.	Low

ID	Risk statement	Existing controls	Likeli-hood	Conse-quence	Risk rating	Additional mitigation	Residual
DL4	Decreased rainfall, increased temperature and evaporation in combination with changes to surface water and groundwater hydrology from the Project lead to impacts on the natural environment within or adjacent to the site (e.g. desiccation or changes to natural wetting or drying regime in key habitats).	The design includes measures to minimise impacts to hydrological regimes and groundwater levels. Key controls to mitigate impacts on groundwater include: • The perimeter drains to reduce hydrological changes and • The cut off wall north of the northern perimeter drain to prevent groundwater drawdown.	Unlikely	Minor	Low	**None proposed**	Low
DL5	New underground services such as power and lighting to the new runway are vulnerable to sea level rise (saltwater intrusion) impacts or by impacts from increased storms and flooding.	Underground services are generally located above forecast flood levels for the runway. Services located in the new road to the Air Traffic Control tower would have some level of immunity.	Unlikely (short – medium term) Possible (only in longer term)	Minor	Medium - Low	If over time permanent inundation is expected, relocation of underground services would be undertaken. This should be monitored over time and built into asset maintenance schemes	Low

ID	Risk statement	Existing controls	Likeli-hood	Conse-quence	Risk rating	Additional mitigation	Residual
O1	Sea level rise, increased storms and flooding lead to decreased useability of the runway.	TRunway to be constructed on fill designed to have immunity for a 2100 climate change scenario 100-year ARI flood event. As a result the runway and taxiway could be operational even during large storm and inundation events or otherwise provide a safe refuge. Nevertheless, it is likely that other factors would lead to normal flights being postponed or cancelled.	Rare	Moderate	Low	Potential delays (while undesirable) associated with storm activity are not seen as a significant impact given the projected runway demand and number of movements projected.	Low
O2	Sea level rise, increased storms and flooding and increased temperature lead to increased requirements for maintenance and/or repair of runway and taxiway infrastructure.	Main elements of project (runway, main taxiway) to be constructed on a fill platform designed to have immunity for a 2100 climate change scenario 100-year ARI flood event.	Rare	Moderate	Low	None required as infrastructure to be designed to provide immunity to flooding and storm surge at least to 2100 levels.	Low

ID	Risk statement	Existing controls	Likeli-hood	Conse-quence	Risk rating	Additional mitigation	Residual
O3	There is a reduction in the useability of the new runway due to aircraft safety issues related to any of the following issues: increased standing water (bird hazard), increased bushfires (smoke hazard), increased temperatures (dust storms, reduction in aircraft payload and/or noise restrictions on operations), increased storminess (lightning, etc.).	Bird Hazard: Increased ponding at the end of the new runway (in areas permanently inundated by future sea level rise predicted between 2050 and 2100) is possible in the long term based on current coastal hazard mapping and should it occur, has the potential to increase risk of bird strike as a result of bird aggregation in wetland areas. However, it should be noted that there are existing control measures implemented on the Airport for bird hazards that could be extended to address the increased risk.	Possible	Moderate	Medium	The extent of impact is uncertain (both in terms of the effects of future sea level rise and the degree to which birds will be attracted to the area), however this issue would be monitored on an on-going basis As outlined in **Section 18.6.3**, there are a range of remedial measures that could be undertaken to manage this risk in the future if required. Additionally, and as discussed above, a regional mitigation strategy would be prepared and implemented by cooperation between appropriate government planning authorities at Federal, State and Local government level as it becomes required. SCA would work with the relevant authorities to ensure that the potential impacts associated with the new runway are accommodated in the regional strategy.	Low

ID	Risk statement	Existing controls	Likeli-hood	Conse-quence	Risk rating	Additional mitigation	Residual
		Bushfires (smoke hazard): Not currently a major hazard as there is a very minimal fire regime on surrounding lands including National Parks. Chapter A4 shows that the project comprises a series of large drains located between the runway and surrounding vegetation. In addition, there is a 150m wide grassed graded runway strip and flyover area either side of the runway centreline. It is considered that these features would act as an adequate firebreak in the case of a wildfire in the National Park. If runway visibility is affected by a fire generated in the surrounding areas including the National Park, AirServices would make the decision to close the runway for safety reasons. Please note that the airport is equipped with an aviation rescue and fire fighting service (ARFFS) to manage all fire/rescue related issues relevant to the airport. It should also be noted that the "airside" element of the airport is a secure area whilst the airport is operational. This would mean that the airport would not normally be available for access purposes to attack a fire in either portion of the national park unless a decision had already been made to shut the airport.	Unlikely	Minor	Low	None Proposed; Design considered appropriate to manage the risk	Low
		Temperature (dust storms): Dust storms not expected to be a significant issue.	Rare	Minor	Low	Potential delays (while undesirable) are not seen as a significant impact given the projected runway demand and movements	Low
		Storminess: Project area may experience increased impacts from cyclones but not expected to be significant as site located at southern extent of main area of tropical cyclone formation.	Unlikely	Minor	Low	The orientation of the new RWY 13/31 provides more resilience with respect to landing in inclement weather conditions.	Low

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