B5

AIRPORT AND SURROUNDS

FLOODING

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FLOODING

GLOSSARY

AEP	Annual exceedance probability The probability that a given rainfall total accumulated over a given duration would be exceeded in any one year.
AHD	Australian height datum
ALS	Aerial laser survey
ARI	Average recurrence interval The average, or expected, value of the periods between exceedances of a given rainfall total accumulated over a given duration.
CAMCOS	Caboolture to Maroochydore Corridor Study
CMP	Coastal Management Plan
Computational Grid	The computational grid is used to describe characteristics that affect hydraulic behaviour within the model domain. Model computations are made at each point in the grid.
Boundary inflows	The stream flow hydrograph (flow rate) applied at the upstream limit(s) of the model domain.
DFE	Defined flood event
DSTE	Define storm tide event
EIS	Environmental impact statement
PMF	Probable maximum flood
PMST	Probable maximum storm tide
Roughness value	Roughness values are used in the flood model to describe frictional resistance. For example, a forested area has a relatively high roughness value, whereas concrete or turf would have a relatively low roughness value.
RWY	Runway
SPP	State Planning Policy
SPRP	State Planning Regulatory Provision
SCA	Sunshine Coast Airport

5.1 INTRODUCTION

5.1.1 Site description

The Sunshine Coast Airport Expansion Project (the Project) is an expansion of the existing Sunshine Coast Airport (SCA) at Marcoola. The new runway and associated development, which is the subject of the Environmental Impact Statement (EIS) is generally to the north and west of the existing runway and terminal. A detailed description of the Project is provided in Chapter A4 – Project Description.

The airport and the Project are located within the floodplain of the Maroochy River. **Figure 5.1a** shows the location of the Sunshine Coast Airport.

5.1.1.1 Maroochy River catchment

The Maroochy River catchment lies on the eastern side of the Blackall Ranges and has a catchment area of approximately 620 km^2 (BOM, 2011). It is bounded in the south by the Buderim Mountain Divide between the Maroochy and Mooloolah Rivers, and in the north by a lowland divide between the Maroochy and Noosa River flood plains (BOM, 2011).

The Maroochy River discharges into the Coral Sea at Maroochydore and extends approximately 30 km inland from the river mouth to the South Maroochy River-North Maroochy River confluence near Yandina. The head of the North Maroochy River is approximately 20 km upstream of the confluence near Cooroy, and the head of the South Maroochy River is approximately 15 km upstream of the confluence near Mapleton. Cooloolabin Dam and Wappa Dam are both located on the South Maroochy River upstream of the confluence. **Figure 5.1b** shows the Maroochy River catchment and the catchments of the major tributaries (SCC, 2010).

The upper reaches of the catchment contain relatively steep terrain while the floodplain of the lower reaches is relatively flat. The floodplain constitutes approximately 30 per cent of the catchment area and includes SCA. Less than half of the floodplain is urbanised, with most of the area consisting of National Park and agricultural land. The Sunshine Motorway crosses the Maroochy River floodplain in a north-south direction between the Maroochy River and the airport.

5.1.1.2 Marcoola drain

The Marcoola drain is located north of the airport and connects to the Maroochy River west of the motorway. It drains the area between Mt Coolum and the drain, as well as part of the area north of the airport, into the Maroochy River west of the Sunshine Motorway. During large floods, the drain allows the passage of floodwaters from the Maroochy River into the floodplain east of the Sunshine Motorway and north of the airport.

The Marcoola drain is a man-made channel, which was built sometime in the 1950's to drain the area for cane farming.

Figure 5.1.a: Location of the Sunshine Coast Airport

Figure 5.1b: Maroochy River catchment (SCC, 2010)

A number of structures have been established on the creek, including a causeway at Finland Road and a bridge at the Sunshine Motorway.

Figure 5.1c shows the location and key features of the Marcoola drain.

5.1.1.3 Sunshine Coast Airport

The airport is located in the floodplain of the Maroochy River south of the Marcoola drain. In general, the airport drains to the Maroochy River to the west, although part of the site drains south to the Maroochy River.

Figure 5.1d shows the major drainage lines on the airport and nearby areas. The figure indicates that most runoff from the airport drains west through a series of constructed open drains (a combination of airport drainage and old cane drains) to the Maroochy River approximately 1 km west of the Sunshine Motorway.

Runoff from part of the existing runway and the residential areas north and east of the runway drains to the partially concrete-lined perimeter drain that flows from north to south along the eastern boundary of the airport. This drain discharges into the canal system of the Twin Waters estate. A weir has been established at the Twin Waters canal to maintain water levels in the system; consequently, runoff from this area only discharges to the Maroochy River in large events when water levels are above the crest of the weir.

5.1.2 Study area

The study area for the flood assessment includes the Maroochy River mouth, Eudlo and Petrie Creek confluences with the Maroochy River, and the Twin Waters canal system.

The locations of the hydraulic model boundaries are shown in **Figure 5.1e**.

5.1.3 Proposed development

The Project includes construction of a new runway, redevelopment of the existing terminal and development of other supporting aviation infrastructure. The new runway would be to the north-west of the existing terminal, as shown in **Figure 5.1f**. The total development area is approximately 230 ha, which includes approximately 30 ha that is currently elevated above the floodplain.

As discussed in the Chapter A4 – Project Description, the new runway has been designed to have immunity from the 100-year average recurrence interval (ARI) flood in combination with a 2100 sea level rise scenario of 0.8 m.

A detailed description of the proposal is included in Chapter A4 – Project Description. Potential impacts from the Project and their mitigation are discussed in **Section 5.5**.

5.1.3.1 Proposed airport drainage

Proposed drainage infrastructure for the Project is shown in **Figure 5.1g**, and includes:

- A new northern perimeter drain, which conveys runoff from the new runway north-west into the Marcoola drain during normal rainfall events. There would be some modification to the Marcoola drain where the drain discharges (scour protection, etc.)
- The western perimeter drain, which conveys some flow from the northern perimeter drain around the end of Runway (RWY) 13/31 into the southern perimeter drain.

Figure 5.1c: Marcoola drain

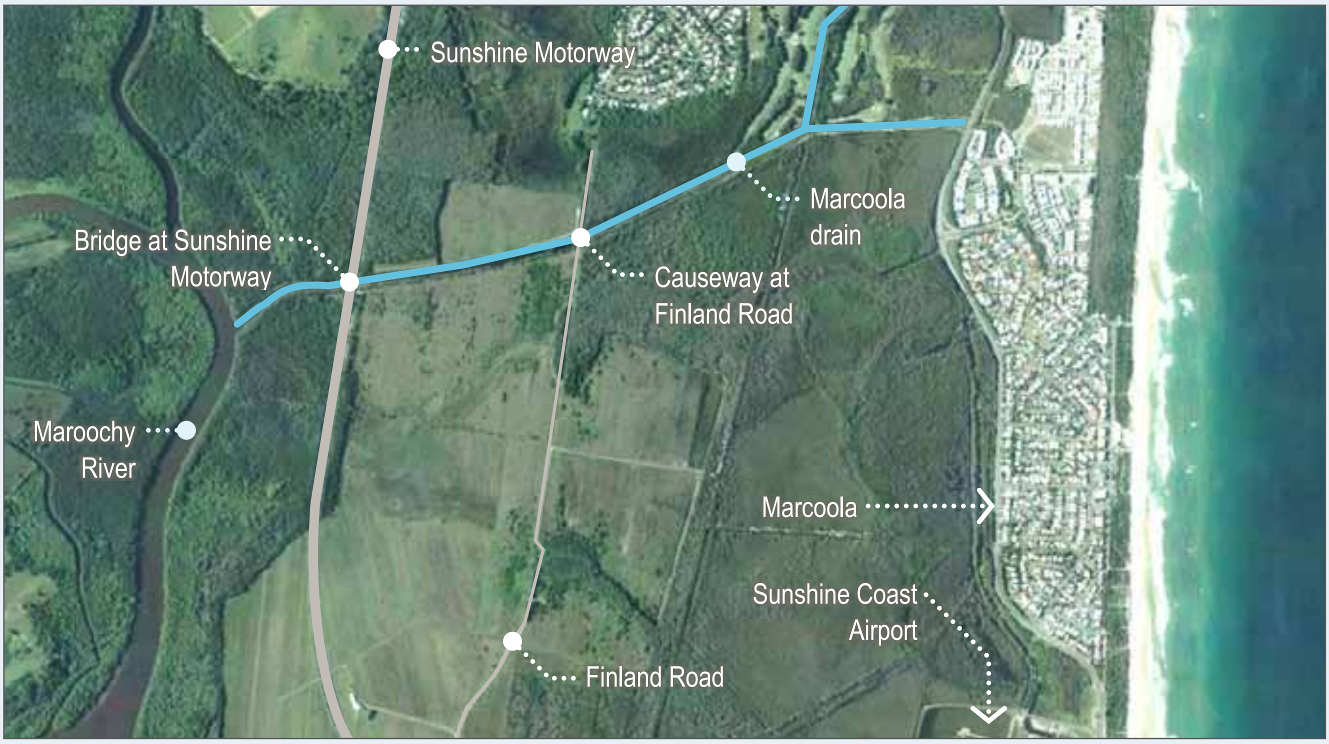


Figure 5.1d: Existing drainage at Sunshine Coast Airport and receiving waters

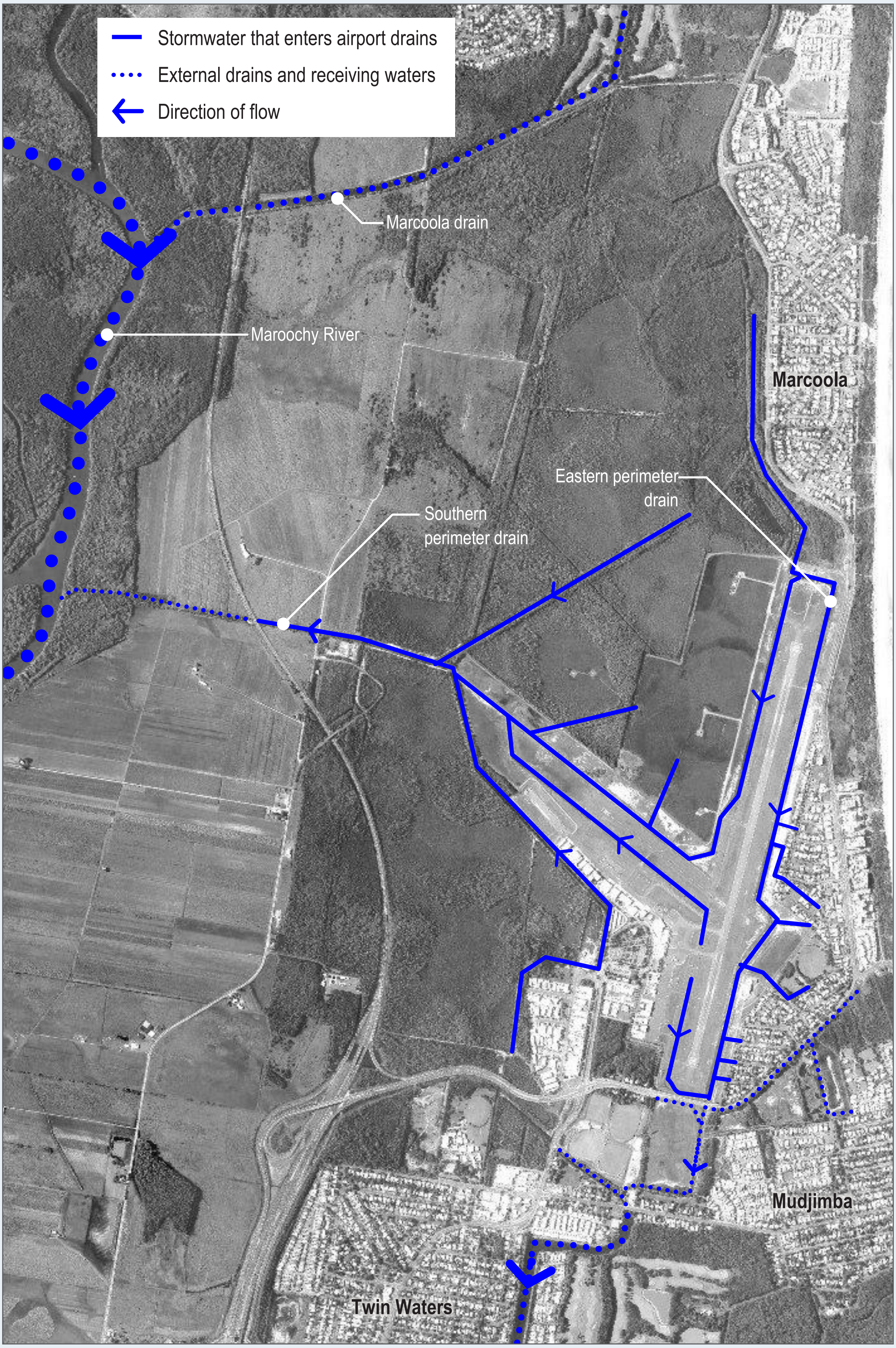


Figure 5.1e: Study area and hydraulic model boundaries

Figure 5.1f: Elements of the Project

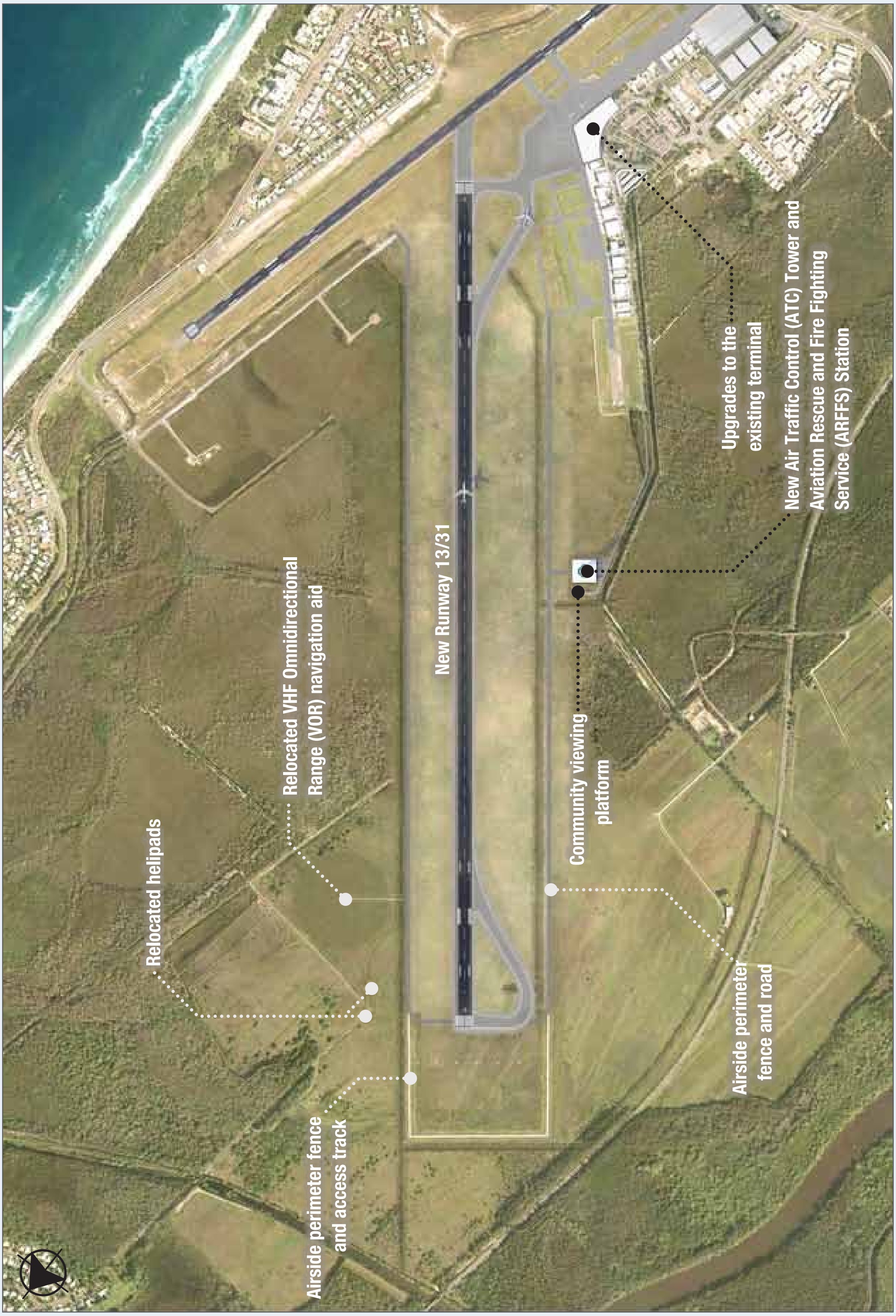


Figure 5.1g: Proposed drainage infrastructure

The purpose of this drain is to improve the conveyance of floodplain flows around the end of the runway, helping to reduce the flood level north of the runway

- The runway drain, which would collect runoff from the runway and direct this into the southern perimeter drain near the Air Traffic Control tower
- A minor realignment of the eastern perimeter drain at the end of RWY 13/31 to maintain the required clear distance from the runway end.

No further structural changes are proposed for the Marcoola drain or the Maroochy River.

Additional detail of the proposed drainage infrastructure is provided in Chapter A4 – Project Description.

5.2 METHODOLOGY

5.2.1 Assessment methodology

Potential impacts from the Project were assessed for a number of flood events as detailed in **Section 5.2.1.3**, including a climate change scenario for 2050. A computer-generated hydraulic model was developed to predict flood levels and duration for pre and post development scenarios for current-day conditions, and to test the effectiveness of the proposed mitigation measures.

5.2.1.1 Assessment parameters

Potential impacts to local and regional flooding were assessed based on changes to:

- Peak water levels
- Duration of inundation
- Peak flow velocity.

5.2.1.2 Assessment locations

Catchment wide impacts to peak flood depth and extent were assessed and reported through catchment mapping, shown in **Section 5.5.2**.

Peak flood depth, duration of inundation and flow velocities were assessed at 11 locations, chosen to represent areas of potential interest, such as residential areas or near major infrastructure. The assessment locations are shown in **Figure 5.2a**.

The duration of inundation was reported at five of these locations, which are located in flood plains and residential areas; the remainder are located within waterways and are inundated for the duration of the simulated flood event and therefore do not provide an indication of floodplain changes with respect to time of inundation.

Peak flood level, velocities and duration of inundation for existing conditions and post-development conditions were compared to identify potential impacts. Significance criteria and areas of notable change are described in **Section 5.5**.

5.2.1.3 Assessment scenarios

Potential flood impacts were assessed for a range of storm events for the current day situation and for the 2050 100–year ARI climate change scenario as outlined in **Table 5.2a**.

5.2.2 Maroochy River flood model

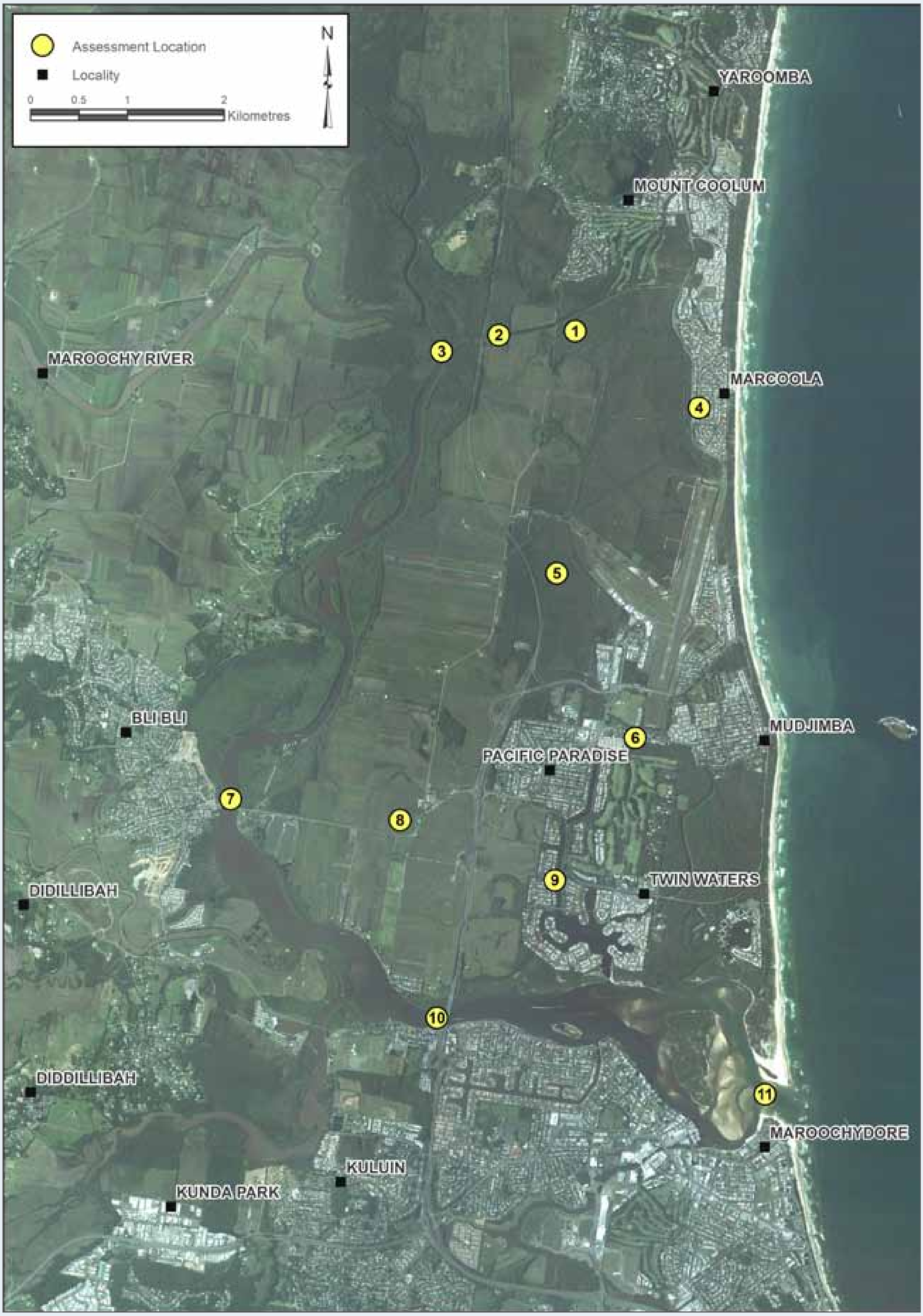
Sunshine Coast Council (SCC) has developed a regional flood model for the Maroochy River, which is used for planning purposes by SCC. The model covers an area of approximately 194 km^2 and includes tributaries of the Maroochy River system, including the Lower Maroochy River, Yandina Creek, Doonan Creek, Petrie Creek, Paynter Creek, and Eudlo Creek. SCC's model was established with an 18 m computational grid.

For the purposes of the EIS, a new project specific model was developed to assess potential flood impacts of the Project. It focuses on the waterways around the Project and has a 10 m computational grid, which provides higher

Table 5.2a: Flood assessment scenarios

Storm Frequency		Scenarios	
Average Recurrence Interval (ARI)	Annual Exceedance Probability (AEP)	Current Day	2050 Climate Change
2-year	39.3%	✔	–
5-year	18.1%	✔	–
10-year	9.5%	✔	–
20-year	4.9%	✔	–
50-year	2%	✔	–
100-year	1%	✔	✔

Figure 5.2a: Assessment locations



resolution than the SCC model. The extent of the model in comparison to SCC's model is shown in **Figure 5.2b**.

The following inputs from SCC's model were used within the Project model:

- Boundary inflows for the Project model were taken from the SCC model
- Roughness values from the SCC model were used in the Project model, with some updates to better reflect ground conditions
- Inflows for local catchments (represented as either point source or direct precipitation) within the Project model were taken from the SCC model.

Details of hydraulic structures within the model were obtained from as-constructed drawings and field survey.

A discussion of the difference in results from the SCC model and the Project model is provided in **Section 5.4.3**.

5.2.2.1 Hydrologic inputs

Hydrologic inputs for the Project model were taken from the SCC Maroochy River model, which used duration independent storms to define extreme rainfall events. The Project model relies on hydrologic inputs from the SCC model as follows:

- Upstream inflows were extracted from SCC's model
- Direct precipitation and point source inflows were taken from SCC's model:
  - To avoid model instabilities, point sources with a peak discharge greater than 40 m^3/s were separated into multiple point sources placed close together
  - To maintain consistency with the SCC model, direct precipitation was used on urban areas within the model.

5.2.2.2 Topography

The model topography (including terrain and bathymetry) was obtained from the following sources and applied as outlined in **Table 5.2b**:

- 2001 bathymetric survey of the Maroochy River
- 2010 bathymetric survey of the Maroochy River mouth
- 2004 aerial laser survey (ALS)
- 2012 field survey
- Information from the SCC Maroochy River flood model.

The resulting model topography is similar to the SCC model topography, with some changes to reflect current catchment conditions.

5.2.2.3 Drainage channels

Drainage channels in the model were represented as 1-dimensional channels coupled with the 2-dimensional grid. This approach allows the conveyance capacity of the channel to be approximated more accurately for relatively small waterways. Drainage channels that experience significant submerged cross-channel flow were modelled within the 2-dimensional grid, as 1-dimensional channels did not correctly represent cross-channel flows in the model.

5.2.2.4 Downstream boundary condition

A constant tailwater level of 1.1 m Australian Height Datum (AHD) was applied in the modelling for current day conditions, which is consistent with the approach adopted by SCC for the Maroochy River flood model.

5.2.2.5 Climate change

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). Predicting potential impacts after this time has a high level of uncertainty, as there are likely to be substantial changes across the catchment, such as urban development and potentially infrastructure to mitigate climate change impacts, which would have significant effects on the flooding environment of the Maroochy River catchment.

In Queensland, climate change is predicted to cause sea level rise and increased rainfall intensity (DERM, 2011), and these changes have the potential to influence flood conditions at the airport.

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 1.4 m AHD was adopted for the climate change scenario (see **Section 5.2.2.4** for a discussion of current tailwater conditions).

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 per cent 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).

It should be recognised that the climate change projections used in the modelling contain various levels of uncertainty given the complexities of the global climate, limitations in modelling and potential variation in future emissions. Additional details of the limitation of climate change predictions can be found in Chapter B18 – Climate Change.

5.2.2.6 Model validation

The results of the Project model were compared to SCC's model results to ensure the results of the Project model were appropriate. This was done for the 100-year ARI and 2-year ARI events.

Figure 5.2b: Extent of SCC model (blue) and the Project model (black)

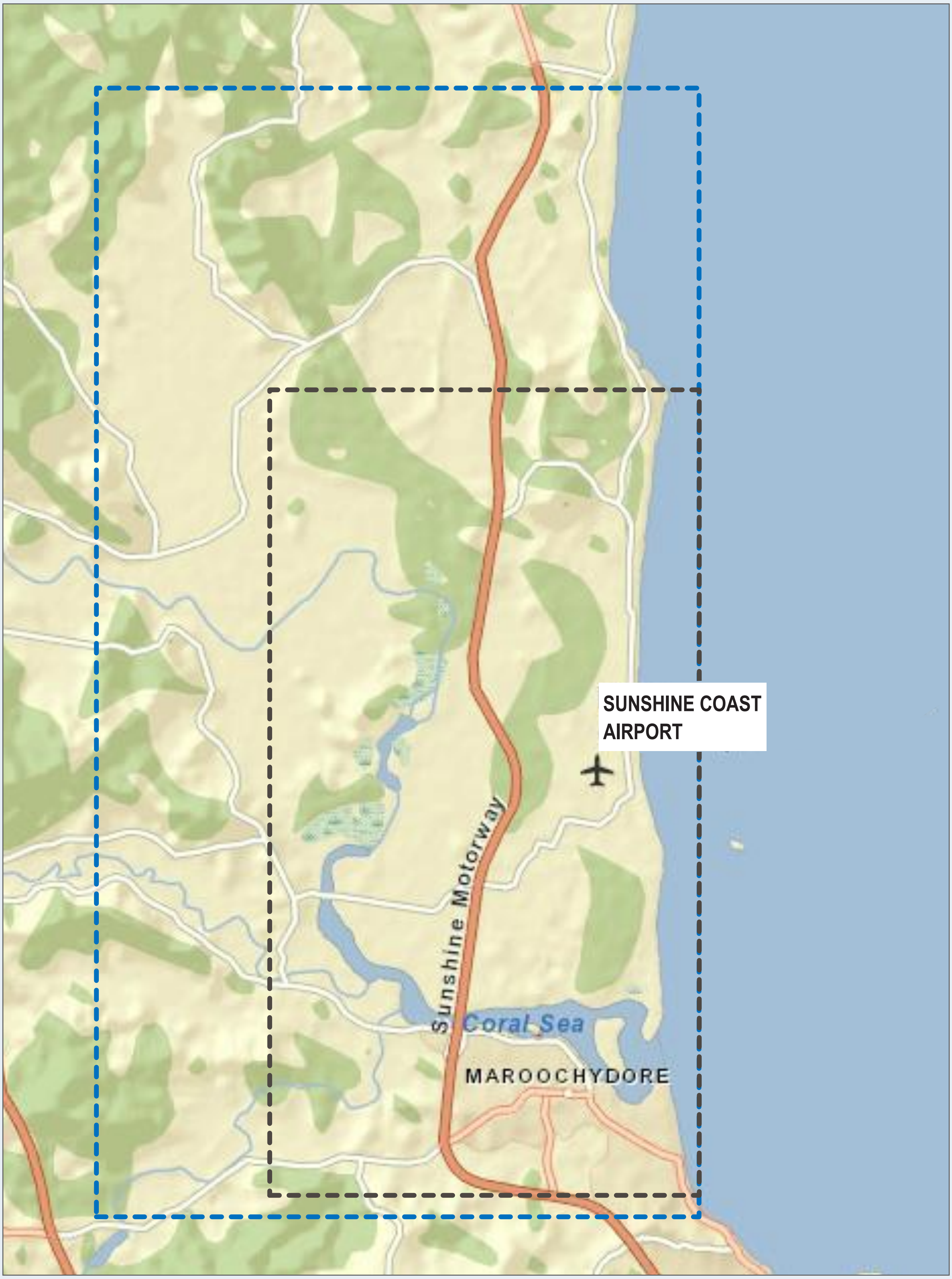


Table 5.2b: Sources of topographic information

Topographic Feature	Data Source	Comments
Upper Reaches of the Maroochy River	2001 bathymetric survey by the former Maritime Division of Queensland Transport	Latest available bathymetry for this area
Lower Maroochy River	SCC Maroochy River flood model	SCC's Maroochy River flood model adopts an intermediate bathymetry, which is considered an appropriate assumption
Maroochy River Floodplain	2004 ALS commissioned by SCC	The 2004 ALS has a greater level of quality assurance than more recent surveys Major topographic features (such as the David Low Way interchange) were manually entered into the model bathymetry
Eudlo Creek	2010 bathymetric survey commissioned by SCC SCC model	Combination of bathymetric survey and model inputs use, as the survey does not cover entire waterway
Petrie Creek	2001 bathymetric survey by the former Maritime Division of Queensland Transport	Latest available bathymetry for this area
Twin Waters Canal System	SCC Maroochy River model	Survey data not available
Bradman Ave Canal System	SCC Maroochy River model	Survey data not available
Coolum Creek	2001 bathymetric survey by the former Maritime Division of Queensland Transport	Latest available bathymetry for this area
Marcoola drain	2004 ALS commissioned by SCC 2012 field survey commissioned by AECOM for the EIS	The extent and alignment of the creek was defined using the 2004 ALS, and invert data from the field survey was used to define the base of the creek

A comparison to the SCC model to test the validity of the Project model results was considered appropriate, as the SCC model represents the most extensive flood modelling effort for the catchment, which includes comparison with the 1992 flood event, which was considered by SCC to be a 100-year ARI event for the catchment (SCC, 2010). The comparison of model results is presented in **Section 5.4.3**.

5.2.2.7 Developed case scenario

The Project was represented within the flood model in two ways:

1) The footprint of the airport under expanded conditions was represented within the topographic grid above existing 100-year ARI flood levels
2) Changes to the airport drainage were represented as one and 2-dimensional elements within the model.

5.2.2.8 Limitations

The flood levels and extents reported herein were modelled for the purpose of the impact assessment of the Project; they should not be relied on for developments other than the new runway.

5.3 POLICY CONTEXT AND LEGISLATIVE FRAMEWORK

5.3.1 State Planning Policy

The State Planning Policy (SPP) is a key component of Queensland's land use planning system, which addresses development, environmental protection and community growth. The SPP provides a comprehensive set of principles that underpin Queensland's planning system to guide local government and the State government in land use planning and development assessment. The SPP defines the Queensland Government's policies about matters of state interest in land use planning and development.

The state interests are addressed through the local government planning schemes, regional plans and when making decisions about the designation of land for community infrastructure.

The relevant state interest for the flood assessment is natural hazards, resilience and risk, which is discussed below.

State interest – natural hazards, resilience and risk

A natural hazard is a naturally occurring event that may cause harm to people and social wellbeing, damage to property and/or infrastructure and affect the economy and the environment. The natural hazards that can be prepared for through land use planning and development decisions are flood, bushfire, landslide, storm tide inundation and coastal erosion.

Planning for these natural hazards through land use planning can also significantly reduce the financial and other resource pressures placed on all levels of government, industry and the community, to respond to and recover from natural disasters. For this reason, there is a shared responsibility to manage the impact these natural hazards may have to people, social wellbeing, property, the economy, the environment and infrastructure.

The state's interest in natural hazards, risk and resilience seeks to ensure natural hazards are properly considered in all levels of the planning system, community resilience is increased, and hazards are avoided or the risks are mitigated to an acceptable or tolerable level. Key to achieving these outcomes is an integrated, evidence-based process that empowers local government and the community to plan for their local circumstances and contribute to achieving a safer and more resilient Queensland.

The state interest in natural hazards, resilience and risk is that:

The risks associated with natural hazards are avoided or mitigated to protect people and property and enhance the community's resilience to natural hazards.

This interest is to be addressed through making or amending a planning scheme, and designating land for community infrastructure. The planning scheme is to appropriately integrate the state interest for all natural hazards by:

For all natural hazards:

1) Identifying natural hazard areas for flood, bushfire, landslide and coastal hazards based on a fit for purpose natural hazards study and
2) Including provisions that seek to achieve an acceptable or tolerable level of risk, based on a fit for purpose risk assessment and
3) Including provisions that require development to:
    a) Avoid natural hazard areas or mitigate the risks of the natural hazard to an acceptable or tolerable level and
    b) Support, and not unduly burden, disaster management response or recovery capacity and capabilities and
    c) Directly, indirectly and cumulatively avoid an increase in the severity of the natural hazard and the potential for damage on the site or to other properties and
    d) Maintain or enhance natural processes and the protective function of landforms and vegetation that can mitigate risks associated with the natural hazard, and
4) Facilitating the location and design of community infrastructure to maintain the required level of functionality during and immediately after a natural hazard event.

The State Interest – Natural Hazards, Risk and Resilience also includes provisions for development in coastal hazard areas, which are discussed in Chapter B4 – Coastal Processes.

5.3.2 Sunshine Coast Planning Scheme

The Sunshine Coast Planning Scheme 2014 commenced on 21 May 2014, replacing the Maroochy Plan 2000.

The relevant requirements for flood impacts are covered under the Flood Hazard Overlay Code, which comes into effect for developments shown as being within a flood hazard area on the Flood Hazard Overlay Map. The Project is shown as being within a flood hazard area, as illustrated in **Figure 5.3a**.

The purpose of the Flood Hazard Overlay Code is to ensure development protects people and avoids or mitigates the potential adverse impacts of flood and storm tide inundation on property, economic activity and the environment, taking into account the predicted effects of climate change.

An assessment of the Project against the Draft Planning Scheme is provided in **Section 5.5.2.4**.

The purpose of the Flood hazard overlay code would be achieved through the following overall outcomes:-

a) Development does not occur on land subject to flooding except wherein specified circumstances (see performance outcome PO2 below) and only where the impacts of flooding can be effectively ameliorated such that there is no foreseeable risk to life or property
b) Development protects floodplains and the flood conveyance capacity of waterways
c) Development in areas at risk from flood and storm tide inundation is compatible with the nature of the defined flood or storm tide event
d) The safety of people is protected and the risk of harm to property and the natural environment from flood and storm tide inundation is minimised and

e) Development does not result in a material increase in the extent or severity of flood or storm tide inundation.

The performance outcomes set out in the code for assessable development are:

PO1 Development is undertaken in a manner that ensures:

a) natural hydrological systems are protected

b) natural landforms and drainage lines are maintained to protect the hydraulic performance of waterways, and

c) development integrates with the natural landform of the floodplain rather than modifying the landform to suit the development.

PO2 In a flood and inundation area, as identified on a Flood Hazard Overlay Map, or in areas otherwise determined as being subject to the defined flood event (DFE) or defined storm tide event (DSTE):

a) any development involving physical alteration to land does not occur, or

b) urban and rural residential development, and other development involving the erection of a building or structure or significant earthworks satisfies at least one of the following criteria:

1) the development is on land already committed to urban or rural residential development by an approval granted prior to the commencement of the planning scheme

2) the development is on land identified in a structure plan as an area intended for urban development

3) the development is redevelopment or infill development within an existing developed area

4) an overriding community need in the public interest has been demonstrated that warrants approval of the development despite its occurrence within an area subject to flooding or

5) the development is for the infrastructure identified on the planning scheme maps, and

6) achieving flood immunity for the development minimises physical alteration to the floodplain.

PO3 Development provides that for all flood and storm tide inundation events up to and including the DFE and DSTE:

a) the safety of people on the site is protected, and

b) the risk of damage to property on the site is avoided or minimised as far as practicable.

PO4 Development does not compromise the safety of people resulting from the residual flood or storm tide inundation risk associated with events exceeding the DFE or DSTE up to and including the probable maximum flood (PMF) or probable maximum storm tide (PMST).

PO5 Development ensures that building design and built form:

a) maintains a functional and attractive street front address appropriate to the intended use and

b) ensures that building materials used have high water resistance and would improve the resilience of a building during and after a flood or storm tide event.

PO6 Essential network infrastructure within a site (e.g. electricity, water supply, sewerage and telecommunications)maintains effective function during and immediately after flood and storm tide inundation events.

PO7 Essential community infrastructure is able to function effectively during and immediately after flood events.

PO8 Development ensures that public safety and the environment are not adversely affected by the detrimental impacts of floodwater on hazardous materials manufactured or stored in bulk during the DFE or DSTE.

PO9 Development does not directly, indirectly or cumulatively alter the flooding characteristics external to the development site for all flood events up to and including the DFE and DSTE, based on:

a) current climate conditions, and

b) incorporating allowance for climate change at the end of the design life of the development.

PO10 Development does not increase the severity of storm tide related impacts for off-site property for all storm tide events up to and including the DFE or DSTE based on:

a) current climate conditions, and

b) incorporating allowance for climate change at the end of the design life of the development.

An assessment of the Project against the above performance outcomes is included in **Section 5.5.2.4**.

5.3.3 Coastal Management Plan

The Coastal Management Plan (CMP) commenced on 18 March 2014. It is made under the *Coastal Protection and Management Act 1995*. The CMP provides non-regulatory policy guidance to coastal land managers.

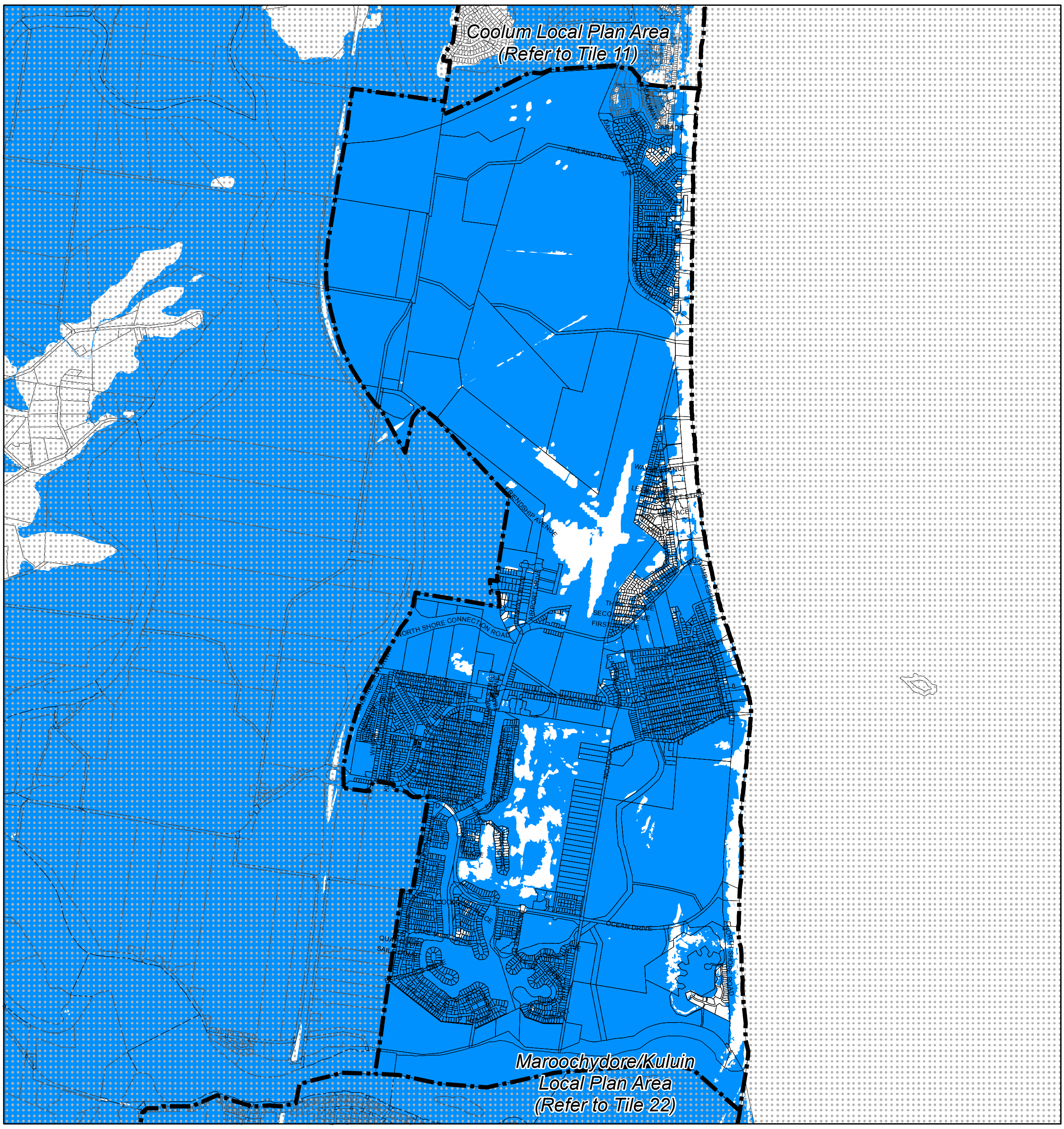
Key management policies dealt with by the CMP include:

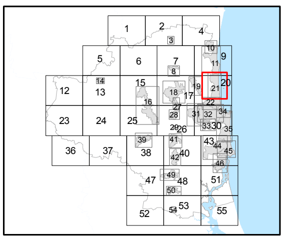
- Maintaining coastal landforms and physical coastal processes
- Conserving nature
- Maintaining access to coastal resources for indigenous cultural activities
- Maintaining or enhancing public access
- Management planning and
- Knowledge sharing and community engagement.

Figure 5.3a: Flood hazard overlay map

Sunshine Coast **Planning Scheme 2014**

Maroochy North Shore Local Plan Area





Overlay Map OVM21G

Flood Hazard Overlay Map

Land Subject to Flood Hazard Overlay

- Flooding and Inundation Area

Other Elements

- Local Plan Area Boundary
- Declared Master Planned Area (see Part 10 - Other Plans)
- Land within Development Control Plan 1 - Kawana Waters which is the subject of the Kawana Waters Development Agreement (see Section 1.2 - Planning Scheme Components)
- Priority Development Area (subject to the *Economic Development Act 2012*)
- DCDB 28 January 2013 © State Government

Note — The Flood Hazard Overlay Maps identify areas (flooding and inundation areas) where flood and storm tide modelling has been undertaken by the Council. Other areas not identified by the Flood Hazard Overlay Maps may also be subject to the defined flood event (DFE) or defined storm tide event (DSTE). Development occurring in such areas will also be assessable against the Flood Hazard overlay code. Definitions of DFE and DSTE are provided in Schedule 1 (Definitions).

Note — The flood hazard and inundation area is a planning tool only and does not specify a level of hazard in different flood events.

Note — Some areas subject to pre-existing development approvals may have modified flood extents that alter or eliminate the risk of flooding for that area.

Note — Some areas subject to pre-existing development approvals may retain a residual risk of flooding due to changes in the way in which the defined flood event has been determined over time.

Note — Overlays provide a trigger for consideration of an overlay issue to be verified by further on-site investigations.

Note — In certain circumstances pre-existing development approvals may override the operation of an overlay.

Geocentric Datum of Australia 1994 (GDA94)

Approx Scale @ A3 1:28,480

0 170 340 680 1,020
Metres

Whilst the CMP is relevant to decisions about management activities and managing coastal resources on public coastal land, it does not address land-use planning or development regulated under the *Sustainable Planning Act 2009*.

5.3.4 Climate Change and Peak Oil Strategy 2010–2020

The SCC Climate Change and Peak Oil Strategy seeks for SCC to provide leadership and demonstrate best practice through endorsing a 100 year planning horizon and incorporating climate change projections up to 2100 in planning and decision making. It also seeks to incorporate climate change into all hydrological mapping and forecasting, and to adapt to climate change to reduce risk to SCC assets and infrastructure.

The relevant components of the Action Plan presented in the Strategy are summarised below:

a) Objective 1: SCC to provide leadership and demonstrate best practice:
   - Endorse 100 year planning horizon
   - Incorporate projections up to 2100 into planning and decision making
   - Integrate climate change into SCC's strategies, policies and plans.

b) Objective 5: Identify and plan for climate change risks:
   - Incorporate climate change into all hydrological mapping and forecasting
   - Complete climate change risk assessments
   - Adjust land use planning approaches to:
     - Avoid urban development in major climate change risk areas
     - Reduce risk to property and assets in major risk areas
     - Long-term disaster response planning to consider climate change risks with particular attention to vulnerable communities, including visitors.

c) Objective 6: Adapt to the impacts of climate change:
   - Reduce risk to council assets and infrastructure.

5.4 EXISTING CONDITIONS

5.4.1 Maroochy River flood regime within the study area

The Project would be located in the Maroochy River floodplain east of the river and Sunshine Motorway.

Flood levels at the site are predominantly driven by large-scale long-duration rainfall events across the catchment. In addition to the rainfall across the catchment, flood levels are affected by the downstream conditions, which would vary depending on tidal conditions, storm surge or inflows from tributaries such as Eudlo and Petrie Creeks.

This flood assessment considers large, regional flood events where widespread heavy rainfall falls across the Maroochy River catchment, leading to raised river levels. Localised, heavy rainfall events (for example at a single suburb) may exceed local drainage systems, causing localised flooding – this type of event is not considered in this assessment. The design of local drainage infrastructure associated with the Project would be undertaken in a way to maintain the existing local drainage conditions.

The area of floodplain under consideration has a very gentle slope west from the dunes along the coast to the Maroochy River; it is very low-lying at elevations ranging from around 7 m AHD at the dune crests to less than 1 m AHD in some areas near the river. All floodwater and stormwater runoff from this area ultimately flows to the river.

The Sunshine Motorway acts as a constriction to floodplain flows in this area. During minor or localised events, when river flood levels are low, stormwater from the floodplain and the Marcoola drain flows west through culverts and bridges beneath the Motorway into the river.

In major river floods, the direction of flow varies during the flood. In the early stages of the flood, water from the floodplain flows west to the Maroochy River. However, as the river breaks its banks and the flood height increases, water is pushed east into the floodplain. During the peak of the event, the culverts and bridges of the Sunshine Motorway control the flow into the floodplain at the site.

The Marcoola drain plays an important role in the dynamics of the floodplain within and surrounding the Project site, and the Sunshine Motorway bridge is the primary control of flows for the creek. During major floods, flows through the bridge can be significant in both directions. For example, the flood modelling indicates that in the early stages of a 100-year ARI flood, the flow rate of the Marcoola drain beneath the Motorway is greater than 70 m^3/s towards the Maroochy River. However, when the river reaches its flood peak for the same event, the flow rate of the Marcoola drain beneath the Motorway is greater than 185 m^3/s away from the river.

5.4.1.1 Flood history

The Maroochy River system is susceptible to episodes of rapid flooding, which can cause considerable damage to public and private property within the catchment. Significant river flooding (i.e. the Maroochy River breaking its banks) occurs relatively infrequently, with significant floods reported in 1893, 1951, 1974 and February 1992. Nevertheless, localised flooding from storm cells occurs more frequently, although these floods affect a much smaller area than a river flood (BOM, 2011).

During the major flood event in 1992, flash flooding occurred in the smaller streams early on Friday 21 February, particularly in the area upstream of the Bruce Highway. At that time, several low level roads had to be closed. By late Saturday 22 February, flooding in the lower reaches of the system caused inundation of about 225 homes to depths of up to 0.8 m. The worst affected area was Pacific Paradise, adjacent to the mouth of the Maroochy River. While this event caused flooding near the mouth of the Maroochy River, flooding near the site of the proposed runway was much less severe (BOM, 2011).

Major flooding of the Maroochy River requires a large-scale rainfall event over the catchment. In general terms, average catchment rainfalls in excess of 200 mm in 24 hours may cause major flooding and traffic disruptions, particularly in low-lying areas and extending downstream (BOM, 2011).

Table 5.4a shows the recorded flood heights for flood gauges near the Project site (BOM, 2011). The flood heights are compared to the major, moderate, and minor flood reference levels, as determined by the Bureau of Meteorology. The flood categories are defined as follows:

- Minor flooding causes inconvenience such as closing of minor roads and the submergence of low-level bridges
- Moderate flooding causes the inundation of low-lying areas requiring the removal of stock and/or the evacuation of some houses. Main traffic bridges may be closed by floodwaters
- Major flooding causes inundation of large areas, isolating towns and cities. Major disruptions occur to road and rail links. Evacuation of many houses and business premises may be required. In rural areas, widespread flooding of farmland is likely.

The records illustrate the spatial variation of flood severity across the catchment; this is due to both spatial variation of rainfall and the type of infrastructure in the vicinity that would be affected by an event.

5.4.2 Model results for existing conditions

The baseline conditions are outlined in the following tables.

Table 5.4b lists flood peak water surface elevations for all assessment locations. The highest elevations are typically near the top of the catchment, near Marcoola and the Maroochy River west of the Marcoola drain.

Durations of inundation are shown in **Table 5.4c** for the relevant assessment locations. Assessment locations not listed in the table are located in waterways and therefore are inundated for the entire duration of the flood event.

The modelled peak velocities are shown in **Table 5.4d**. The results reflect the slow flow of floodwaters across the floodplain. Peak velocities are slightly higher where the river passes beneath the Maroochy River Bridge and at the mouth of the river. The predicted velocities are unlikely to cause scour in the locations assessed.

The existing case flood extents and depths for each of the flood frequency scenarios are shown in **Figure 5.4a** to **Figure 5.4f**.

5.4.3 Comparison with Maroochy River flood study

The peak flood levels predicted by the Project model were compared to the peak levels from the SCC model. This comparison was done for the 100-year and 2-year ARI events for the existing case scenario. The results of the comparison are reported as a positive value where the Project model produces a higher peak flood level and a negative value where a lower level is produced.

Table 5.4a: Recorded flood heights for notable flood events from 1982 (red: major, orange: moderate, green: minor, no colour: below minor or no record, grey: gauge not established)

	Gauge	Height of Maroochy River (m AHD)				Height in tributaries (m AHD)	
		Yandina	Dunethin	Stoney Wharf Rd1	Picnic Point	Warana Bridge	Diddillibah
	Installation Date	1982	1982	2007	1982	1978	1994
Flood Event	Jun 1983	15.36	2.30	–	1.50	23.71	–
	Apr 1989	14.22	–	–	–	21.45	–
	Feb 1992	14.48	4.40	–	1.95	22.62	–
	Feb 1995	13.81	2.67	–	1.44	20.87	7.46
	Feb 1999	14.24	3.65	–	1.61	21.59	–
	Mar 2004	13.79	2.12	–	–	20.90	7.41
	Aug 2007	13.18	2.27	2.62	–	19.06	8.11
	Jun 2008	13.68	2.35	1.45	1.27	21.28	7.61
	Apr 2009	13.49	–	–	–	21.24	7.46

[1]No flood classification defined for Stoney Wharf Rd

Table 5.4b: Flood peak water surface elevation for existing conditions

Assessment location	Peak flood level (m AHD)					
	100-year ARI	50-year ARI	20-year ARI	10-year ARI	5-year ARI	2-year ARI
1	3.158	2.908	Dry	Dry	Dry	Dry
2	3.164	2.913	2.560	2.265	2.032	1.663
3	3.182	2.927	2.567	2.266	2.032	1.657
4	3.145	2.859	2.739	2.727	2.717	2.700
5	3.050	2.823	2.721	2.680	2.649	2.614
6	1.938	1.743	1.527	1.402	1.360	1.294
7	2.634	2.414	2.107	1.855	1.674	1.413
8	2.608	2.394	2.099	1.854	1.673	1.407
9	1.861	1.696	1.500	1.369	1.290	1.217
10	2.018	1.836	1.616	1.462	1.364	1.233
11	1.397	1.325	1.244	1.192	1.163	1.128

Table 5.4c: Duration of inundation for existing conditions for assessment locations in the floodplain

Assessment location	Duration of inundation (h)					
	100-year ARI	50-year ARI	20-year ARI	10-year ARI	5-year ARI	2-year ARI
1	15.4	9.2	0.0	0.0	0.0	20.5
4	58.8	55.0	47.3	47.0	46.6	61.2
5	41.1	31.7	17.8	13.3	10.8	45.8
8	54.6	53.0	51.2	41.4	32.8	N/A

Table 5.4d: Peak velocity for existing conditions

Assessment location	Peak velocity (m/s)					
	100-year ARI	50-year ARI	20-year ARI	10-year ARI	5-year ARI	2-year ARI
1	0.040	0.015	0.000	0.000	0.000	0.000
2	0.939	0.747	0.611	0.672	0.589	0.629
3	0.675	0.640	0.603	0.562	0.526	0.447
4	0.094	0.094	0.092	0.089	0.088	0.086
5	0.089	0.110	0.108	0.101	0.090	0.063
6	0.725	0.688	0.610	0.522	0.453	0.349
7	1.340	1.308	1.232	1.130	1.018	0.772
8	0.181	0.147	0.087	0.041	0.013	0.001
9	0.237	0.183	0.160	0.149	0.136	0.118
10	2.366	2.214	1.943	1.654	1.415	1.005
11	1.804	1.606	1.335	1.106	0.933	0.651

Figure 5.4a: Existing peak flood depth and extent for the 2-year ARI flood

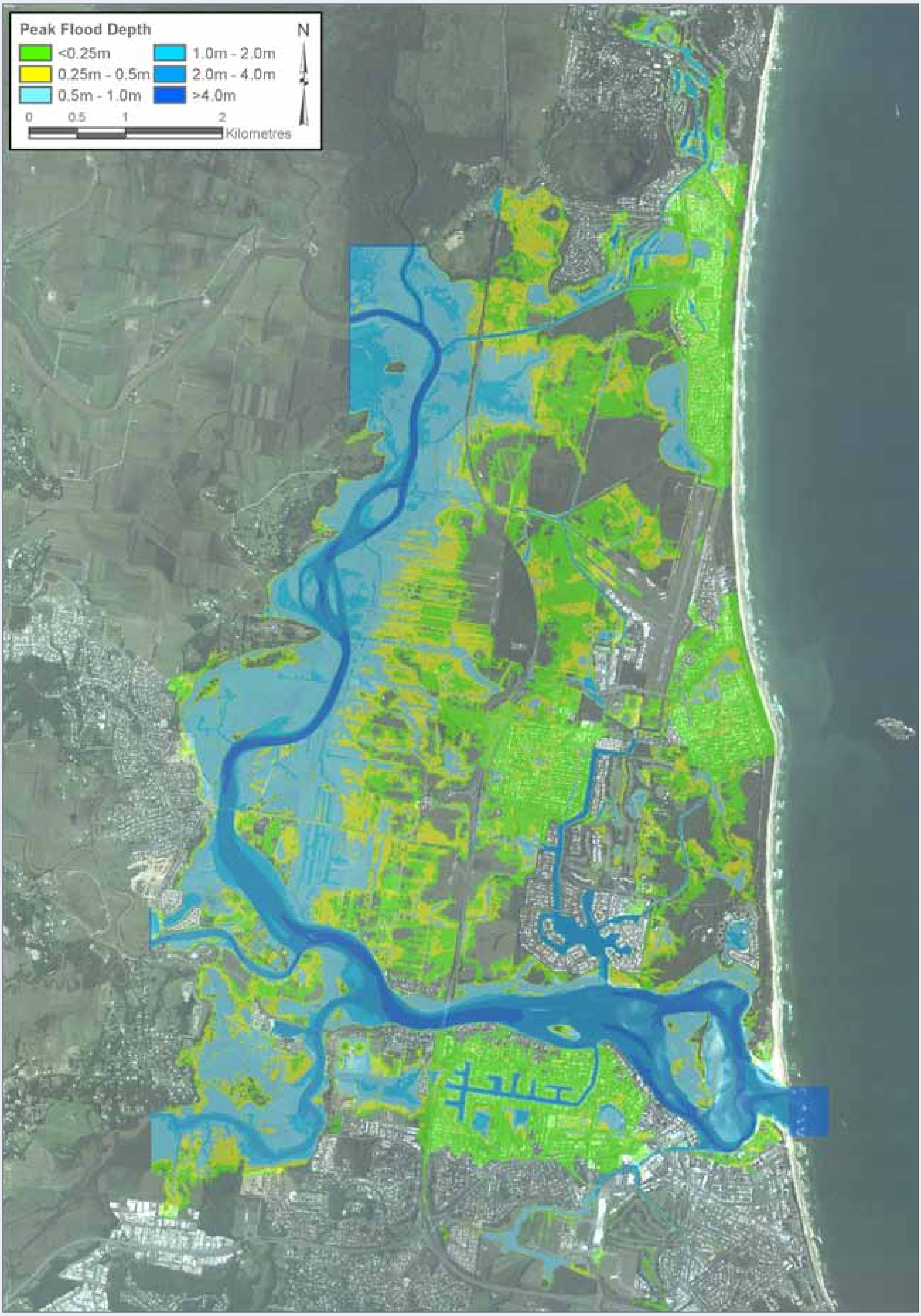


Figure 5.4b: Existing peak flood depth and extent for the 5-year ARI flood

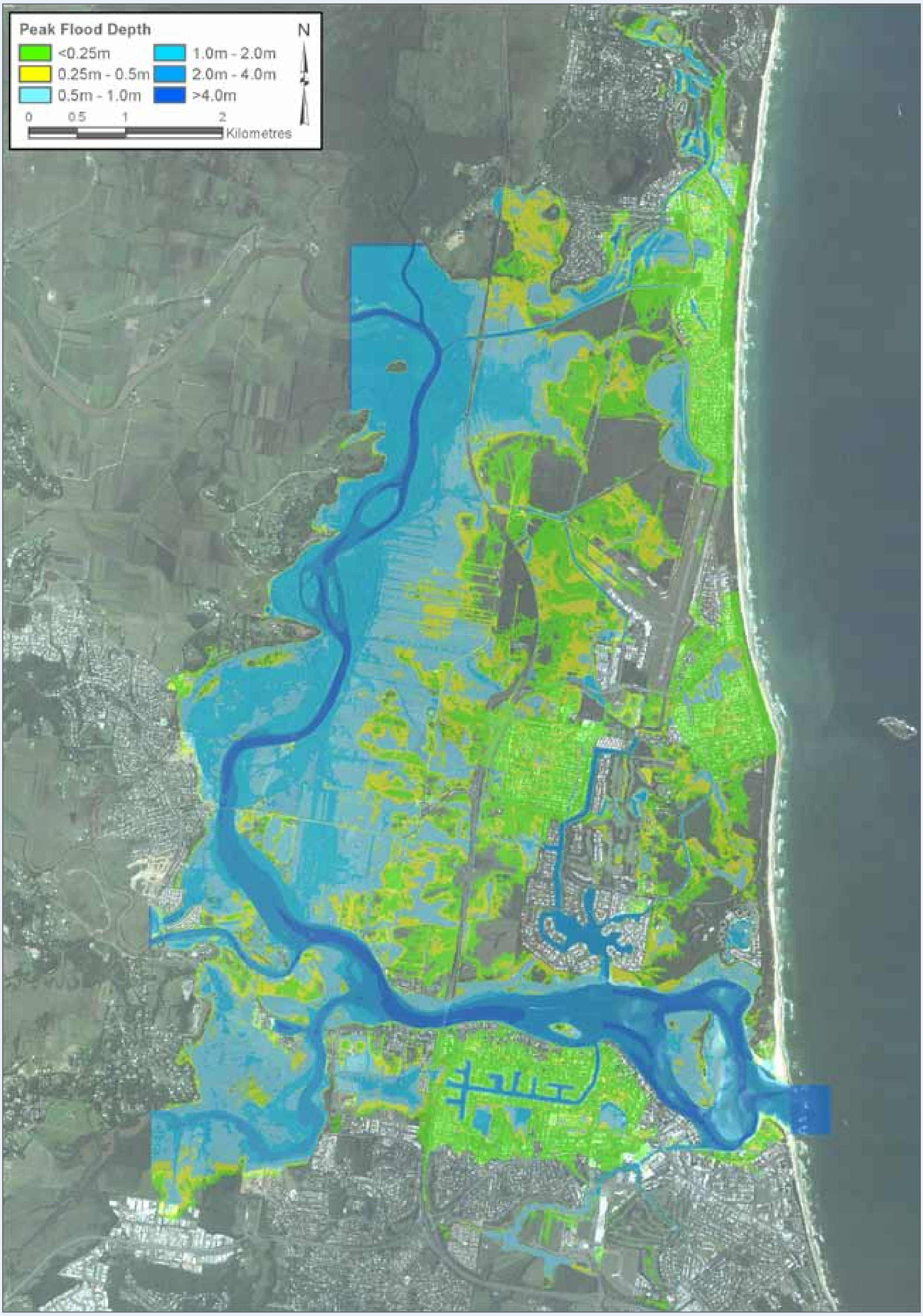


Figure 5.4c: Existing peak flood depth and extent for the 10-year ARI flood

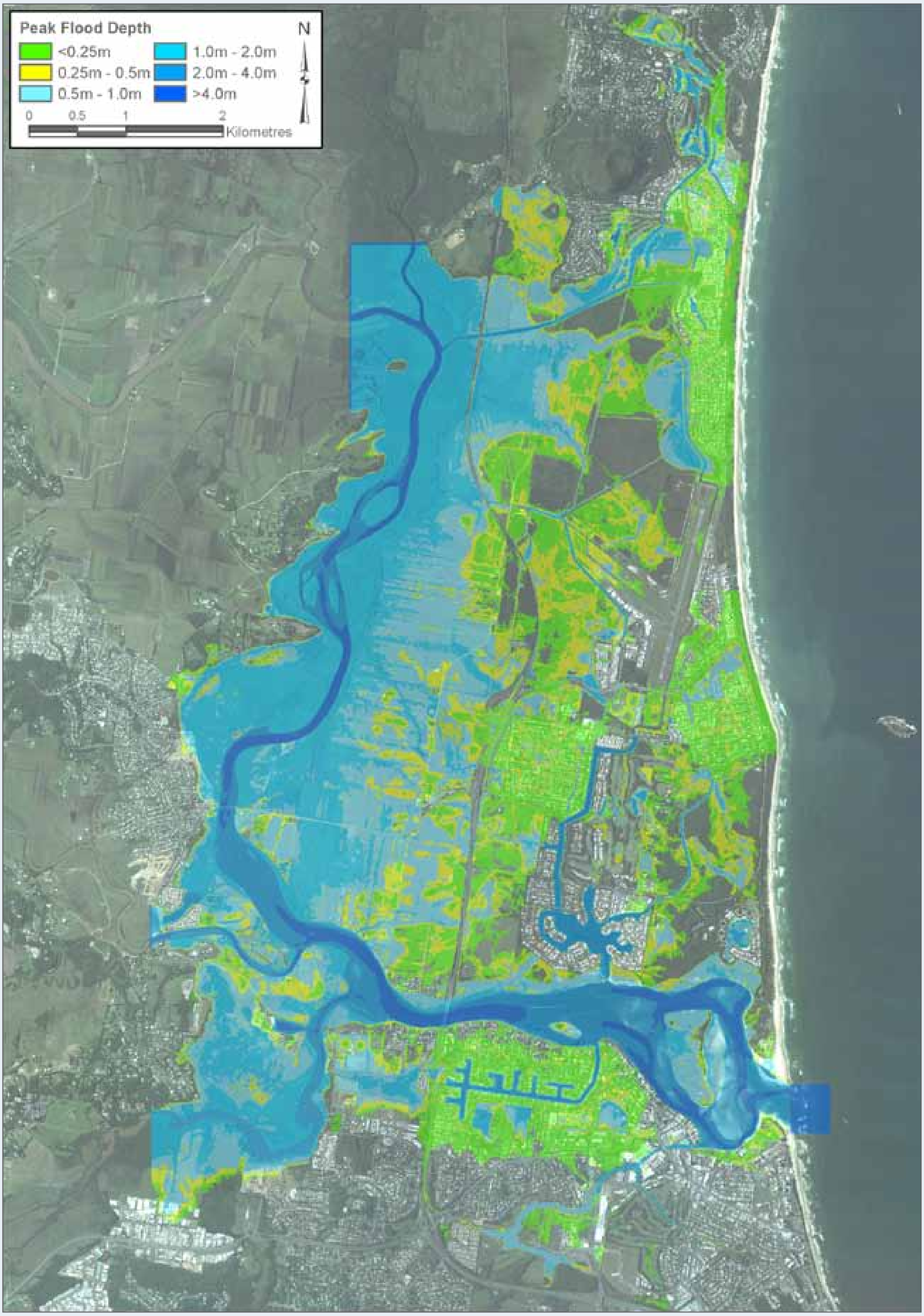


Figure 5.4d: Existing peak flood depth and extent for the 20-year ARI flood

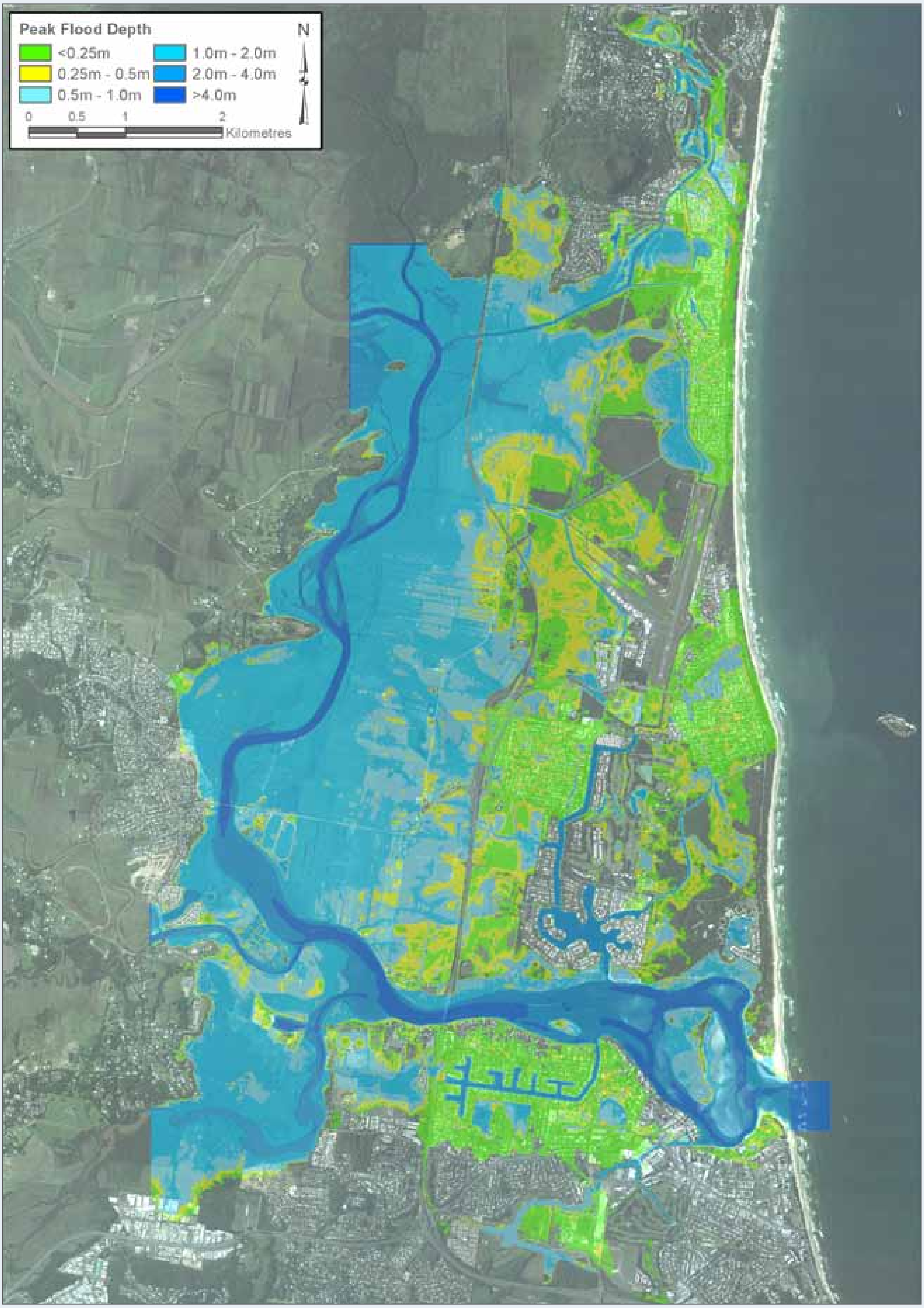


Figure 5.4e: Existing peak flood depth and extent for the 50-year ARI flood

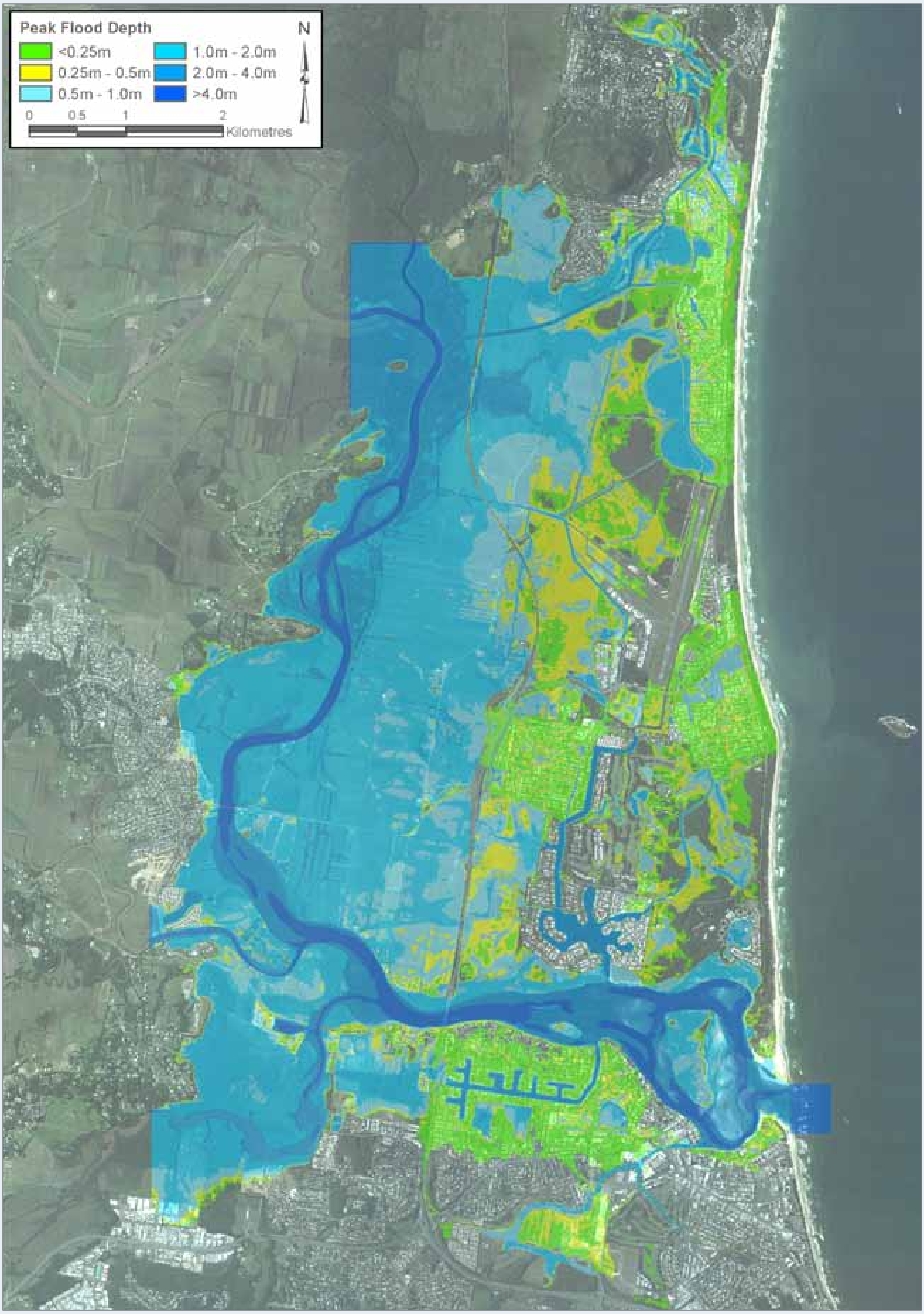


Figure 5.4f: Existing peak flood depth and extent for the 100-year ARI flood

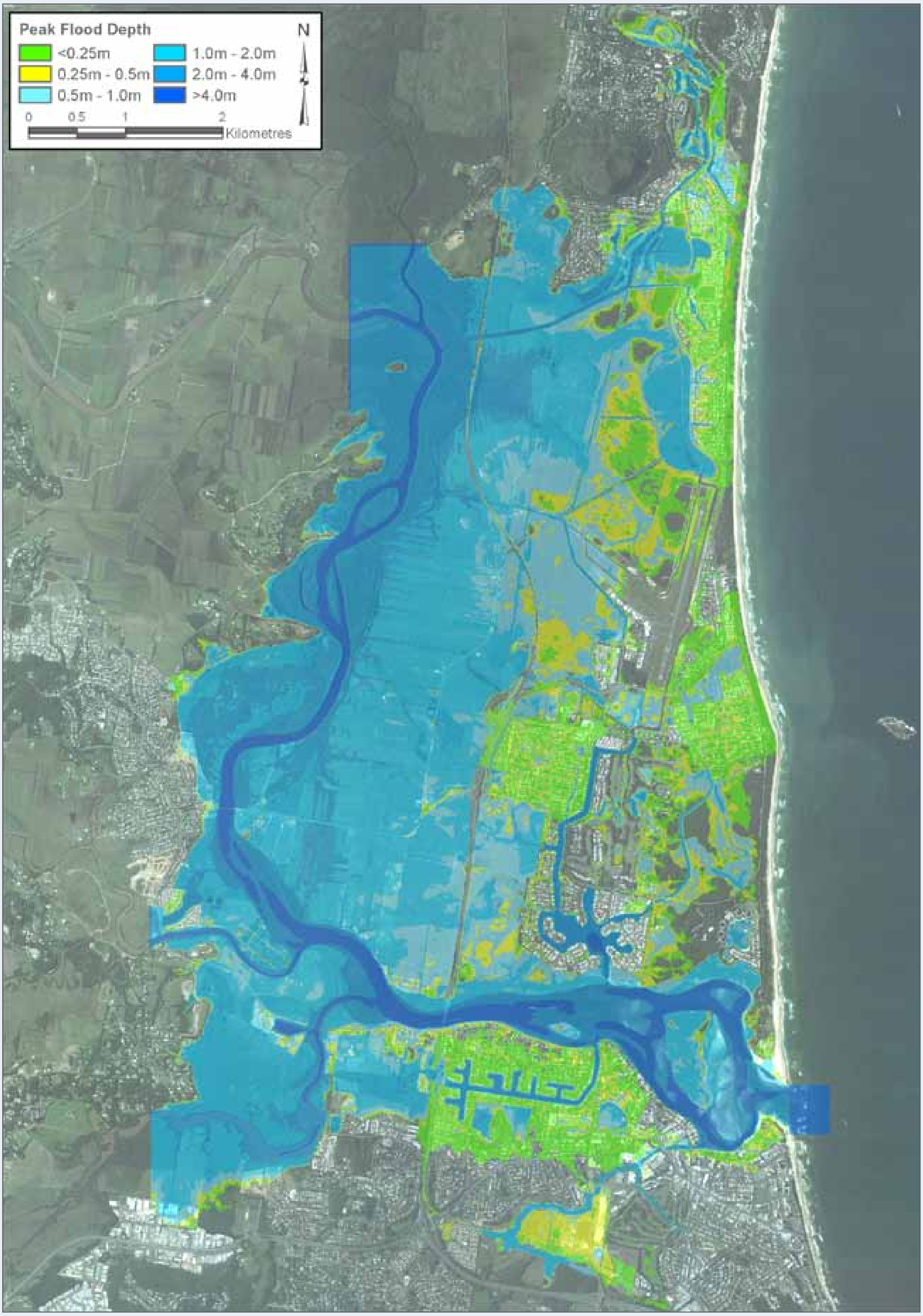


Table 5.4e presents a comparison of the model results for the 11 assessment locations. **Figure 5.4g** shows a comparison of the Project and SCC model peak water level for the Project model domain for the 100-year ARI event.

As shown in **Figure 5.4g**, the Project model produces higher flood levels in the northern area of the model domain and lower flood levels in the southern section of the model domain, compared to SCC model. This is a result of updates to the model including:

- Changes to the hydraulic roughness layer for the Project model to better represent an area of dense mangroves bordering the Maroochy River and densely vegetated floodplain west of the existing runway
- Changes to topography to reflect significant development that has occurred since SCC's model was built and
- Refinements in hydrologic modelling, allowing more accurate representation of local rainfall runoff in the model.

5.5 IMPACT ASSESSMENT

5.5.1 Description of impact assessment criteria

The flood impact assessment considers potential changes to flood levels, duration and flow velocities in both residential and non-residential areas. The site of the Project is within the Maroochy River floodplain and therefore may alter the flood regime through changes to flows across the floodplain and reduction of floodplain storage.

To assess the impacts, a risk assessment approach was adopted. By considering the combination of the significance of the impact and likelihood of that impact occurring, it is possible to obtain an overall risk rating for the activity. Mitigation measures are proposed for potential impacts assessed as having a medium risk or higher. The residual risk was assessed for the mitigated scenario to assess the effectiveness of the proposed mitigation measures.

The impact significance criteria described in **Table 5.5a** were applied to the impact assessment reported herein.

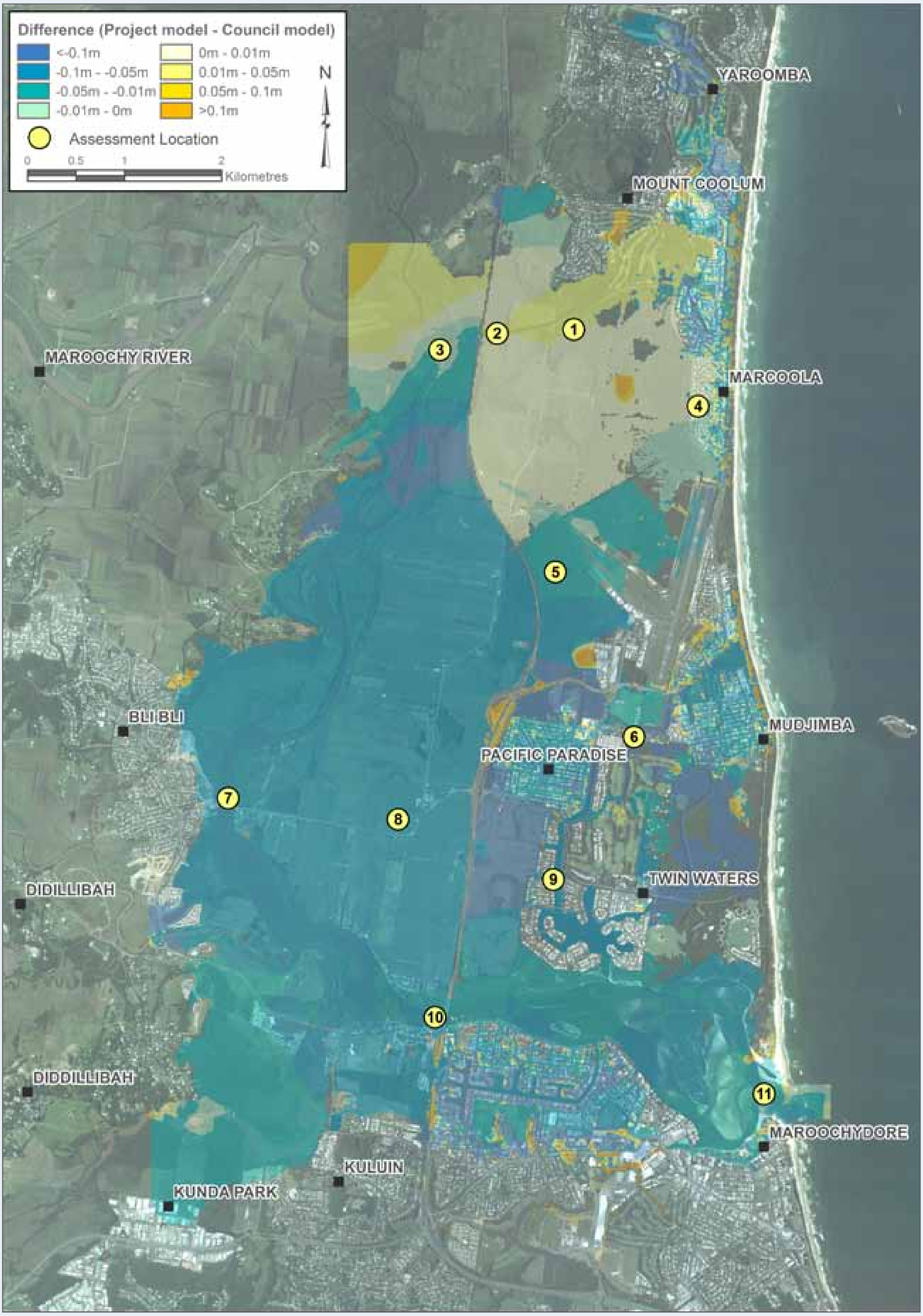
Table 5.4e: Project and SCC existing model 100-year and 2-year ARI results comparison

	Peak water surface level and difference at the assessment location (m AHD)										
Flood scenario	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
100-year ARI Project	3.158	3.164	3.182	3.145	3.050	1.938	2.634	2.608	1.861	2.018	1.397
100-year ARI SCC	3.148	3.154	3.182	3.144	3.091	2.063	2.704	2.679	1.921	2.088	1.425
Difference (mm)	10	10	0	0	-41	-125	-70	-70	-60	-71	-29
2-year ARI Project	2.744	1.663	1.657	2.700	2.614	1.294	1.413	1.407	1.217	1.233	1.128
2-year ARI SCC	2.674	1.725	1.721	2.807	2.603	1.246	1.441	1.628	1.197	1.246	1.130
Difference (mm)	70	-62	-64	-107	11	48	-28	-221	20	-13	-2

Table 5.5a: Significance criteria for flood impact assessment

Impact significance	Description of significance
Very high	• the impact is considered critical to the approvals process • impacts tend to be permanent or irreversible, or otherwise long term • impacts can occur over large scale areas
High	• the impact is considered likely to be important to the approvals process • impacts tend to be permanent or irreversible or otherwise long to medium term • impacts can occur over large or medium scale areas
Moderate	• the impact is relevant to the approvals process • impacts can range from long term to short term in duration • impacts can occur over medium scale areas, or otherwise represent a significant impact at a local scale
Minor	• the impact is unlikely to be of importance in the approvals process • impacts tend to be short term or temporary and/or occur at local scale
Negligible	• minimal change to the existing situation, e.g. impacts that are within the normal bounds of variation

Figure 5.4g: Comparison between SCC and Project model flood peak levels for the 100-year ARI flood



The likelihood criteria for the assessment are:

- Highly unlikely
- Unlikely
- Possible
- Likely and
- Almost certain.

For all events a likelihood of 'almost certain' was adopted as the modelling results indicate that the impact would occur for each of the given flood events.

The risk assessment matrix adopted for the environmental impact statement (EIS) is shown in **Table 5.5b**.

5.5.2 Model results

5.5.2.1 Current day scenarios

The likely impacts of the Project were assessed by comparing flood modelling results for the existing case with the modelling results for the proposed development.

Generally, the construction of the new runway would lead to some changes to floodplain flow and a reduction in floodplain storage. In large events, these changes result in floodwater being detained north of the new runway, causing a small increase in peak flood levels north of RWY 13/31. The reduction of floodplain flows also results in a decreased amount of floodwater reaching the Mt Coolum National Park south of the proposed development, which generally results in a decrease in flood levels and the duration of inundation in this area in large events (up to 50 mm reduction in a 20-year ARI event).

An iterative process was adopted to identify mitigation options to address potential flood impacts associated with the RWY 13/31 in large events (100-year and 50-year ARI events). Given the constraints of the site, flood mitigation for the Project relies on improving the drainage of local runoff.

The mitigation measures incorporated within the developed scenario modelling include:

- An increased capacity of the northern perimeter drain to help drain local runoff before floodwater from the Maroochy River backs up into the floodplain
- The addition of a western perimeter drain to increase flows around the western end of the new runway.

While the proposed mitigation measures significantly improve drainage, they do not completely mitigate potential increases in peak flood levels for the 100-year ARI events. In the 100-year ARI event, there would be a small increase in peak flood levels of less than 18.5 mm in local areas of Marcoola. Modelling undertaken for the Project and by SCC indicates these areas currently experience flooding in major and minor flood events. Existing flood depths in these areas for the 100-year ARI event are approximately 0.25 m to 0.8 m.

The modelling indicates no impacts of concern on the drainage structures or the flood immunity of the Sunshine Motorway.

The modelling indicates that the extent of flooding would not change with development of the Project, that is, potential impacts are confined to properties that currently experience flooding.

The potential impacts identified using the flood modelling are detailed in **Table 5.5c**. Details of changes to flood peak levels, duration and peak velocities at the 11 assessment locations are included in **Table 5.5d**, **Table 5.5e** and **Table 5.5f**. Maps of the flood levels before and after development of the Project, and the change in levels are shown in **Figure 5.5a** to **Figure 5.5r**.

Table 5.5b: Risk assessment matrix adopted for the EIS

	Significance				
Likelihood	**Negligible**	**Minor**	**Moderate**	**High**	**Very High**
Highly Unlikely	Negligible	Negligible	Low	Medium	High
Unlikely	Negligible	Low	Low	Medium	High
Possible	Negligible	Low	Medium	Medium	High
Likely	Negligible	Medium	Medium	High	Extreme
Almost Certain	Low	Medium	High	Extreme	Extreme

Table 5.5c: Description of predicted impacts

Flood Scenario	Description of Impacts		
	Peak Flood Levels	**Peak Velocities**	**Duration of Inundation**
2-year ARI	Modelling indicates the following changes to peak flood levels: • there are negligible increases to peak flood levels of less than 10 mm in developed areas • a reduction in peak flood levels of approximately 11 mm in a low-lying area west of Marcoola • a reduction in peak flood levels of up to 20 mm south of RWY 13/31 • a small reduction in peak flood levels in localised areas immediately north of RWY 18/36, which is likely to be due to the improved drainage from the northern perimeter drain • localised increases to peak flood levels of greater than 50 mm immediately north of RWY 13/31, which is caused by changes to the local drainage within the floodplain north of the new runway.	Modelling indicates negligible changes to peak flow velocities.	Modelling indicates a reduction in the duration of inundation at assessment location 5 south of RWY 13/31 of approximately 1 hour. This is a result of the development reducing floodplain flows. No significant changes to the duration of inundation were predicted for the other 3 locations assessed.
5-year ARI	The modelling indicates similar impacts for the 2-year and 5-year ARI events, with reductions in peak flood level south of RWY 13/31 of up to 40 mm. There are negligible increases to peak flood levels of less than 10 mm in developed areas.	The modelling indicates an increase in the flow velocity on the eastern side of the Sunshine Motorway bridge over the Marcoola drain of up to 0.1m/s. The change in velocity is not expected to increase scour potential.	Modelling indicates a reduction in the duration of inundation at assessment location 5 south of RWY 13/31 of approximately 1 hour 45 minutes. This is a result of the development reducing floodplain flows. No significant changes to the duration of inundation were predicted for the other 3 locations assessed.
10-year ARI	Modelling indicates the following changes to peak flood levels: • there are negligible increases to peak flood levels of less than 10 mm in developed areas • a reduction in peak flood levels of up to 50 mm south of RWY 13/31 • an increase in the flood level of up to 14 mm immediately east of the Sunshine Motorway, where it intersects the southern perimeter drain • an increase in flood levels of approximately 60 mm immediately north of RWY 13/31 • a reduction in peak flood level of approximately 10 mm at the sports grounds and open fields south of David Low Way and RWY 18/36.	The modelling indicates an increase in the flow velocity on the eastern side of the Sunshine Motorway bridge over the Marcoola drain of up to 0.2 m/s. The change in velocity is not expected to increase scour potential.	Modelling indicates a reduction in the duration of inundation at assessment location 5 south of RWY 13/31 of approximately 1 hour 45 minutes. This is a result of the development reducing floodplain flows. No significant changes to the duration of inundation were predicted for the other 3 locations assessed.

Flood Scenario	Description of Impacts		
	Peak Flood Levels	Peak Velocities	Duration of Inundation
20-year ARI	The modelling indicates similar impacts for the 10-year ARI and 20-year ARI events, with the following differences: • an increase in the flood level of up to 19 mm immediately east of the Sunshine Motorway, where it intersects the southern perimeter drain • an increase in flood levels of approximately 80 mm in an undeveloped area immediately north of RWY 13/31.	The modelling indicates similar impacts for the 10–year ARI and 20-year ARI events. The change in velocity is not expected to increase scour potential.	Modelling indicates a reduction in the duration of inundation at assessment location 5 south of RWY 13/31 of approximately 1 hour 20 minutes. This is a result of the development reducing floodplain flows. No significant changes to the duration of inundation were predicted for the other 3 locations assessed.
50-year ARI	Modelling indicates the following changes to peak flood levels: • there are negligible increases to peak flood levels of less than 10 mm in developed areas • an increase in peak flood levels of approximately 11 mm for an area between the eastern side of the Sunshine Motorway where it intersects the southern perimeter drain and RWY 13/31 • an increase in peak flood level of up to 100 mm in an undeveloped area immediately north of RWY 13/31.	The modelling indicates similar impacts for the 20-year ARI and 50-year ARI events. The change in velocity is not expected to increase scour potential.	Modelling indicates a reduction in the duration of inundation at assessment location 5 south of RWY 13/31 of approximately 50 minutes. This is a result of the development reducing floodplain flows. No significant changes to the duration of inundation were predicted for the other 3 locations assessed.
100-year ARI	Modelling indicates the following changes to peak flood levels: • a small increase in peak flood levels (<18.5 mm) in an area of Marcoola north of RWY 18/36. A detailed assessment of potential impacts in this area was undertaken, as described in **Section 5.5.2.2**. • there are negligible changes to peak flood levels of less than 10 mm in other developed areas • an increase in peak flood levels of up to 19 mm in the undeveloped area north of RWY 18/36 and west of Marcoola extending into the northern section of the National Park • an increase in peak flood level of approximately 16 mm at the sports grounds and open fields south of David Low Way and RWY 18/36 • an increase in peak flood level of up to 65 mm in an undeveloped area immediately north of RWY 13/31.	The modelling indicates an increase in the flow velocity on the eastern side of the Sunshine Motorway bridge over the Marcoola drain of up to 0.3 m/s. The change in velocity is not expected to increase scour potential.	Modelling indicates a reduction in the duration of inundation at assessment location 5 south of RWY 13/31 of approximately 2 hours. This is a result of the development reducing floodplain flows. No significant changes to the duration of inundation were predicted for the other 3 locations assessed.

Table 5.5d: Peak flood levels for existing and developed conditions

Flood Scenario		Peak flood levels and change at each assessment location (m AHD and mm)										
		1	2	3	4	5	6	7	8	9	10	11
100-year ARI	existing case	3.158	3.164	3.182	3.145	3.050	1.938	2.634	2.608	1.861	2.018	1.397
	developed case	3.170	3.172	3.187	3.162	3.056	1.946	2.640	2.614	1.866	2.022	1.398
	difference (mm)	12	8	6	18	6	7	5	5	5	4	1
50-year ARI	existing case	2.908	2.913	2.927	2.859	2.823	1.743	2.414	2.394	1.696	1.836	1.325
	developed case	2.917	2.919	2.932	2.869	2.833	1.744	2.419	2.399	1.699	1.840	1.327
	difference (mm)	9	6	5	10	10	2	5	5	3	4	1
20-year ARI	existing case	2.744	2.560	2.567	2.739	2.721	1.527	2.107	2.099	1.500	1.616	1.244
	developed case	2.7	2.564	2.571	2.739	2.697	1.526	2.112	2.104	1.501	1.618	1.244
	difference (mm)	0	4	4	0	-24	0	5	5	1	3	1
10-year ARI	existing case	2.744	2.265	2.266	2.727	2.680	1.402	1.855	1.854	1.369	1.462	1.192
	developed case	2.744	2.268	2.269	2.727	2.664	1.400	1.858	1.858	1.369	1.463	1.193
	difference (mm)	0	3	3	0	-17	-2	3	3	0	1	0
5-year ARI	existing case	2.744	2.032	2.032	2.717	2.649	1.360	1.674	1.673	1.290	1.364	1.163
	developed case	2.744	2.034	2.034	2.717	2.643	1.358	1.676	1.676	1.290	1.365	1.163
	difference (mm)	0	2	3	0	-6	-2	2	2	0	1	0
2-year ARI	existing case	2.744	1.663	1.657	2.700	2.614	1.294	1.413	1.407	1.217	1.233	1.128
	developed case	2.744	1.664	1.658	2.700	2.614	1.292	1.414	1.408	1.216	1.234	1.128
	difference (mm)	0	1	1	0	0	-2	1	1	-1	0	0

Table 5.5e: Duration of inundation for existing and developed conditions

		Duration of inundation and change at each assessment location (h)			
Flood Scenario		**1**	**4**	**5**	**8**
100-year ARI	existing case	15.4	58.8	41.1	54.6
	developed case	15.4	58.6	39.2	54.7
	difference	0.0	-0.2	-1.9	0.1
50-year ARI	existing case	9.2	55.0	31.7	53.0
	developed case	9.4	54.9	30.8	53.2
	difference	0.25	-0.1	-0.8	0.2
20-year ARI	existing case	0.0	47.3	17.8	51.2
	developed case	0.0	47.3	16.4	51.3
	difference	0.00	0.0	-1.3	0.1
10-year ARI	existing case	0.0	47.0	13.3	41.4
	developed case	0.0	47.0	11.5	41.7
	difference	0.0	0.0	-1.8	0.3
5-year ARI	existing case	0.0	46.6	10.8	32.8
	developed case	0.0	46.6	9.1	32.8
	difference	0.00	0.0	-1.8	0.1
2-year ARI	existing case	0.0	44.3	6.4	24.0
	developed case	0.0	44.3	5.5	23.9
	difference	0.0	0.0	-0.9	-0.1

Table 5.5f: Peak velocity for existing and developed conditions

Flood Scenario		Peak velocity and change at each assessment location (m/S)										
		1	2	3	4	5	6	7	8	9	10	11
100-year ARI	existing case	0.04	0.94	0.68	0.09	0.09	0.72	1.34	0.18	0.24	2.37	1.80
	developed case	0.03	0.86	0.67	0.09	0.10	0.72	1.34	0.18	0.24	2.37	1.80
	difference	-0.01	-0.08	0.00	0.00	0.01	-0.01	0.00	0.00	0.00	0.00	0.00
50-year ARI	existing case	0.02	0.75	0.64	0.09	0.11	0.69	1.31	0.15	0.18	2.21	1.61
	developed case	0.01	0.70	0.64	0.09	0.12	0.67	1.30	0.15	0.18	2.22	1.61
	difference	0.00	-0.05	0.00	0.00	0.01	-0.02	0.00	0.00	0.00	0.00	0.00
20-year ARI	existing case	0.00	0.61	0.60	0.09	0.11	0.61	1.23	0.09	0.16	1.94	1.33
	developed case	0.00	0.56	0.60	0.09	0.11	0.59	1.23	0.09	0.16	1.95	1.34
	difference	0.00	-0.05	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.01	0.00
10-year ARI	existing case	0.00	0.67	0.56	0.09	0.10	0.52	1.13	0.04	0.15	1.65	1.11
	developed case	0.00	0.62	0.56	0.09	0.10	0.51	1.13	0.04	0.15	1.66	1.11
	difference	0.00	-0.05	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00
5-year ARI	existing case	0.00	0.59	0.53	0.09	0.09	0.45	1.02	0.01	0.14	1.41	0.93
	developed case	0.00	0.55	0.52	0.09	0.09	0.43	1.02	0.01	0.14	1.42	0.93
	difference	0.00	-0.04	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	0.00
2-year ARI	existing case	0.00	0.63	0.45	0.09	0.06	0.35	0.77	0.00	0.12	1.01	0.65
	developed case	0.00	0.63	0.45	0.09	0.06	0.34	0.77	0.00	0.12	1.01	0.65
	difference	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.00	0.00

Figure 5.5a: Existing peak flood depth and extent, 2-year ARI

Figure 5.5b: Developed case peak flood depth and extent, 2-year ARI

Figure 5.5c: Change in peak flood depth and extent, 2-year ARI

Figure 5.5d: Existing peak flood depth and extent, 5-year ARI

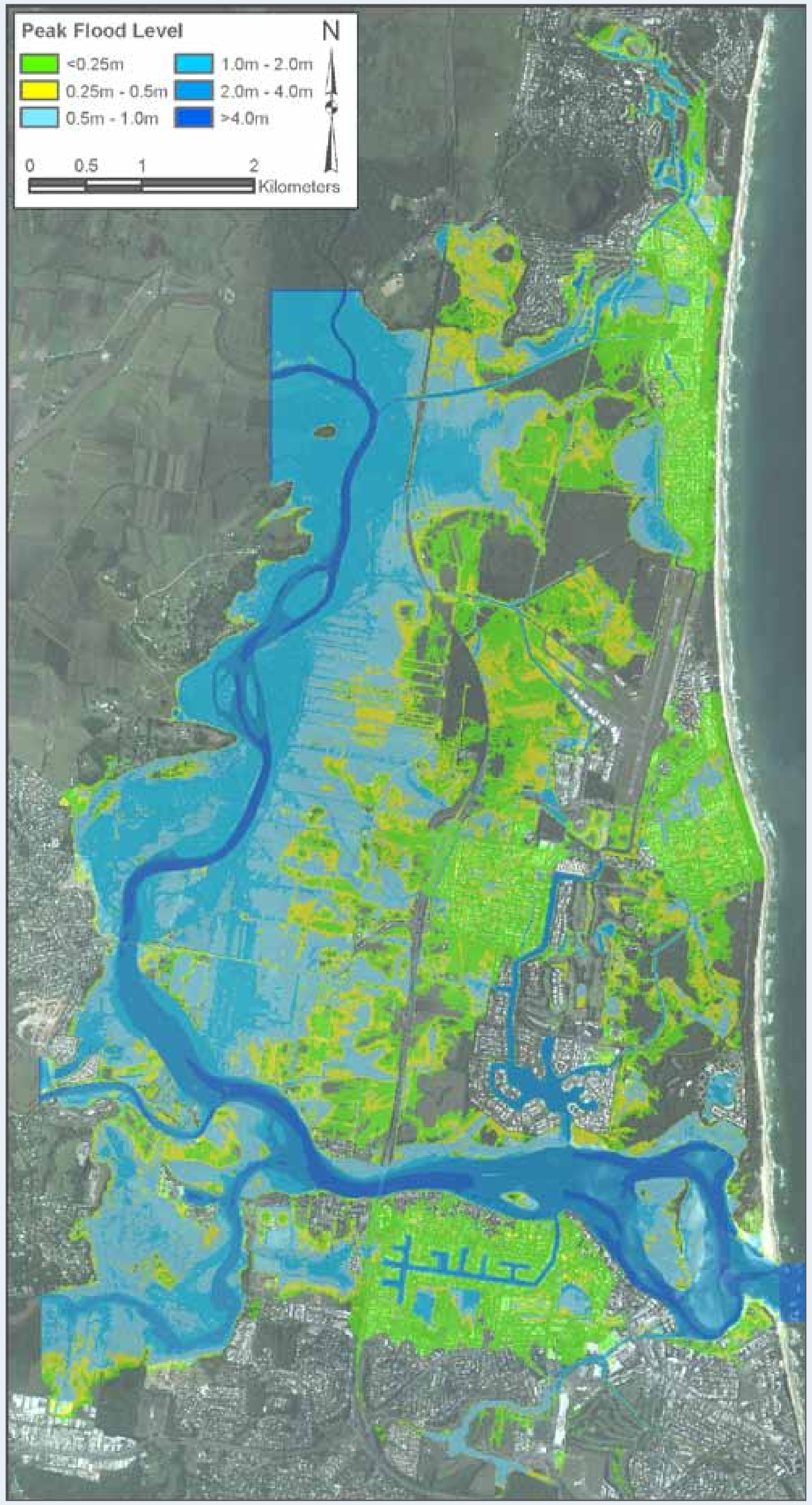


Figure 5.5e: Developed case peak flood depth and extent, 5-year ARI

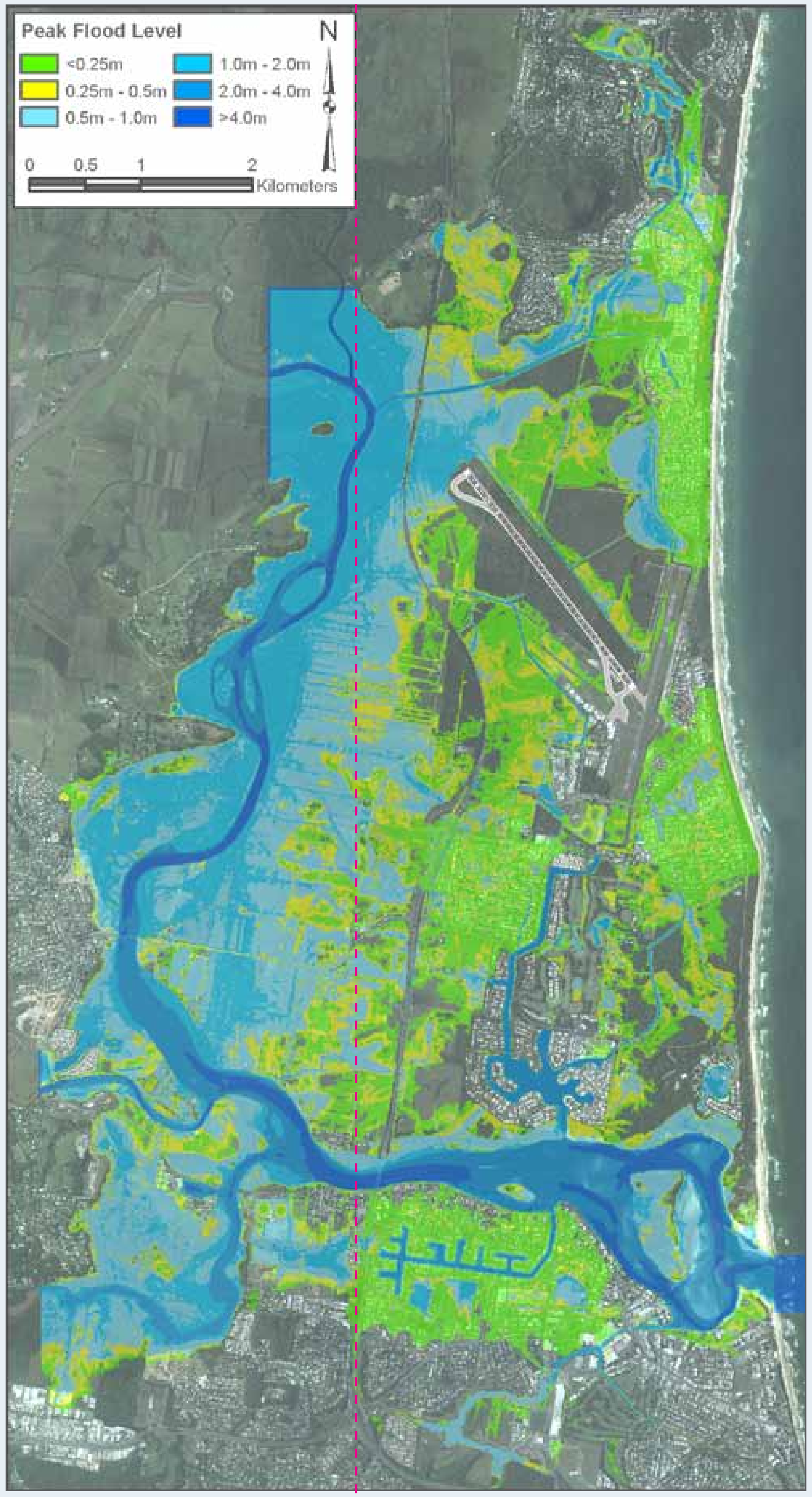


Figure 5.5f: Change in peak flood depth and extent, 5-year ARI

Figure 5.5g: Existing peak flood depth and extent, 10-year ARI

Figure 5.5h: Developed case peak flood depth and extent, 10-year ARI

Figure 5.5i: Change in peak flood depth and extent, 10-year ARI

Figure 5.5j: Existing peak flood depth and extent, 20-year ARI

Figure 5.5k: Developed case peak flood depth and extent, 20-year ARI

Figure 5.5l: Change in peak flood depth and extent, 20-year ARI

Figure 5.5m: Existing peak flood depth and extent, 50-year ARI

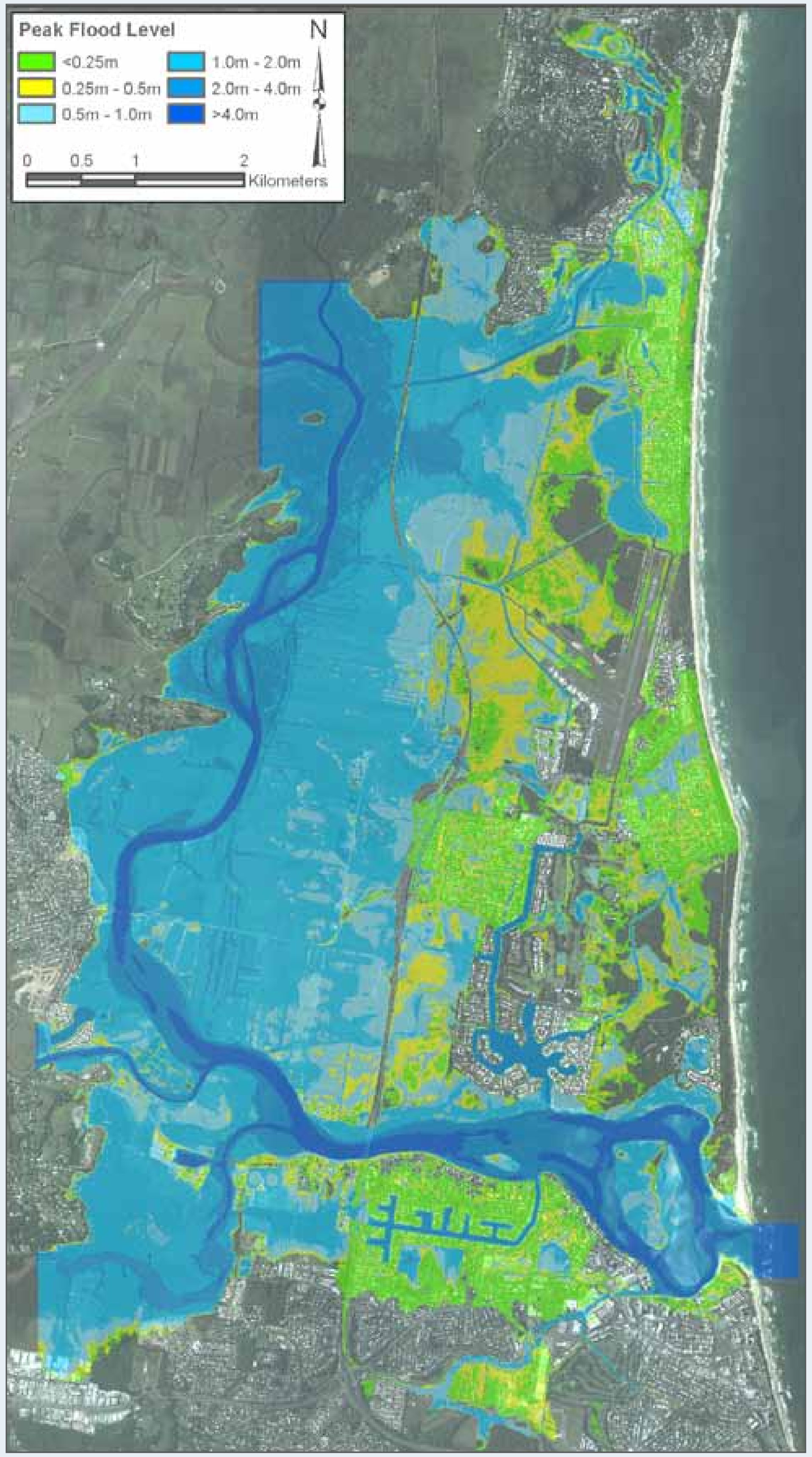


Figure 5.5n: Developed case peak flood depth and extent, 50-year ARI

Figure 5.5o: Change in peak flood depth and extent, 50-year ARI

Figure 5.5p: Existing peak flood depth and extent, 100-year ARI

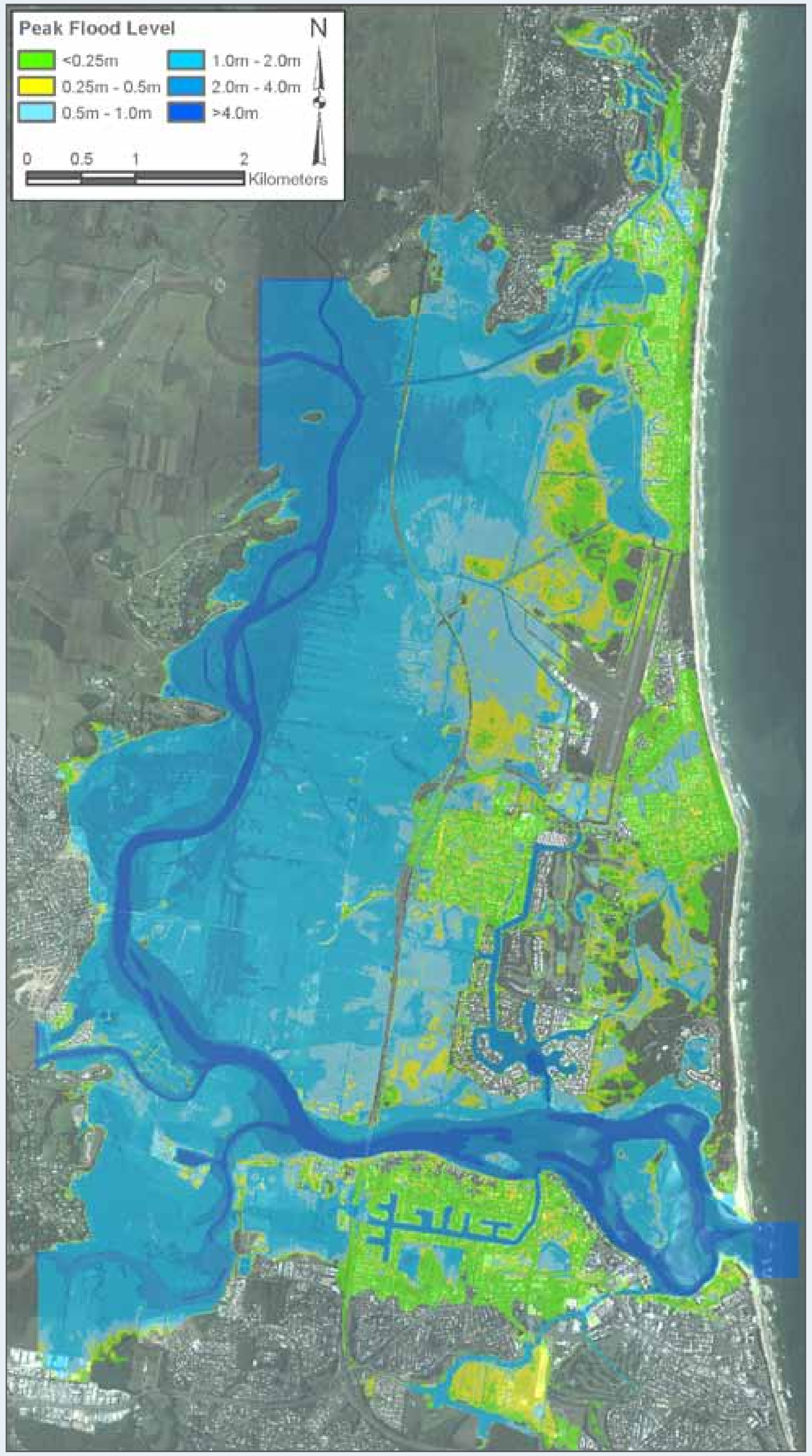


Figure 5.5q: Developed case peak flood depth and extent, 100-year ARI

Figure 5.5r: Change in peak flood depth and extent, 100-year ARI

5.5.2.2 Flood impact assessment

A flood impact assessment was undertaken for residential areas in Marcoola where the predicted increase in flood levels was greater than 10 mm in the 100-year ARI event.

Where over floor flooding occurs, the potential for damages increases significantly. Many houses in the Marcoola area are identified as likely to currently experience over floor flooding in a 100-year ARI event. Where over floor flooding currently exists, the minor increase in flood levels of 10 to 18.5 mm is expected to cause a negligible change to the damage incurred to a property. Where existing houses are not predicted to currently experience over floor flooding during the 100-year ARI event, and the increase in flood levels of 10 to 18.5 mm would cause over floor flooding, the incremental damage is considered to require mitigation.

SCA commissioned a laser floor level survey taken from the road corridor for the area in Marcoola predicted to be affected by greater than 10 mm increase in peak flood levels in a 100-year ARI event. The accuracy of the initial survey was ± 50 mm, which is considerably greater than the predicted increase in peak flood level (less than 18.5 mm). This survey was used to identify houses that would potentially experience over floor flooding as a result of the 10 to 18.5 mm increase in flood levels (i.e. houses with floor levels above the modelled 100-year ARI existing flood level minus 50 mm and below the modelled 100-year ARI developed flood level plus 50 mm). Once potentially affected properties were identified, an accurate (± 5 mm) laser survey of those properties was completed. Houses that could not be surveyed (e.g. because of high fences) were assessed based on the ± 50 mm surveyed floor level of neighbouring properties.

The flood impact assessment indicates that:

- Nine (9) houses are likely to experience flood impacts in the 100-year ARI event based on the ± 5 mm survey and
- Five (5) houses would potentially experience flood impacts in the 100-year ARI event based on the ± 50 mm survey.

The potentially affected property owners would be contacted during the public notification period for the EIS to arrange additional surveys to confirm the potential impacts and determine the need for property-scale mitigation.

5.5.2.3 Climate change scenario

A 100-year ARI 2050 climate change scenario was modelled to understand the likely effect of the proposed new runway with rising sea levels and increased storm intensity. As discussed in **Section 5.2.2.5**, the climate change scenario incorporated a 0.3 m sea level rise and 10 per cent increase in rainfall intensity.

The modelling results indicate 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 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).

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. The 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.

5.5.2.4 Assessment against Planning Scheme

Table 5.5g shows an assessment of the Project against the Planning Scheme (refer **Section 5.3.2**) based on the results of the flood modelling.

Table 5.5g: Assessment of the Project against the Planning Scheme Flood Hazard Overlay Code Criteria for Assessable Development

Performance outcome		Assessment of Project
PO1	Development is undertaken in a manner that ensures: a) Natural hydrological systems are protected b) Natural landforms and drainage lines are maintained to protect the hydraulic performance of waterways, and c) Development integrates with the natural landform of the floodplain rather than modifying the landform to suit the development.	The existing drainage and hydrological system at and around the airport has been significantly modified by urban development to date. Therefore, the hydrological system is considered not to be natural in its current situation. Additional drainage to maintain existing flood conveyance under local and regional flooding is proposed as part of the Project. The Project design has minimised landform changes within the floodplain as far as possible within the design requirements of the runway.
PO2	In a flood and inundation area, as identified on a Flood Hazard Overlay Map, or in areas otherwise determined as being subject to the defined flood event (DFE) or defined storm tide event (DSTE): a) Any development involving physical alteration to land does not occur, or b) Urban and rural residential development, and development involving the erection of a building or structure or significant earthworks satisfies at least one of the following criteria: 1) The development is on land that is already committed to urban or rural residential development by an approval granted prior to the commencement of the planning scheme 2) The development is on land identified in a structure plan as an area intended for urban development 3) The development is redevelopment or infill development within an existing developed area 4) An overriding community need in the public interest has been demonstrated that warrants approval of the development despite its occurrence within an area subject to flooding or 5) The development is for the infrastructure identified on the planning scheme maps, and 6) Achieving flood immunity for the development minimises physical alteration to the floodplain.	The Project is for the development of infrastructure identified on the planning scheme maps. The Project is an important piece of community infrastructure for the Sunshine Coast, as discussed in Chapter A2 – Project Need. The runway design minimise changes to the floodplain by providing floodplain flows between the end of the runway and Sunshine Motorway. Additionally, earthworks have been minimised to that required to provide the runway and two end loop taxiways.
PO3	Development provides that for all flood and storm tide inundation events up to and including the DFE and DSTE: a) The safety of people on the site is protected, and b) The risk of damage to property on the site is avoided or minimised as far as practicable.	The Project is designed to provide 100-year ARI flood immunity for the runway taking into account a 2100 climate change scenario, including a 0.8 m sea level rise and 20 per cent increase in rainfall intensity.

Performance outcome		Assessment of Project
PO4	Development does not compromise the safety of people resulting from the residual flood or storm tide inundation risk associated with events exceeding the DFE or DSTE up to and including the probable maximum flood (PMF) or probable maximum storm tide (PMST).	A suitable emergency flood management plan would be prepared during the detailed design phase of the Project. This plan would incorporate suitable early flood warning systems, procedures for progressive airport shut down in response to flooding, evacuation procedures and the provision of suitable facilities above extreme flooding as shelter/safe refuge areas on the site. In terms of the safety of people, given the presence of the existing terminal building and its expansion, suitable on site safe refuge areas can be adequately provided within this building for extreme flood events. Previous studies (SCC, 2010) indicate that the PMF is more than 2.0 m higher than the current-day 100-year ARI event. Consequently, the PMF is more than 1.0 m above the design height of the new runway and floodwaters would flow from north to south over the runway. The drainage design generally equalises flood levels north and south of the runway (e.g. they are within 50 mm in the 100-year ARI) and so when the runway overtopped in a PMF, there would not be a sudden rush of floodwater into the area south of the runway. Even without the Project, the potential consequences of a PMF in the catchment around the runway would be significant, with several metres of floodwater likely to flow through developed areas. The potential increase in flood levels caused by the runway would be minor relative to the overall flood depth, and the residual risk of this event is unlikely to change.
PO5	Development ensures that building design and built form: a) Maintains a functional and attractive street front address appropriate to the intended use and b) Ensures that building materials used have high water resistance and would improve the resilience of a building during and after a flood or storm tide event.	No new buildings are proposed within the DFE or DSTE. Materials used in the terminal expansion will be selected to be appropriate for the building purpose and site, including appropriate water resistance. The terminal expansion and upgrade would be undertaken to maintain or enhance the current character of the terminal precinct. Materials used in the construction of the runway, for example electrical conduits for lighting, would be installed above the DFE and DSTE, or be designed with an appropriate level of water resistance.
PO6	Essential network infrastructure within a site (e.g. electricity, water supply, sewerage and telecommunications) maintains effective function during and immediately after flood and storm tide inundation events.	No essential network infrastructure that serves facilities external to the airport is proposed as part of the Project. Should substations be required for the Project, they will be located above the DFE and DSTE. The major infrastructure of concern for the new runway is the runway lighting and movement area guidance signs. These would be installed at the runway level, and have flood immunity similar to the runway, which is described above for PO3.
PO7	Essential community infrastructure is able to function effectively during and immediately after flood events.	The runway has been designed with immunity for a 100-year ARI 2100 climate change scenario. The design positions the pavement layers above the flood level to reduce the risk of pavement damage and consequently allow a rapid return to operations.

<table>
<tr><th colspan="2">Performance outcome</th><th>Assessment of Project</th></tr>
<tr><td>PO8</td><td>Development ensures that public safety and the environment are not adversely affected by the detrimental impacts of floodwater on hazardous and other materials manufactured or stored in bulk during the DFE or DSTE.</td><td>The Project does not include the storage and manufacture of hazardous materials.
The existing fuel storage area for the airport is above the DFE, and it will continue to be operated in its current manner. SCA may upgrade the fuel storage area in the future; however, this is not within the scope of this EIS.</td></tr>
<tr><td>PO9</td><td>Development does not directly, indirectly or cumulatively alter the flooding characteristics external to the development site for all flood events up to and including the DFE or DSTE, based on:
c) current climate conditions, and
d) incorporating an appropriate allowance for the predicted impacts of climate change.</td><td>Flood modelling indicates the following:
• There would be no change to the extent of flooding as a result of the Project (i.e. no new properties affected), and
• In some parts of Marcoola that already experience flooding, very small increases of less than 20 mm are predicted.
Consequently, the Project is not considered to alter the flooding characteristics external to the development site for flood events up to and including the 100-year ARI for current climate conditions.
In terms of cumulative effects, the Project is identified as vital community infrastructure. No other similar development is proposed or planned within the floodplain, and therefore the potential for subsequent cumulative impacts is negligible.
Flood modelling for a 2050 climate change scenario indicated that without development of the Project, climate change would cause a widespread increase in predicted levels across the catchment. The potential impacts associated with the runway are an order of magnitude less than those caused by climate change. These results indicate a requirement for a regional approach to mitigating climate change for the Maroochy River catchment regardless of development at SCA. SCA would work with the relevant authorities to ensure that the potential impacts associated with the new runway are accommodated in the regional strategy.</td></tr>
<tr><td>P10</td><td>Development does not increase the severity of storm tide related impacts for off-site property for all storm tide events up to and including the DFE or DSTE based on:
a) Current climate conditions, and
b) Incorporating an appropriate allowance for climate change at the end of the design life of the development.</td><td>The Project does not increase the severity of storm tide related impacts.</td></tr>
</table>

5.5.3 Flood risk assessment

The flood risk assessment for the Project is presented in **Table 5.5h**. Overall, the residual flood impact risk from the Project is negligible.

5.5.4 Cumulative effects from other planned future development

5.5.4.1 Planned future development

A number of projects are currently planned in the Maroochy River catchment; those that are of interest from a cumulative flood impact perspective are those that could affect the flooding regime in areas near the Project. **Table 5.5i** summarises the projects in the catchment, and whether they have the potential to cause cumulative flood impacts.

5.5.4.2 Assessment of cumulative impacts from planned future development

To assess the cumulative impacts of a desalination plant north of the proposed new runway, the Project-specific model was run with the following inputs:

- Current day 100-year ARI event
- The Project and
- A 13 ha earthworks platform at 3.8 m AHD (which provides current day 100-year ARI flood immunity) to represent the proposed desalination plant.

The model results indicate that the development of a desalination plant in the current proposed location north of RWY 13/31 is likely to have a minor impact on flood levels north of the Project, with an increase in peak flood levels during a 100-year ARI event of approximately 3 mm north of the proposed new runway compared to the developed scenario without the desalination plant.

Table 5.5h: Flood risk assessment for the Project

Flood event	Potential impacts	Likelihood	Significance	Risk	Mitigation	Likelihood	Significance	Risk
2–year ARI	• A negligible increase in peak flood levels of less than 10 mm is predicted within developed areas • The impact would be temporary during the flood and of local scale.	Almost certain	Negligible	Negligible	No additional mitigation proposed	Almost certain	Negligible	Negligible
5–year ARI	• A negligible increase in peak flood levels of less than 10 mm is predicted within developed areas. • The impact would be temporary during the flood and of local scale.	Almost certain	Negligible	Negligible	No additional mitigation proposed	Almost certain	Negligible	Negligible
10–year ARI	• A negligible increase in peak flood levels of less than 10 mm is predicted within developed areas. • A negligible increase in the flood level of less than 14 mm is predicted immediately east of the Sunshine Motorway, where it intersects the southern perimeter drain. • Minor increases in the flow velocity of less than 0.2 m/s is predicted on the eastern side of the Sunshine Motorway bridge over the Marcoola drain . • The impact would be temporary during the flood and of local scale.	Almost certain	Negligible	Negligible	No additional mitigation proposed	Almost certain	Negligible	Negligible
20–year ARI	• A negligible increase in peak flood levels of less than 10 mm is predicted within developed areas. • A negligible increase in the flood level of less than 19 mm is predicted immediately east of the Sunshine Motorway, where it intersects the southern perimeter drain. • Minor increases in the flow velocity of less than 0.2 m/s is predicted on the eastern side of the Sunshine Motorway bridge over the Marcoola drain. • The impact would be temporary during the flood and of local scale.	Almost certain	Negligible	Negligible	No additional mitigation proposed	Almost certain	Negligible	Negligible

Flood event	Potential impacts	Likelihood	Significance	Risk	Mitigation	Likelihood	Significance	Risk
50–year ARI	• A negligible increase in peak flood levels of less than 10 mm is predicted within developed areas. • A negligible increase in the flood level of less than 11 mm is predicted between the eastern side of the Sunshine Motorway where it intersects the southern perimeter drain and RWY 13/31. • Minor increases in the flow velocity of less than 0.2m/s is predicted on the eastern side of the Sunshine Motorway bridge over the Marcoola drain. • The impact would be temporary during the flood and of local scale.	Almost certain	Negligible	Negligible	No additional mitigation proposed.	Almost certain	Negligible	Negligible
100–year ARI	• Fourteen houses would potentially experience flood damage in the 100-year ARI event. SCA would consult with the property owners, and agree appropriate property-scale mitigation if required. • Minor increases in the flow velocity of less than 0.3 m/s is predicted on the eastern side of the Sunshine Motorway bridge over the Marcoola drain. • A minor increase in peak flood level of approximately16 mm is predicted at the sports grounds and open fields south of David Low Way and RWY 18/36. • The impact would be temporary during the flood and of local scale.	Almost certain	Minor	Medium	Detailed survey of properties that were unable to be surveyed. Property owner consultation and property-scale mitigation as agreed with the property owner.	Almost certain	Negligible	Negligible

Table 5.5i: Cumulative effects on the flood regime

Project name	Comment on potential for cumulative flood impacts
Caboolture to Maroochydore Corridor Study (CAMCOS)	The CAMCOS corridor follows the existing Sunshine Motorway alignment, and terminates at the proposed New Terminal. It is anticipated that the project would need to show negligible changes to flood impacts.
Bruce Highway upgrades	Located west of the Maroochy River near existing infrastructure. Consequently, it is unlikely to affect the flood regime at the proposed project site
Sunshine Motorway upgrades	Upgrades to the Motorway could affect the flooding regime in the area surrounding the Project. It is anticipated that the project would need to show negligible changes to flood impacts.
Desalination plant north of the proposed runway	Given the proximity to the Project, there is potential for cumulative impacts from the desalination plant. This is explored in more detail in **Section 5.5.4.2**.
Nambour Station upgrade	Located west of the Maroochy River in a developed area. Consequently, it is unlikely to affect flood regime at the proposed project site
Sunshine Coast Airport Aeronautical Precinct	Located at the airport, potential impacts would be related to local drainage rather than regional flooding. It is anticipated that the project would need to show negligible changes to flood impacts.
Nambour Landfill	Located on Petrie Creek west of the Maroochy River. Expansion of the landfill is unlikely to have a measurable effect on regional flooding near the Project.
Sand extraction areas	The removal of sand from the floodplain is unlikely to reduce the floodplain storage capacity, and therefore is not expected to negatively affect the flood regime near the Project.
Sunshine Coast Entertainment, Convention and Exhibition Centre	Located at Maroochydore in a developed area. It is anticipated that the project would need to show negligible changes to flood impacts.
Maroochy bus interchange	Located at Maroochydore in a developed area. It is anticipated that the project would need to show negligible changes to flood impacts.

5.6 SUMMARY

The Project, including the new runway, is to be located in the Maroochy River flood plain east of the Sunshine Motorway. Construction of the runway requires the importation of approximately 1.1 M m^3 of fill to provide a suitable earthworks platform and flood immunity for the runway. Consequently, the Project has potential to alter flood conditions in the Maroochy River floodplain.

To assess the potential impacts, a Project specific flood model was prepared to predict and compare flood levels, flow rates and duration of inundation for pre- and post-development scenarios. The Project flood model was based on SCC's existing Maroochy River model, with some updates to reflect current catchment conditions.

Extensive numerical flood modelling was performed to assess the potential impacts of the Project in surrounding areas. Modelling was performed for existing and developed scenarios for flood events of varying frequency, and the results were compared to assess the impacts of the development. Given the constraints of the site, flood mitigation for the Project relies on improving the drainage of local runoff. To this end, mitigation measures in the Project include major drainage infrastructure described in Chapter A4 – Project Description.

A 100-year ARI 2050 climate change scenario was also modelled to understand the implications of climate change on the potential flood impacts for the Project design year (2040). The 2050 climate change scenario incorporates sea level rise of 0.3 m and a 10 per cent increase in rainfall intensity.

The modelling indicates that with the implementation of the mitigation measures, the following impacts to flood levels could be expected:

- The extent of flooding is not expected to change with development of the Project, that is, no new properties are expected to experience flooding
- In all current day modelled events, except the 100-year ARI event, the modelling indicates there would be a negligible increase in peak flood levels (less than 10 mm)
- In the 100-year ARI event, the modelling indicates that an area of Marcoola north of RWY 18/36 would experience a small increase in peak flood levels of less than 18.5 mm. This area currently experiences flood depths of 0.25 to 0.8 m during the 100-year ARI event
- Up to 15 houses on 14 properties within the affected area have existing floor levels that may be affected by the increase in depth of up to 18.5 mm in the 100-year ARI event. The owners of the affected properties would be contacted during the public notification for the EIS to conduct detailed surveys to confirm the potential impact and determine the need for property-scale mitigation.

The duration of inundation was assessed at five locations surrounding the development. Inundation times for the Project scenario were generally similar to the without Project scenario, with some areas predicted to have a reduced duration of inundation of up to 1.8 hours after development of the Project.

Changes to peak flow velocities were assessed for areas surrounding the development. A minor increase in peak flow velocity of up to 0.3 m/s is predicted in the Marcoola drain at the Sunshine Motorway.

Overall, with the implementation of the mitigation measures, the residual flood impact risk from the Project is negligible.

The results of the 100-year ARI 2050 climate change scenario modelling indicate a widespread increase in predicted flood levels across the catchment from climate change with or without the development of the Project. Under the 2050 climate change assumptions, peak flood levels in the 100-year ARI event are predicted to be approximately 200 mm to 350 mm higher than current day 100-year ARI flood levels (without the Project). With the inclusion of the new runway, the forecast flood levels are predicted to increase to a minor extent north and east of the existing RWY 18/36. The considerable increase in forecast flood levels across the catchment as a result of climate change indicates a requirement for regional climate change mitigation for the Maroochy River catchment regardless of the development at SCA. A regional mitigation strategy should be prepared and implemented by cooperation between appropriate government planning authorities at Federal, State and Local government levels. SCA would work with the relevant authorities to ensure that the potential impacts associated with the new runway are accommodated in the regional strategy. The predicted climate change impacts do not exist at present, and are future possible impacts. There is sufficient time over the next 10 to 20 years for the required regional climate change mitigation measures to be implemented.

5.7 REFERENCES

BOM, 2011. *Flood Warning System for the Maroochy River*. [Online]

Available at: http://www.bom.gov.au/hydro/flood/qld/brochures/maroochy/maroochy.shtml

[Accessed 12 December 2012].

DERM, DIP, LGAQ, 2010. *Increasing Queensland's resilience to inland flooding in a changing climate: Final report on the Inland Flooding Study*, Brisbane: Queensland Government, Department of Environment and Resource Management, Department of Infrastructure Planning and the Local Government Association of Queensland.

DERM, 2011. *Queensland Coastal Processes and Climate Change*, Brisbane: Queensland Government, Department of Environment and Resource Management.

Engineers Australia, 2013. *Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering*, Barton, ACT: Engineer Australia.

SCC, 2010. *Maroochy River Flood Study*, Maroochydore: Sunshine Coast Regional Council.