CAIRNS SHIPPING DEVELOPMENT PROJECT

Revised Draft Environmental Impact Statement

Chapter B17: Hazard and Risk

TABLE OF CONTENTS

List of Figures

List of Tables

B17.1 Introduction

B17.1.1 Scope

Each chapter of Part B of this Revised Draft EIS ('technical chapters') involves the use of risk assessment and management principles in the assessment of impacts and the subsequent re-assessment of residual risk following consideration of potential mitigation measures. The overall framework is described in **Chapter A1** (Project Introduction) and this is customised for the relevant topic in each technical chapter. In general these environmental risk assessments are self-contained and do not require repeating in this chapter. However, there are a number of risks that are not covered in the technical chapters and they are addressed below. The corresponding chapter of the Draft EIS described a number of risks associated with workplace health and safety and the findings of this work are summarised here. While the Draft EIS briefly mentioned many other hazards and risks, the CSD Project as it was at the time when the Draft EIS was prepared did not include land placement of dredge material. Accordingly, additional commentary on these issues is required.

This chapter presents the results of an overall assessment of hazard and risk associated with the CSD Project. It deals with a number of different types of hazards and risks as required by the ToR. Following a discussion on the nature of risk and hazards, these are dealt with in the following 'packages':

- natural hazards e.g. cyclones, flood, fire, earthquake
- geo-environmental hazards (e.g. unexploded ordnances, contaminated land, acid sulphate soils)
- biological and animal hazards e.g. crocodiles, biting insects
- hazardous goods storage and movement
- construction risks
- operational risks
- occupational risk (working over water, moving vehicles, security incidents, health and safety risk)
- other (pandemic, counter-terrorism, security incidents).

B17.1.2 The Study Area and Project Areas

The 'study area' for the EIS varies depending on the issue at hand while the 'project area' is the immediate footprint of the proposed works. In the consideration of water resources as defined above, the 'local scale' is appropriate. The local scale (**Figure B17-1**) is defined as follows:

- The township of Cairns.
- The marine environment including the Trinity Inlet, Trinity Bay and surrounding waters including:
  - all waters of Trinity Bay
  - the tidal waters of Trinity Inlet, including landward areas to the boundary of the Fish Habitat Area
  - Double Island
  - the coastline and nearshore waters of Cairns' Northern Beaches
  - Mission Bay
  - the coastline extending to Cape Grafton.

Project Areas are also shown on **Figure B17-1** and encompass:

- Channel Project Area including the shipping channel and the route to the pump-out point at the seaward end of the pipeline to the Northern Sands DMPA.
- Landside Works Project Area for wharf upgrades and berthing of cruise ships.
- Northern Sands DMPA Project Area (includes the DMPA, delivery pipeline, tailwater ponds, and tailwater outlet works).
- Tingira Street Stiff Clay DMPA Project Area.

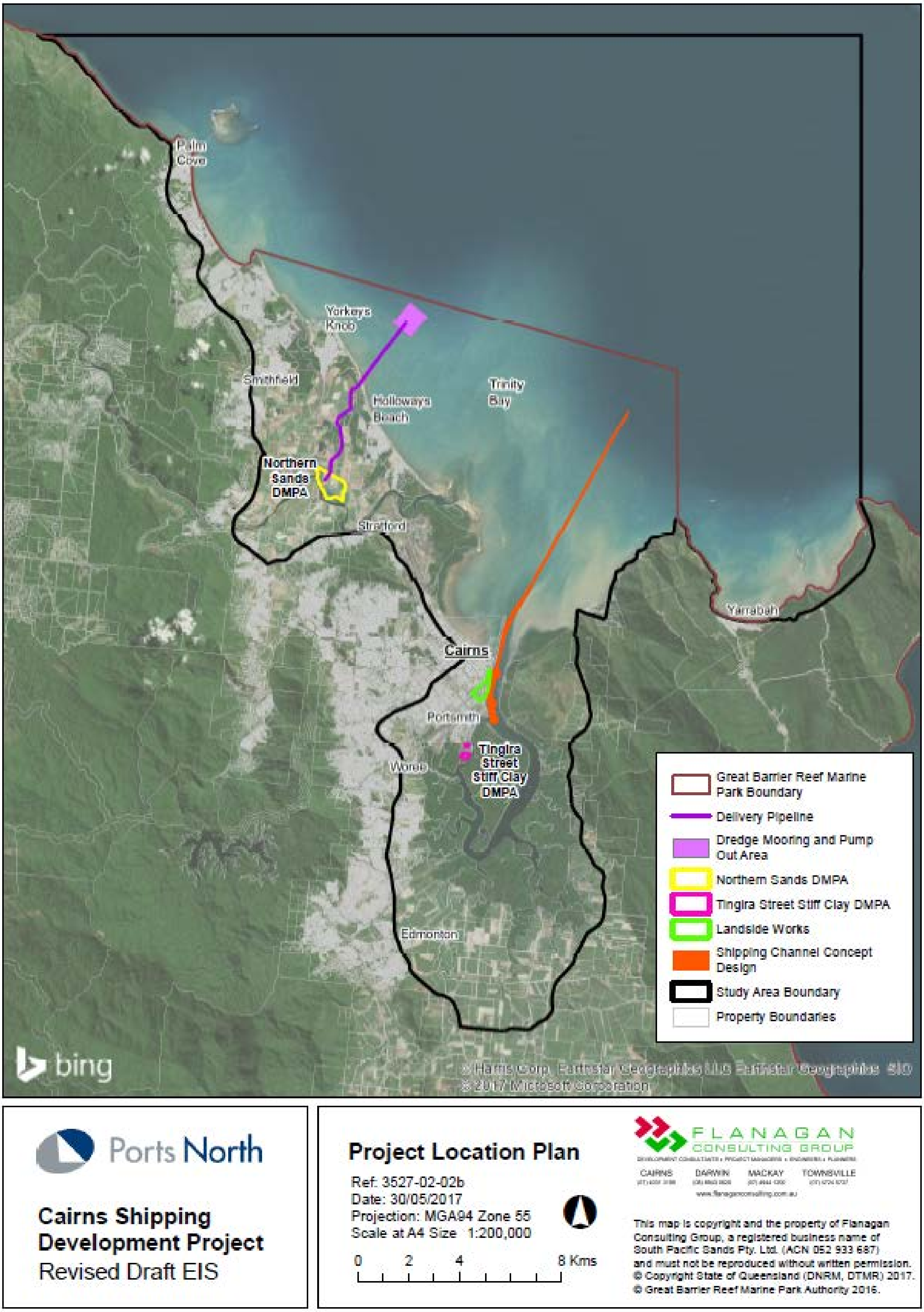

Figure B17-1 Study Area and Project Areas.

B17.1.3 End Use of DMPAs

End uses of the DMPAs are described below because an appreciation of these is critical to the assessment of hazards and risks. In particular, the Tingira Street DMPA will only be used for a period of several months during the dry season, limiting its exposure to many seasonal hazards. At the Northern Sands DMPA the exposure will cover one wet season, but specific hazard management measures will in place as described in detail later in this chapter.

B17.1.3.a Northern Sands DMPA

The Northern Sands DMPA contains an operating sand mine and a 25 ha water-filled void (known locally as Lake Narelle) that is to be enlarged and used for the placement of soft clays pumped to the site. The current void contains fresh water from groundwater seepage and rainfall.

The soft clay placement campaign will fill all or most of the void over a period of some three months after which it will settle over one wet season. Once this filling is complete, the DMPA will revert to the control of the owner who will then determine subsequent uses. No assumptions can be made about this use although current approvals imply that at some time the void is to be completely filled.

The use of the DMPA and the associated infrastructure described below will be of a duration of several months, approximately for a period starting in March 2019 and being essentially complete by the end of September 2019 (as described in **Chapter A3** (Project Description) these dates may be varied but are generally appropriate for the purposes of this assessment. As detailed in **Section B17.4.1.f**, legacy management issues at the DMPA itself will extend past the time when the pumping infrastructure is removed and ongoing management will be undertaken.

B17.1.3.b Delivery Pipeline

Soft clay will be delivered to the Northern Sands DMPA via the dredge material delivery pipeline which commences at the offshore dredge mooring and pump out facility located approximately 2.8 km offshore from Yorkeys Knob. The marine section of the pipeline will be submerged, while the landward section will be constructed above ground and suspended on low (<0.5 m) earthen plinths. Up to three terrestrial booster stations and one marine booster station may be necessary because of the pipeline length. Terrestrial booster stations will be placed in cleared grassland areas or cane headlands in consultation with landowners, to minimise interference with farming operations.

After the completion of the soft clay placement campaign, the inlet pipeline (landward and marine sections) and booster stations will be disassembled and removed. The disturbed area will be restored and the small amount of natural vegetation cleared for its construction will be rehabilitated using appropriate native species. A specific Restoration Plan will be prepared and implemented for this purpose.

B17.1.3.c Tailwater Discharge Pipeline(s)

Similarly, the tailwater discharge pipeline(s) will be disassembled and removed and the disturbed area restored rehabilitated as described in **Chapter C1** (Construction Environmental Management Plan).

B17.1.3.d Tailwater Ponds

When no longer required, the tailwater ponds will be filled and the disturbed area restored such that the area can be re-used. No rehabilitation will be necessary.

B17.1.3.e Tingira Street Project Area

The Tingira Street DMPA is currently cleared (although some marine plants have recolonised much of the area not covered by anthropogenic grasslands) and in its past has been filled to above Highest Astronomical Tide. The placed stiff clay will be used to fill and preload the site to accelerate settlement. As a separate project, Ports North intends to import additional fill and construct industrial hardstands and other infrastructure. This project has been under consideration for many years and most of the necessary approvals have already been obtained.

B17.2 Methodology

B17.2.1 Detailed Technical Assessments

Several detailed technical assessments were undertaken in support of both the concept design of the project (documented in **Chapter A2** (Project Background)) and this chapter. These are listed in **Table B17-1** below. The final column shows where these reports are located in this Revised Draft EIS (i.e. appendix number).

TABLE B17-1 DETAILED TECHNICAL ASSESSMENTS

STUDY	DETAILS	APPENDIX NUMBER
Desktop Assessment of Storm Tide Risk at Tingira St Portsmith	Flooding assessment of the Tingira Street DMPA.	**Appendix AL**
Flood and Dredge Spoil Mobilisation Technical Studies – Investigations for the Northern Sands Placement Site Option	Flooding assessment of the Northern Sands DMPA (remobilisation of placed material and afflux cause by the required protection works).	**Appendix AD**

These studies are referred to where appropriate. While all relevant findings have been incorporated into this chapter, readers are referred to the original reports for further details if required. These technical studies involved:

- numerical modelling of Barron River flooding (levels, afflux)
- consideration of bed shear and remobilisation issues.

Summaries are provided below. Many detailed tables are mentioned but not duplicated here. Readers requiring this detailed information are referred to the relevant material where appropriate.

B17.2.2 Approaches to Risk Management

B17.2.2.a National Standard

The national standard for risk management is AS/NZS ISO 31000:2009 Risk management—Principles and guidelines ('the national standard'). The need for a consistent approach to risk management is stated early in the document:

> Although the practice of risk management has been developed over time and within many sectors to meet diverse needs, the adoption of consistent processes within a comprehensive framework helps ensure that risk is managed effectively, efficiently and coherently across an organization. The generic approach described in this Standard provides the principles and guidelines for managing any form of risk in a systematic, transparent and credible manner and within any scope and context. (p iv)

The standard specifies the detailed framework and defines key terms as described later in this chapter and used throughout this Revised Draft EIS. Of interest is that the definition of risk has changed from that used in the now superseded version of the standard from 'the chance of something happening that will have an impact on objectives' to 'the effect of uncertainty on objectives'.

This current definition is explained by the following notes as documented in the national standard:

- An effect is a deviation from the expected — positive and/or negative.
- Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organisation-wide, project, product and process).
- Risk is often characterised by reference to potential events and consequences, or a combination of these.
- Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence.

These terms are further defined below. It should be noted that the national standard does not define 'hazard'.

B17.2.2.b Ports North Risk Management Framework

At the CSD Project level, Ports North's Risk Management Framework (Ports North 2015) is relevant. It states that:

> Risks are evaluated by first identifying the worst credible consequence that could evolve from a risk event, and then evaluating the Likelihood of that event occurring. The combination of Consequence and Likelihood is represented in the risk matrix, and will determine the overall risk rating allocated to that risk. (p 6)

In the Ports North framework, the following key definitions are included:

- 'Risk' – the chance of something happening that will have an impact upon objectives of Ports North. It is measured in terms of consequences and likelihood.
- 'Hazard' – a source of potential harm or a situation with a potential to cause loss.

In the interests of consistency with other environmental impact statements, the framework set up by the national standard and its terminology is used wherever possible below. However, the two approaches outlined above are consistent, with only minor variations of terminology.

B17.2.2.c The Nature of Risk Assessment for Natural Hazards

The publication Natural Hazards in Australia – Identifying Risk Analysis Requirements produced by Geoscience Australia (Middelmann 2007) provides a national context for risk analysis of natural hazards and defines important terminology for many of the issues dealt with in this chapter. Although produced before AS/NZS ISO 31000 was released, the publication includes a useful definition of 'risk' and 'hazard' that is still relevant.

> Risk is defined by the risk management standard AS / NZS 4360:2004 [superseded] as (p4): 'the chance of something happening that will have an impact on objectives' [under AS/NZS ISO 31000 this has been redefined as 'the effect of uncertainty on objectives']. A risk is often specified in terms of an event or circumstance and the consequences that may flow from it. Risk is measured in terms of a combination of the consequences of an event and their likelihood.
>
> 'Likelihood' describes how often a hazard is likely to occur, and is commonly referred to as the probability or frequency of an event. 'Consequence' describes the effect or impact of a hazard on a community. Both likelihood and consequence may be expressed using either descriptive words (i.e. qualitative measures) or numerical values (i.e. quantitative measures) to communicate the magnitude of the potential impact (AS / NZS 4360:2004).
>
> Risk in disaster management has been described … as the probability of a loss, which depends on three factors: hazard, exposure and vulnerability.
>
> - A 'hazard' refers to a single event or series of events which is characterised by a certain magnitude and likelihood of occurrence.
> - 'Exposure' refers to the elements that are subject to the impact of a specific hazard, such as houses on a floodplain.
> - 'Vulnerability' is the degree to which the exposed elements will suffer a loss from the impact of a hazard. […]. That is, risk is the interaction between likelihood and consequence. (p33)

The central concepts of likelihood and consequence remain and are inherent in the methodology adopted in this chapter and the EIS in general. These and allied terms and concepts are explained below.

B17.2.3 Risk-based Approach to Impact Assessment

B17.2.3.a Revised Draft EIS methodology

Where relevant, chapters in Part B of this Revised Draft EIS follow the risk-based approach to impact assessment described in **Chapter A1** (Introduction). This involves the following key steps:

- Identification: This step identifies the hazards and risks, areas of impact, potential events and their causes and potential consequences.
- Analysis: This involves developing an understanding of the risks, including the likelihood and consequences. The following tables are used during the analysis:
  - **Table B17-2** is used to identify the consequence of the risk (in impact assessment methodologies the term 'significance' is often used although it often has a specific meaning, especially in biodiversity assessments)
  - **Table B17-3** is used to identify the duration of impact
  - **Table B17-4** is used to determine the likelihood of impact
- Evaluation: Information from the risk analysis is combined to assess the overall level of risk as per **Table B17-5**. This helps to determine which hazards and risks need treatment or management. It also prioritises treatment.
- Treatment: This involves identification of treatment options and planning for implementation.

Further details are provided below, with definitions being quoted from AS/NZS ISO 31000:2009 wherever possible (including the notes attached to each definition). It should be noted that in each technical chapter the explanation of this risk management framework is introduced after the description of the existing situation and immediately prior to the actual impact assessment, it is discussed early in this chapter on the basis that for natural hazards in particular, the principles of risk assessment are inherent to the description of the hazard itself and not just a subsequent assessment of impacts. This is because of the concept of 'exposure' as explained below.

B17.2.3.b Risk Identification

AS/NZS ISO 31000:2009 defines *risk identification* as:

- 'process of finding, recognizing and describing risks'
- NOTE 1: Risk identification involves the identification of risk sources, events, their causes and their potential consequences.
- NOTE 2: Risk identification can involve historical data, theoretical analysis, informed and expert opinions, and stakeholder's needs.

Source: AS/NZS ISO 31000:2009.

This process is informed by prior assessment of values and the activities required to implement the CSD Project that could have an impact on these values (or existing situation).

B17.2.3.c Consequence

AS/NZS ISO 31000:2009 defines *consequence* as:

- 'outcome of an event affecting objectives'
- NOTE 1: An event can lead to a range of consequences.
- NOTE 2: A consequence can be certain or uncertain and can have positive or negative effects on objectives.
- NOTE 3: Consequences can be expressed qualitatively or quantitatively.
- NOTE 4: Initial consequences can escalate through knock-on effects.

Source: AS/NZS ISO 31000:2009.

The definition of consequence will vary depending on the topic under discussion and as noted above, can have many variables. **Table B17-2** below is a typical example extracted from **Chapter A1** (Introduction) and applies to public health and safety topics. Different consequences apply to the different topics covered in Part B of this Revised Draft EIS and they are described in each technical chapter.

TABLE B17-2 CONSEQUENCE CRITERIA

IMPACT CONSEQUENCE	DESCRIPTION OF CONSEQUENCE
Very High	Death or serious injury to the public.
High	Member of the public or site workers/staff suffers irreversible disability or serious injuries requiring long-term hospitalisation.
Moderate	Injury requiring hospitalisation or resulting in a temporary disability
Minor	Moderate level of injury requiring offsite medical treatment.
Negligible	No injury to the public. Minor injury to workers that requires on-site treatment but does not result in lost time.
Beneficial	Impacts have a positive outcome on the existing situation. This could include for example, an improvement in vegetation management or an improvement in air quality as a result of the project. Results in a positive health benefit for the public or workers/staff.

B17.2.3.d Duration

'Duration' is not defined by AS/NZS ISO 31000:2009 or the Ports North (2015) framework. However, it is critical to an appreciation of impacts, along with concepts such as reversibility and predictability. **Table B17-3** shows the approach taken in this Revised Draft EIS to classifying the duration of identified impacts.

TABLE B17-3 CLASSIFICATIONS OF THE DURATION OF IDENTIFIED IMPACTS

RELATIVE DURATION OF IMPACTS	
Temporary	Days to Months
Short Term	Up to one Year
Medium Term	From one to five Years
Long Term	From five to 50 Years
Permanent / Irreversible	In excess of 50 Years

B17.2.3.e Likelihood

AS/NZS ISO 31000:2009 defines *likelihood* as:

- 'chance of something happening'
- NOTE 1 In risk management terminology, the word 'likelihood' is used to refer to the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically (such as a probability or a frequency over a given time period).

Source: AS/NZS ISO 31000:2009.

In the Ports North (2015) risk framework:

- 'Likelihood' is used as a qualitative description of probability or frequency.
- 'Probability' is the likelihood of a specific event or outcome, measured by the ratio of specific events or outcomes to the total number of possible events or outcomes. Probability is expressed as a number between 0 and 1, with 0 indicating an impossible outcome or event and 1 indicating an event or outcome is certain.

Table B17-5 outlines how the likelihood of an impact occurring has been assessed in this Revised Draft EIS. This includes both qualitative and quantitative terms that are applied as appropriate.

TABLE B17-4 LIKELIHOOD OF IMPACT

LIKELIHOOD OF IMPACTS	RISK PROBABILITY CATEGORIES
Highly Unlikely	Highly unlikely to occur but theoretically possible
Unlikely	May occur during construction of the project but probability well below 50%; unlikely, but not negligible
Possible	Less likely than not but still appreciable; probability of about 50%
Likely	Likely to occur during construction or during a 12 month timeframe; probability greater than 50%
Almost Certain	Very likely to occur as a result of the proposed project construction and/or operations; could occur multiple times during relevant impacting period

In discussing natural hazards, the probability of occurrence can include two alternative terms / concepts:

- Average Recurrence Interval (ARI) – the annual period between events of the specified magnitude, expressed in years (i.e. 100 year or 1000 year ARI)
- Annual Exceedance Probability (AEP) – the probability that events of the specified magnitude occur in 1 year, expressed as a percent (i.e. 1% AEP or 0.1% AEP). This is the preferred terminology.

These are related concepts in that ARIs of greater than 10 years are very closely approximated by the reciprocal of the AEP (i.e. 100 year ARI ~ 1% AEP). Note that the old approaches of referring to probability as, for example, the '1 in 100 year flood', or a 'Q100' while being statistically identical to 100 year ARI to an AEP of 1%, are no longer in official usage as the concept implies that rare events are in some way separated by fixed periods of time. As noted above, the preferred terminology is AEP.

When considering periods that relate to the design life of a structure or facility, the principle of *encounter probability* is applicable. This is defined as the exceedance probability of the event over a specific timeframe.

B17.2.3.f Level of Risk

AS/NZS ISO 31000:2009 defines *level of risk* as

- 'magnitude of a risk or combination of risks, expressed in terms of the combination of consequences and their likelihood'.

Source: AS/NZS ISO 31000:2009.

For the CSD Project, the level of risk has been generated for the key impacts to identified values and is summarised in each technical chapter. This has been done by assessing consequence versus likelihood within a risk matrix with up to five levels of risk (Negligible, Low, Medium, High, or Extreme). Risk is determined by the interaction of likelihood and consequence as shown in **Table B17-5** below. This matrix applies to any topic.

TABLE B17-5 LEVEL OF RISK

LIKELIHOOD	CONSEQUENCE				
	NEGLIGIBLE	MINOR	MODERATE	HIGH	VERY HIGH
Highly Unlikely/ Rare	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

The level of risk as assessed above is as shown in **Table B17-6** below. This is unique to the topic being assessed.

TABLE B17-6 LEVEL OF RISK LEGEND

Extreme Risk	An issue requiring change in project scope; almost certain to result in a 'significant' impact on the issue under consideration
High Risk	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in a 'significant' impact on the issue under consideration
Medium Risk	An issue requiring project specific controls and procedures to manage
Low Risk	Manageable by standard mitigation and similar operating procedures
Negligible Risk	No additional management required

B17.2.3.g Risk Treatment

AS/NZS ISO 31000:2009 defines *risk treatment* as:

- 'process to modify risk'
- NOTE 1 Risk treatment can involve:
  - avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk;
  - taking or increasing risk in order to pursue an opportunity;
  - removing the risk source;
  - changing the likelihood;
  - changing the consequences;
  - sharing the risk with another party or parties (including contracts and risk financing); and
  - retaining the risk by informed decision.
- NOTE 2 Risk treatments that deal with negative consequences are sometimes referred to as 'risk mitigation', 'risk elimination', 'risk prevention' and 'risk reduction'.
- NOTE 3 Risk treatment can create new risks or modify existing risks.

Source: AS/NZS ISO 31000:2009.

One or several of the above treatments are appropriate under various circumstances. Recommendations are made in **Section B17.5**.

Ports North (2015) defines *risk treatment* as 'selection and implementation of appropriate options for dealing with risk'.

B17.2.3.h Variations in Terminology

It should be noted that in many of the existing risk assessments referred to below (e.g. **Table B17-7)**, the terminology varies slightly. For example, the following terms are used interchangeably:

- Likelihood:
  - highly unlikely/ rare ~ rare
  - possible ~ moderate
- Consequence:
  - negligible ~ insignificant
  - high ~ major
  - very high ~ extreme ~ catastrophic.

Such minor differences are not considered to be of concern and are explained when possible.

B17.3 Existing Situation

B17.3.1 Introduction

The existing situation with respect to risks and hazards involves the packages described in the introduction. Some of these risks and hazards exist in the absence of the CSD Project (e.g. natural hazards) while some arise only as a consequence of the project. Those in the latter category are described only in terms of impact assessment (**Section B17.4**).

In this section on the Existing Situation, risks and hazards are considered for the relevant project areas of the CSD Project (i.e. spatial extent) wherever possible. Commentary is also provided on the hazard management framework that presently exist independent of the CSD Project, such as via local and regional disaster management plans.

B17.3.2 Relevant Disaster and Hazard Management Plans, Policies and Strategies

B17.3.2.a Regional and Local Counter Disaster Plans

A significant volume of work has been undertaken on the description and impacts of natural hazards in the Cairns region and their management. The following documents are particularly relevant and are referred to in the detailed assessment of hazards and the description of current hazard management:

- CairnsPlan 2016 – the Cairns Regional Council (CRC) Planning Scheme, which maps areas of flood inundation (Q100), bushfire hazard, ASS, and hillslopes.
- The Cairns District Disaster Management Plan (Cairns District Disaster Management Group 2014). The plan was prepare by the Queensland Police and the Cairns District Disaster Management Group, under the Queensland Government, to facilitate the implementation of effective and efficient disaster management strategies and arrangements. The plan includes a hazards analysis to identify the most serious events in terms of probability of occurrence and severity of consequence.
- The Local Disaster Management Plan – Cairns Region (Local Disaster Management Group – Cairns Region (LDMG-CR) on behalf of Cairns Regional Council and endorsed through Council Resolution (2016).
- While not a policy or standard, the Australian Geological Survey Organisation's (AGSO) *Community Risk in Cairns – A Multi Hazard Risk Assessment* (Granger *et al.* 1999) includes a suburb-by-suburb risk assessment for the then Cairns Local Government Area. This is referred to below where relevant.

B17.3.2.b Statewide and National Documents

All of the above documents have been produced within the context of statewide and national policies of which the following are particularly relevant:

- Australia's National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances, which contains a framework enabling effective response to marine pollution incidents.
- The Queensland Coastal Contingency Action Plan (QCCAP). The action plan, supported by Maritime Safety Queensland (MSQ), supports Australia's national arrangements for oil and chemical spills under the Inter- Governmental Agreement on Australia's National Plan to Combat Pollution of the Sea by Oil and Other Noxious and Hazardous Substances. QCCAP also links to Queensland's revised disaster management arrangements and supports Queensland's recently revised State Disaster Management Plan. The project will have procedures and protocols set in place to meet the objectives on the QCCAP in future phases of the project delivery.
- The Queensland Counter-Terrorism Strategy 2014-16, which provides guidance in the key areas of focus for counter-terrorism activities during 2014-16.
- The Queensland State Planning Policy (SPP), which outlines state interests in making or amending a planning scheme for emissions and hazardous activities as well as natural hazards such as flood, bushfire, landslide, and coastal hazards.
- The International Ship and Port Facility Security Code (IMO 2004). The code provides an international

framework involving cooperation between governments, agencies, and the shipping and port industries to identify and assess threats affecting ships and port facilities. Under the code, Australia's responses to maritime security incidents is undertaken through its law enforcement agencies and under existing arrangements for responding to terrorist incidents generally (e.g. through the National Counter-Terrorism Plan). The Maritime Transport and Offshore Facilities Security Act 2003 (Cth) gives effect to Australian implementation and interpretation of the code.

- AS/NZS ISO 31000:2009 Risk management Principles and guidelines (Standards Australia/Standards New Zealand 2009).
- AS 3846:2005 The handling and transport of dangerous cargoes in port areas (Standards Australia 2005a).
- AS/NZS 3833:2007 The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers (Standards Australia 2007).
- HB 76:2010 Handbook – Dangerous goods – initial emergency response guide.

Unless essential to the following assessment, these are not referred to specifically as they have been subsumed in or used in the preparation of the local and regional plans.

B17.3.3 Natural Hazards

B17.3.3.a Background

Natural hazards all exist independent of the CSD Project and are features of the existing environment. As previously explained, risk in disaster management is the probability of a loss, which depends on three factors: hazard, exposure, and vulnerability. Paraphrasing the definitions in **Section B17.2.2.c** above:

- A 'hazard' refers to a single event or series of events which is characterised by a certain magnitude and likelihood of occurrence.
- 'Exposure' refers to the elements that are subject to the impact of a specific hazard, such as houses on a floodplain. To some extent this is loosely equivalent to 'consequence' as it defines the spatial extent and severity of a hazard.
- 'Vulnerability' is the degree to which the exposed elements will suffer a loss from the impact of a hazard and is equivalent to risk (i.e. the interaction between likelihood and consequence).

A number of relevant risk assessments have been undertaken in relation to hazards that have the potential to occur in the Cairns region. This section collates relevant information gathered by Commonwealth, state and local governments. Specifically it draws on information from the following documents described above:

- Granger *et al.* (1999). This includes a suburb-by-suburb risk assessment for the then Cairns Local Government Area and covers the terrestrial project areas of the CSD Project.
- Cairns DDMP (2014). This has been developed by the State Government Cairns District Disaster Management Group (CDDMG 2014). The Cairns DDMP:
  - includes a broad description of hazards potentially occurring in the Cairns district
  - makes a risk assessment of the hazard
  - assigns responsibilities for the response of specific hazards
  - provides some details regarding the planned response.
- LDMP – CR (2016). This provides a risk assessment and broad strategy of response for hazards that potentially occur in the Cairns LGA. Note that this document refers to the work by Granger *et al.* (1999) and notes that it should be used until updates have been produced. To date this work has not been updated and is still relevant.

B17.3.3.b Risk (Exposure) Mapping

The work by Granger *et al.* (1999) is useful as it provides spatial information on where the hazard occurs as well as an assessment of the vulnerability to its effects. The authors note that the methodology used in formal risk standards (now AS/NZS ISO 31000:2009 Risk management—Principles and guidelines) is too general and they chose to follow the following system:

- *Natural hazard* means the probability of occurrence, within a specified period of time in a given area, of a potentially damaging natural phenomenon.
- *Vulnerability* means the degree of loss to a given element at risk or set of such elements resulting from the occurrence of a natural phenomenon of a given magnitude…
- *Elements at risk* means the population, buildings and civil engineering works, economic activities, public services, utilities and infrastructure, etc., at risk in a given area.
- *Specific risk* means the expected degree of loss due to a particular natural phenomenon: it is a function of both natural hazard and vulnerability.
- *Risk* (i.e. 'total risk') means the expected number of lives lost, persons injured, damage to property and disruption of economic activity due to a particular natural phenomenon, and consequently the product of specific risk and elements at risk. *Total risk* can be expressed simply in the following pseudo-mathematical form:
  - Risk (Total) = Hazard x Elements at Risk x Vulnerability

In simple terms, it is possible to use the 'Exposure Profile' maps produced as measures of risk for the purposes of this chapter (i.e. **Table B17-5**) as follows:

- High (Granger *et al.*) = Very High / Extreme (**Table B17-5**)
- Significant = High
- Moderate = Medium
- Low = Negligible or Low.

Where possible, local disaster management plan risk ratings are also cited.

B17.3.3.c Earthquake

Risk Assessment

According to Granger *et al.* (1999) Cairns has experienced at least 11 significant earthquakes over the last 100 years with the most damaging (term not defined) measuring 4.3 on the Richter Scale. While the likelihood of a stronger magnitude earthquake of 5 to 6 would be rare, the consequences would be catastrophic. This study concluded that while all Cairns suburbs have some degree of exposure, buildings on soft sediments of river deltas and coastal plains will suffer the most damage as the soft sediments amplify earthquake shaking and become unstable (liquefaction).

Figure B17-2 below is an extract from Granger *et al.* (1999) superimposed on a Google Earth image showing the CSD Project local study area.

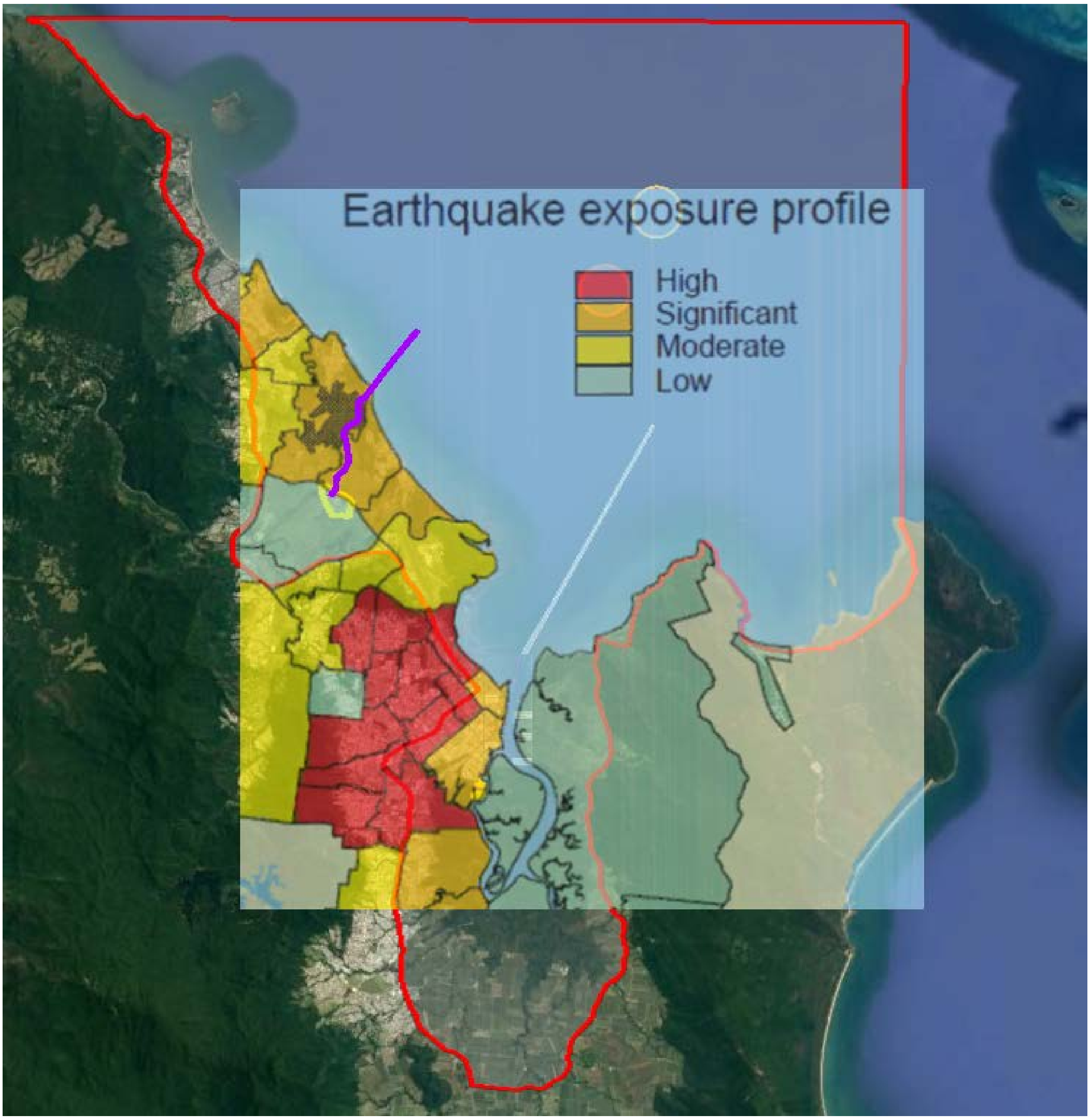

Figure B17-2 Earthquake exposure profile.

Source: Granger *et al.* (1999).

Figure B17-2 shows the following earthquake exposure levels for each project area (text in square brackets are equivalent terms from **Table B17-5**):

- Channel – not assessed
- Land-side Works Area – significant [High]
- Northern Sands DMPA – low [Low]
- Northern Sands Project Area – significant [High]
- Tingira Street Project Area – significant (High].

According to local disaster planning information (city-wide) (terms from the CSD Project risk assessment methodology are shown in square brackets):

- Cairns DDMP (2014). Earthquake is an *Unlikely* [Unlikely] event and the consequences would be *Catastrophic* [Very High]. Application of **Table B17-5** to these values produces an overall risk level of High.
- LDMP (CRC 2012). Earthquake is a *Rare* event (1000 year ARI / 0.1% AEP) and the consequences would be *Catastrophic* [Very High]. Application of **Table B17-5** to these values produces an overall risk level of High.

Hazard Management

Earthquake Response

The Standard Emergency Warning Signal is used in the event of an earthquake. However, the nature of earthquakes in Australia is such that there is usually very little warning of their occurrence. General advice is provided on Queensland Government and Commonwealth Government websites regarding what action residents can take in the event of an earthquake.

Cairns DDMP (2014) notes that:

> Like any other natural disaster, it is not possible to prevent earthquakes from occurring. Earthquake disaster mitigation and preparedness strategies are the need of the hour to fight and reduce its miseries to mankind. Comprehensive mitigation and preparedness planning includes avoiding hazard for instance, by providing warning to enable evacuation preceding the hazard, determining the location and nature of the earthquake hazard, identifying the population and structures vulnerable for hazards and adopting strategies to combat the menace of these. (p 307)

Engineering Requirements

Recent research into Earthquake Hazards in Australia undertaken by Geoscience Australia (Burbidge 2012) has resulted in a map of probability which is to be used for engineering application under the Australian Earthquake Loading Code (AS1170.4). This map shows that in the Cairns area earthquake is of low (but not lowest) risk.

B17.3.3.d Tsunami

Risk Assessment

According to Granger *et al.* (1999) off-shore earthquakes have the potential to generate tsunamis as do underwater volcanos and landslides. The amplitude of the wave/s depends on the amount of displacement in the water column caused by the triggering event, the off-shore bathymetry, and gradient of the shoreline. According to the Bureau of Meteorology (BoM) (2013) tsunamis are recorded in Australia about once every two years.

According to local disaster planning information (city-wide):

- Cairns DDMP (2014). Considers that a tsunami has an overall risk rating of Medium, based on the combination of Moderate likelihood (will occur at some time), and Moderate consequence (moderate delays, inconvenience, financial loss, etc.).
- LDMP (CRC 2012). Concludes that the risk is the same as the DDMP (i.e. Moderate) but in this case has a lower likelihood (Rare – 1000 year ARI (0.1% AEP)) but higher consequence (Catastrophic).

Work undertaken for the Aquis Resort (Aquis 2014) notes that hazard maps produced by Geoscience Australia are defined at a bathymetry water depth contour of 100 m off-shore. This normally falls outside of the Great Barrier Reef or other reef systems. The 100 m depth contour is chosen because:

- estimating the tsunami closer to the coast requires high resolution bathymetric data which does not always exist for the entire coast
- estimating the tsunami closer to the coast is a more computational and time intensive task.

So, while these maps help to identify the areas which are most likely to be at risk to damaging tsunami waves and are used by Australian emergency managers in understanding the tsunami hazard to Australia, they cannot be used directly to infer:

- how far a tsunami will inundate on-shore (inundation extent)
- how high above sea level they will reach on land (run-up)
- the extent of damage
- any other on-shore phenomena.

To estimate the on-shore effect of a tsunami, detailed bathymetry and topography of the specific region concerned is required for input to a detailed inundation model. However, the catalogue of tsunami events can be used by emergency managers, researchers and individuals to develop detailed inundation models at any on-shore location.

The Aquis (2014) study refers to modelling carried out by DSITIA and the possible reduced tsunami wave height of 0.2 to 0.6 m at the -10 m contour, concluding that it is unlikely that this will shoal significantly as it propagates to the shore. Additional detailed shoreward propagation and inundation modelling would be required to further assess safe refuge heights for coastal communities. However, it is considered that the selection of the +6 m AHD contour by the CRC is a conservative estimate of a safe zone (see following discussion).

Hazard Management

Cairns DDMP (2014) notes that:

> Whilst the threat of a natural disaster cannot be mitigated against [sic], to mitigate the risk of loss of life, effective communication strategies be put in place so residents within the District are warned with up to date information - this can be done via media, SMS and a range of different methods. Police traffic control could assist with many residents escaping to higher ground to mitigate the risk of bottlenecks of traffic. (p 305)

The CRC published a Cairns Tsunami Evacuation Guide for residents in the Cairns area (CRC 2007). The information guide provides a map showing the 6 m Australian Height Datum (AHD) contour and advises that once a tsunami warning is given, residents are to move to higher ground above the 6 m AHD contour.

B17.3.3.e Landslide

Risk Assessment

Landslides in Cairns are a significant risk and occur regularly at varying scales. In recent years landslides associated with heavy rains have resulted in large sections of road on the Gillies, Kuranda and Rex ranges becoming impassable and requiring emergency clearing and subsequent reconstruction. The risk assessment (Granger *et al.* 1999) noted that most landslides in Cairns appear to be associated with disturbances of the natural surface by the construction of infrastructure or building sites. In particular, hillslopes in the Freshwater Creek valley pose a high level of risk.

Figure B17-3 below is an extract from Granger *et al.* (1999) superimposed on a Google Earth image showing the CSD Project local study area.

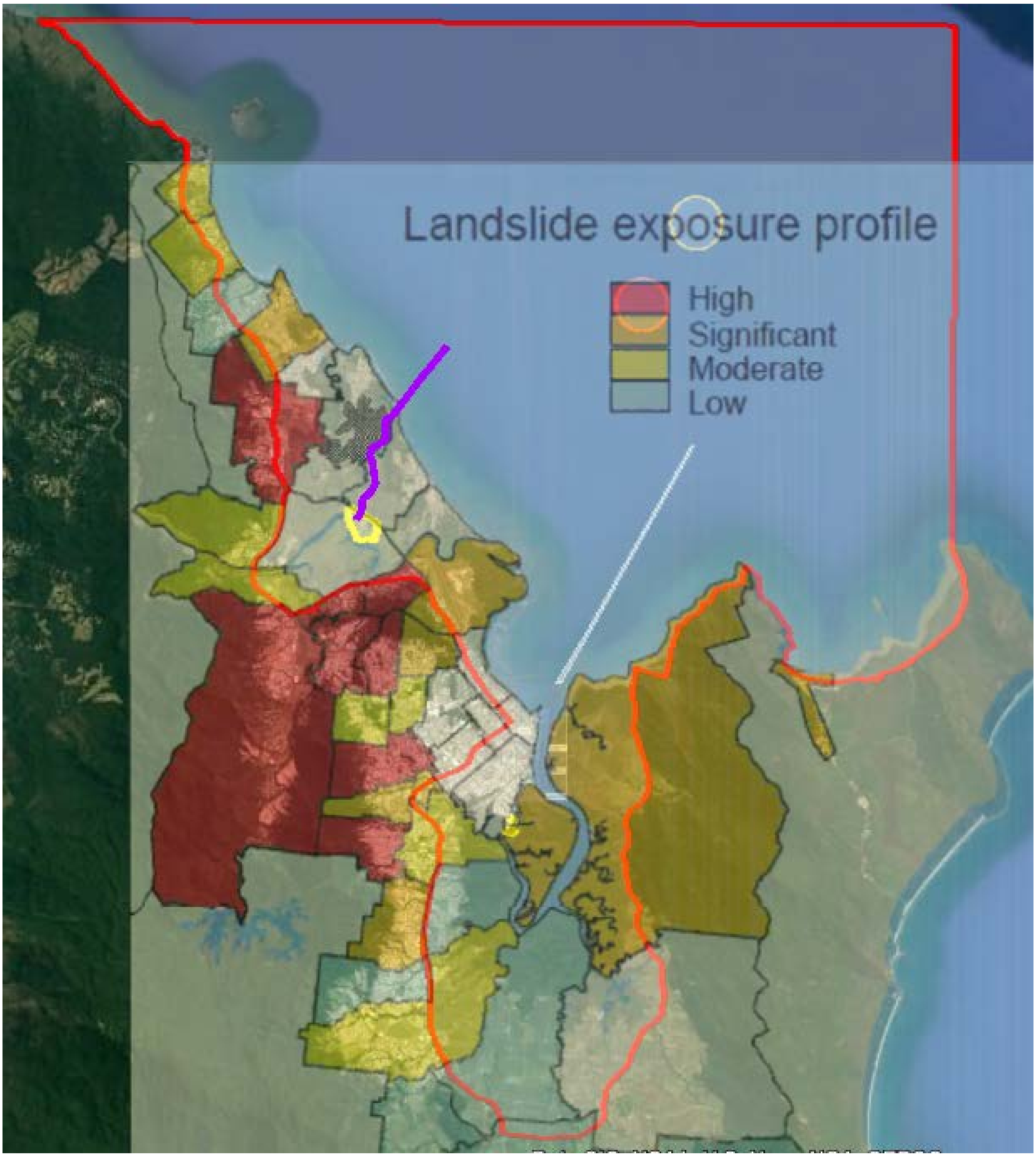

Figure B17-3 Landslide.

Source: Granger *et al.* (1999).

The landslide risk assessment (see **Figure B17-3**) shows the following exposure levels for each project area:

- Channel – nil / not assessed
- Land-side Works Area – nil / not assessed
- Northern Sands DMPA – nil / not assessed
- Delivery Pipeline – nil / not assessed
- Tingira Street DMPA – nil / not assessed.

While the coastal area between Yorkeys Knob and the Barron River has been classified as having no landslide risk (see **Figure B17-3**), the risk assessment states that it was undertaken at a broad reconnaissance level and a more detailed site geotechnical investigation at the individual property level would be required for more certainty. However, due to its distance from any steep ground, it is highly unlikely that landslide would directly affect any of the project elements.

According to local disaster planning information (city-wide):

- Cairns DDMP (2014). Considers that a landslide has an overall risk rating of High, based on the combination of Likely likelihood (will probably occur in most circumstances), and Major consequence (The event causes extensive injury / injuries resulting in hospitalisation of person / persons within Cairns LDMG area, or has the potential to cause extensive injury or death (e.g. dangerous event)).
- LDMP (CRC 2012). Landslide poses a High level of risk with a likelihood of Possible (100 year ARI (1% AEP)) and consequences of Moderate.

Hazard Management

The primary mechanism for managing landslide hazard is through the CairnsPlan which includes an overlay code for hillslopes. Part of the function of the overlay code is to protect slope stability from development. This approach is consistent with that recommended by the Cairns DDMP.

B17.3.3.f Bushfire

Risk Assessment

Cairns receives high rainfall during the wet season and this results in high vegetation growth rates. During the dry season this biomass dries out and can pose a bushfire threat. CairnsPlan includes a Bushfire Risk Analysis Overlay that shows areas of high and medium risk hazard. This risk analysis was undertaken by the Rural Fire Services.

The CairnsPlan Bushfire Hazard Overlay Map (not shown below) shows that no project areas have been assessed as having a bushfire hazard.

Hazard Management

Emergency services undertake controlled burns each year to reduce the fuel load and minimise the risk the uncontrolled fires. Furthermore, the overlay code in CairnsPlan provides performance criteria and acceptable measure to mitigate the risk. However, as no project elements are within a high or medium risk area, the code does not apply to the proposed development.

B17.3.3.g Barron River Flooding

Risk Assessment

Granger *et al.* (1999) shows that the northern beaches have a High level of exposure of flood from the Barron River. However, the authors consider that flooding posed a relatively limited threat because urban development has (to date) largely been excluded from the most flood-prone areas of the Barron River delta. The most significant economic loss is associated with damage to roads, other infrastructure and sugar cane. The isolation of the northern beachside suburbs from the Cairns CBD and its critical facilities is considered the most significant ‘inconvenience’.

Figure B17-4 below is an extract from Granger *et al.* (1999) superimposed on a Google Earth image showing the CSD Project local study area. Note that other catchments (e.g. Trinity Inlet) were not covered by this assessment. See **Section B17.3.3.h** for details of an assessment of Trinity Inlet flooding.

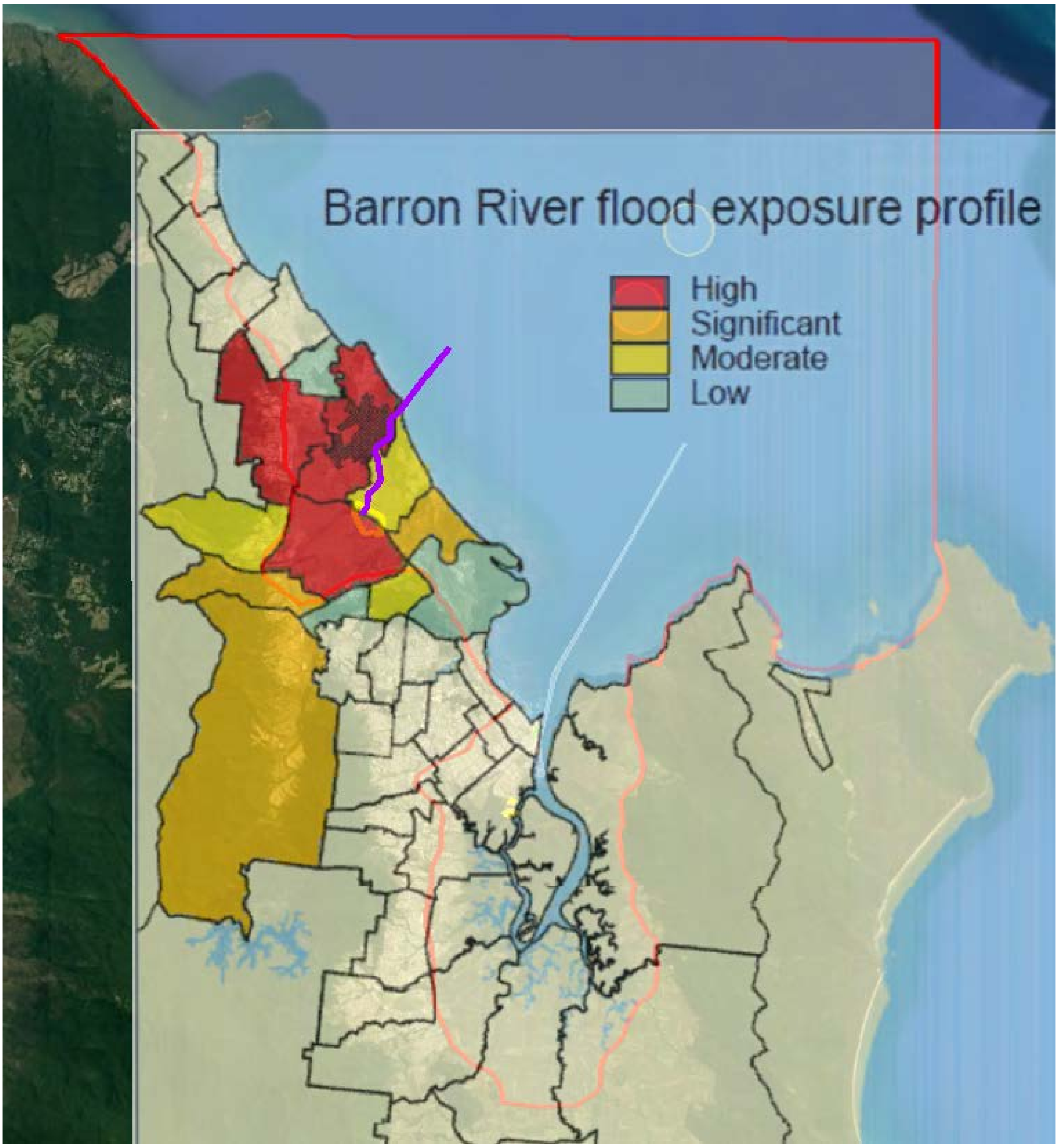

Figure B17-4 Barron River flooding.

Source: Granger *et al.* (1999).

The Barron River Flooding risk assessment (see **Figure B17-4**) shows the following exposure levels for each project area (text in square brackets are equivalent terms from **Table B17-5**):

- Channel – nil / not assessed
- Land-side Works Area – nil / not assessed
- Northern Sands DMPA – high [High]
- Delivery Pipeline – moderate (inland section) / high (coastal section) [Medium / High]
- Tingira Street DMPA – nil / not assessed.

According to local disaster planning information (city-wide):

- Cairns DDMP (2014). Considers that a Barron River flooding has an overall risk rating of Medium, based on the combination of Moderate likelihood (will occur at some time), and Moderate consequence (moderate delays, inconvenience, financial loss, etc.)
- LDMP (CRC 2012). A Barron River flood up to a 100 year ARI (1% AEP) is considered to have a likelihood of Possible by the LDMP while a Probable Maximum Flood (PMF) is considered to have a likelihood of Rare (1000 year ARI (0.1% AEP)). However, both are considered to have major consequences, resulting in a High level of risk for both levels of flood.

A detailed assessment of Barron River flooding has been undertaken for the Northern Sands DMPA and Pipeline. This is documented in **Section B17.4.1.f**. No similar study has been undertaken for any other project elements as they are not subject to flooding.

Hazard Management

According to Granger *et al.* (1999) in order to manage the risk for Barron River flooding, the following steps have been taken:

- some flood mitigation works have been established
- a flood warning system has been installed
- formal land use planning constraints have been implemented for development in areas likely to be affected by a flood with an ARI of 100 years (1% AEP).

Regarding the last point, planning controls permit certain development in the delta but require compliance with a number of criteria related to minimum building levels, access provisions, prohibition on affecting other properties (afflux, velocities) and other matters covered in CairnsPlan's Flood Management Code and Excavation and Filling Code.

As part of the Cairns DDMP, the Standard Emergency Warning Signal is used for major floods, flash floods or dam-breaks as well as intense rainfall > 50 year ARI (2% AEP).

B17.3.3.h Trinity Inlet Flooding

Trinity Inlet flooding was not assessed by Granger *et al.* (1999). Reference is made to the CairnsPlan (2016) Flood and Inundation Hazard Overlay area shown on **Figure B17-5**. This shows that both the Landside Works Project Area and Tingira Street Project Area are outside the mapped area.

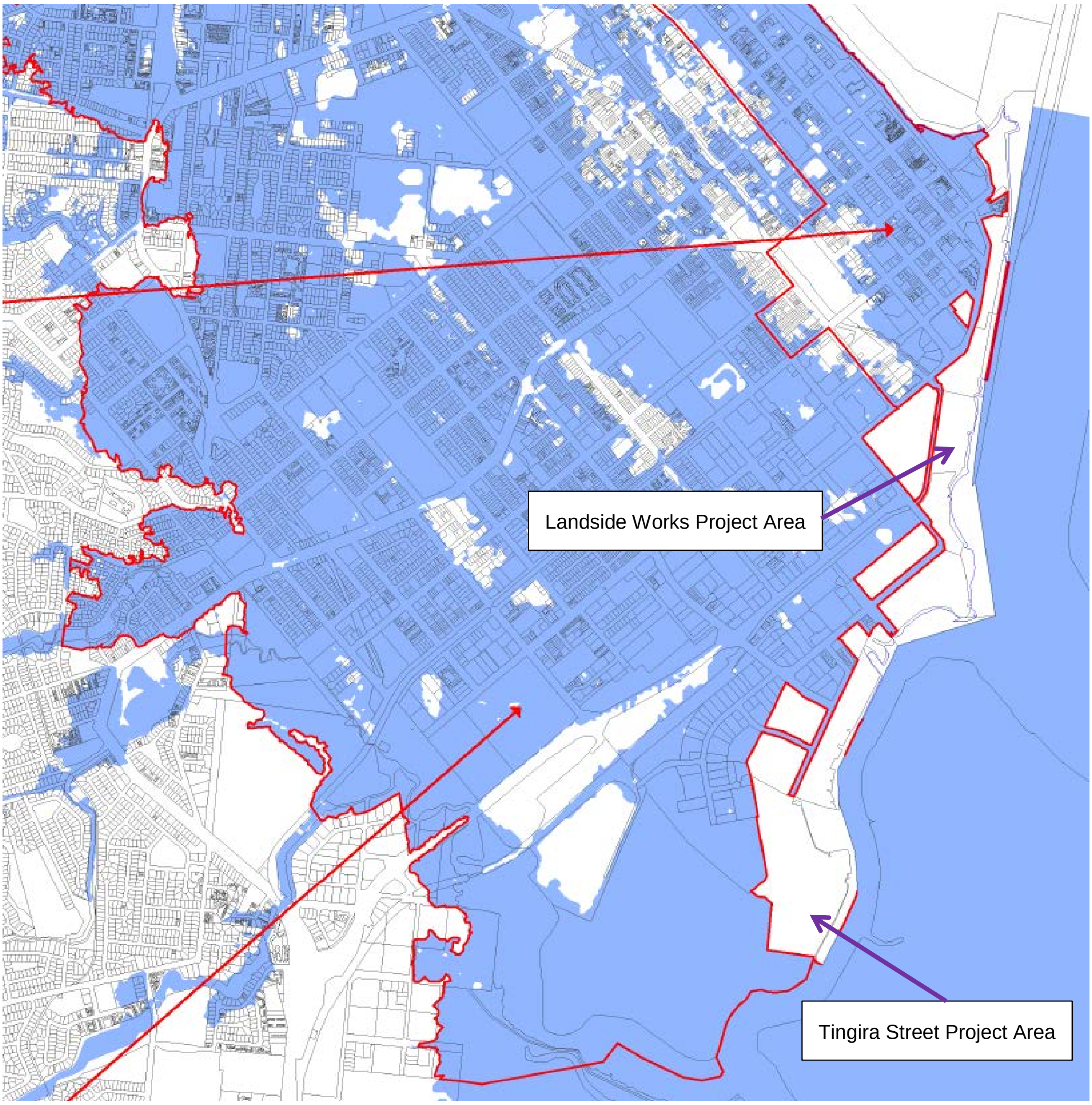

Figure B17-5 Flood inundation hazard overlay.

Source: CairnsPlan (Cairns Regional Council 2016).

B17.3.3.i Cyclones and Cyclone-induced Water Level

Risk Assessment

Tropical cyclones pose a considerable threat to Cairns with a cyclone affecting Cairns on average once every two years. Cyclones can approach the Cairns area from any direction. In terms of local topography and coastal processes, a cyclone that makes landfall just north of Cairns is expected to produce the worst result in terms of flooding (principally on the northern beaches) and risk to human life.

The main effects of a cyclone are:

- strong winds
- elevated water level (see below for a discussion on the components of elevated water level)
- flooding once the cyclone is over, although the two effects are not always a feature of the same event.

In terms of wind, gusts in excess of 90 km / h are common around the centre and, in the most severe cyclones, gusts can exceed 280 km / h. These very destructive winds can cause extensive property damage and are a risk to human life.

When a cyclone approaches the coast, the resulting water level is a result of the following factors:

- astronomical tide at the time (e.g. low, high, incoming, outgoing)
- storm surge (the increase in sea level due to low air pressure)
- wave set-up (the increase is sea level due to cyclonic winds creating larger waves)
- wave run-up (the increase in sea level due to waves breaking on a sloping shore).

A common term in disaster management is 'storm tide'. This is the combined effect of storm surge, astronomical tide, and wave set-up. It does not represent the maximum water level from a particular event as it excludes wave set-up and wave run-up.

Figure B17-6 and **Figure B17-7** below are extract from Granger *et al.* (1999) superimposed on a Google Earth image showing the CSD Project local study area and exposure of destructive (cyclonic) winds and storm tide respectively.

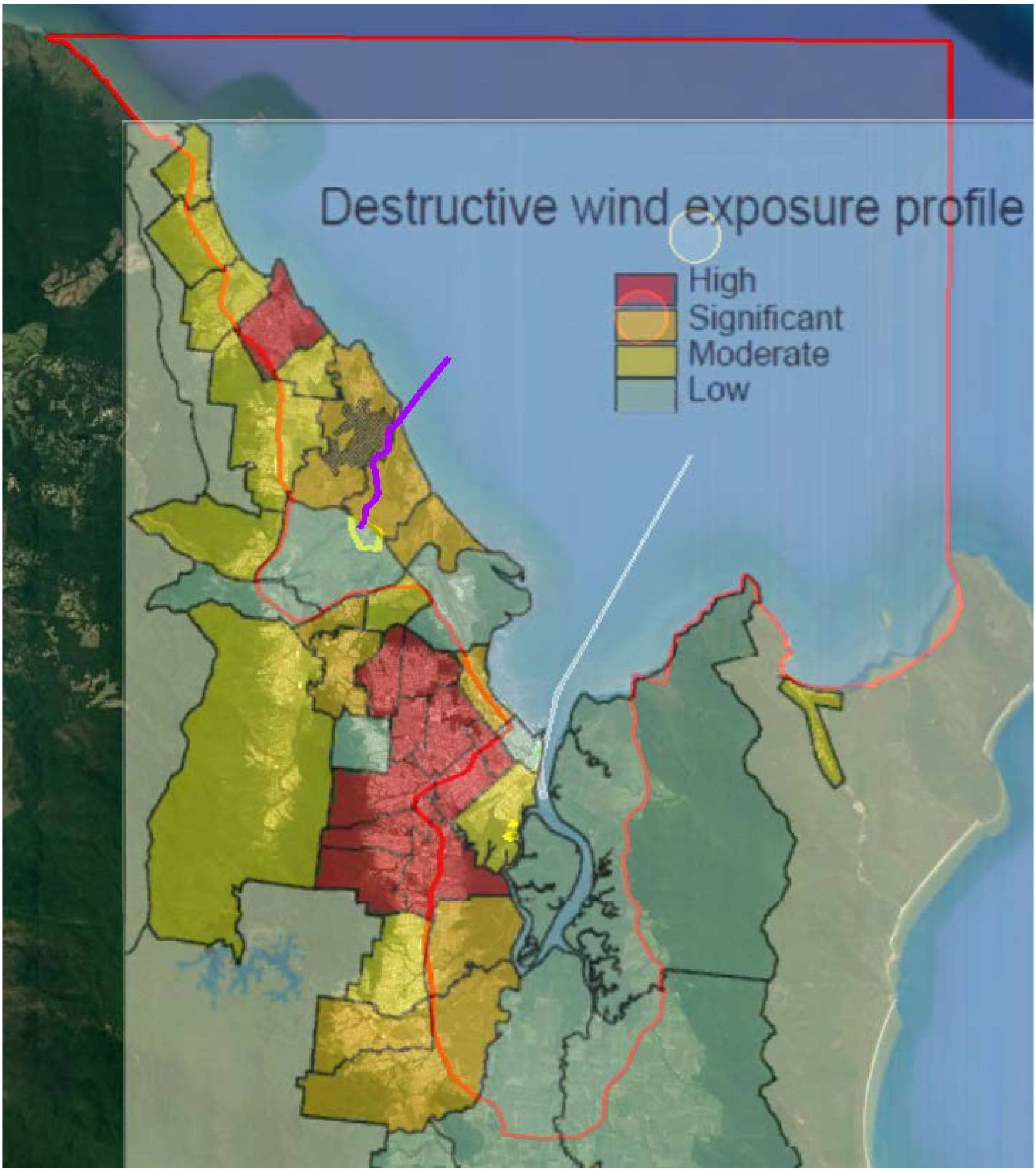

Figure B17-6 Destructive (cyclonic) winds.

Source: Granger *et al.* (1999).

The destructive (cyclonic) winds risk assessment (see **Figure B17-6**) shows the following exposure levels for each project area (text in square brackets are equivalent terms from **Table B17-5**):

- Channel – nil / not assessed
- Land-side Works Area – significant [High]
- Northern Sands DMPA – low [Low]
- Delivery Pipeline – significant (High)
- Tingira Street DMPA – high [High].

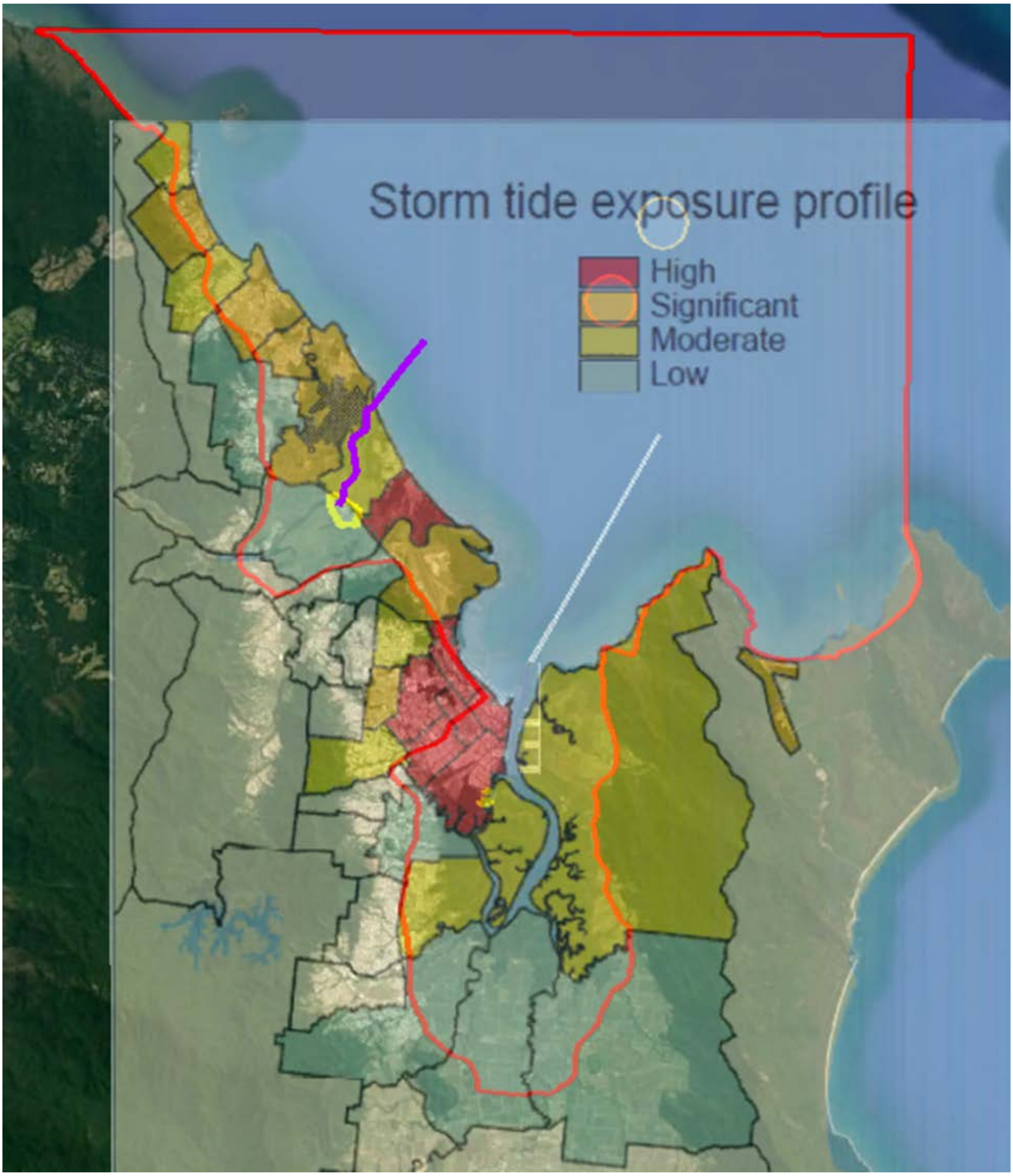

Figure B17-7 Storm tide.

Source: Granger *et al.* (1999).

The storm tide risk assessment (see **Figure B17-7**) shows the following exposure levels for each project area (text in square brackets are equivalent terms from **Table B17-5**):

- Channel – nil / not assessed
- Land-side Works Area – high [High]
- Northern Sands DMPA – low [Low]
- Delivery Pipeline – moderate [Medium]
- Tingira Street DMPA – high [High].

According to local disaster planning information (city-wide):

- Cairns DDMP (2014). Considers that a cyclone has an overall risk rating of Extreme, based on the combination of Almost Certain likelihood (even is likely to occur in most circumstances), and Catastrophic consequence (event causes fatality or multiple fatalities within the Cairns area)
- LDMP (CRC 2012). Cyclones are considered to pose a High level of risk to the Cairns area according to the LDMP. This is regardless of the fact that the likelihood and consequences are considered to be Likely and Minor for category 1-3 cyclone and Rare and Major to Catastrophic for category 4+ cyclones.

A desktop assessment of storm tide has been undertaken for both the Northern Sands Project Area and the Tingira Street Project Area. This is documented in **Section B17.4.1.g**.

Hazard Management

The Cairns DDMP advises that while the conventional response to impending cyclone impact is for people to take shelter in their own homes, there is an increased risk of residents drowning in low lying areas as a result of storm tide inundation. Hence, evacuation is sometimes necessary and must be completed before winds reach 75 km/hr (approximately six hours before landfall).

CRC has published a Storm Tide Evacuation Guide (CRC no date) for residents to follow in the event of a cyclone. It provides maps that show predicted storm tide flooding associated with a cyclone.

B17.3.3.j Shoreline Erosion and River Migration

These risks are not considered relevant for the following reasons:

- Shoreline erosion and river migration (Barron River) are both long term risks. All construction activities are most likely to be complete before these could be expected to occur.
- **Appendix AD** concludes that the Northern Sands DMPA will be stable after only a few years (see **Section B17.4.1.f**) and it is reasonable to assume that this will occur before any significant shoreline erosion and river migration occur.
- The Tingira Street DMPA is destined to become an industrial area, and is presently surrounded by a revetment installed during the reclamation and presumably designed to withstand appropriate coastal processes. Shoreline erosion is not an issue in this portion of Trinity Inlet due to the high prevalence of mangrove vegetation along shorelines.
- Similarly, the Landside Works will be designed to withstand relevant coastal processes.

Shoreline erosion and river migration are not considered further in this chapter.

B17.3.3.k Climate Change

Climate change is addressed in detail in **Chapter B16 (**Climate Change and Greenhouse). This concludes that:

- All construction activities will be complete before any of the predicted long term climate change impacts take effect.
- A residual risk rating of Medium remains for four impacts, three of which are related to an increase in the intensity of frequency of tropical cyclones. The impact to infrastructure (including the inner and outer channels) from cyclones can be mitigated by adaptive maintenance, including redesign. This reduces the likelihood of impacts to 'unlikely'. However, due to the potential for cyclones to cause high impacts and as a result of uncertainty associated with climate-driven changes to cyclones, a Medium residual risk rating is required.
- The other Medium risk rating is for inundation of berthing structures caused by sea level rise. This impact is not expected based on current climate change projections and does not require action other than monitoring of projections. If sea level rise projections increase to a level where inundation could occur, reconstruction of structures to appropriate levels and standards will be required.
- No change in risk profile (significance and likelihood) for a number of impacts. This is due to the project having mitigation measures inherently included in design or initial risks being considered to not require further control.

Climate change is not considered further in this chapter.

B17.3.3.l Summary of Natural Hazards

Table B17-7 summarises the risk assessment based on the nominated sources. As not all project elements (e.g. channel, DMPA) are at risk from all hazards, this table also provides a screening of hazard by project element. The following issues should be noted:

- Some hazards have different risk profiles depending on location. This is noted where relevant.
- Various sources have determined different risk ratings. The colour coding (based on **Table B17-5**) is applied for the highest of these unless noted otherwise.
- Many assessments cannot be applied spatially. In this case an estimate has been made if possible.
- Finally, when considering construction phase hazards, it is relevant to take into account the time of exposure. That is, for works undertaken during the dry season have a very low risk from hazards like cyclones that usually only occur during the wet season. This is further considered in **Section B17.4.1**.

Hazards shown as N/A (not applicable) are not taken forward into the impact assessment in **Section B17.4.1**.

TABLE B17-7 SUMMARY OF NATURAL HAZARDS BY PROJECT ELEMENT

HAZARD	RISK ASSESSMENT (LOCAL AREA)			RISK ASSESSMENT (PROJECT AREAS)				
	LIKELIHOOD (S,L)	CONSEQUENCE (S,L)	RISK (S,L,C)	CHANNEL	LANDSIDE	NORTHERN SANDS DMPA	NORTHERN SANDS PIPELINE	TINGIRA STREET DMPA
Earthquake	*Unlikely* *Rare*	*Catastrophic* *Catastrophic*	*Medium+* *High* *Significant*	*Nil / not assessed*	*Significant (C)*	*Low (C)*	*Significant (C)*	*Significant (C)*
Tsunami	*Moderate* *Rare*	*Moderate* *Catastrophic*	*Medium-* *Moderate* *NR*	*Medium*	*Medium*	*Medium*	*Medium*	*Medium*
Landslide [1]	*Likely* *Possible*	*Major* *Moderate*	*High* *High* *NR* Study team assessment is *Low*	*Nil / not assessed* Study team assessment is *N/A*	*Nil / not assessed* Study team assessment is *Negligible*	*Nil / not assessed* Study team assessment is *Negligible*	*Nil / not assessed* Study team assessment is *Negligible*	*Nil / not assessed* Study team assessment is *Negligible*
Bushfire [2]	*Moderate* *Likely*	*Moderate* *Minor*	*Medium -* *High* *NR* Study team assessment is *Negligible*	*Nil / not assessed* Study team assessment is *N/A*	*Nil / not assessed* Study team assessment is *Negligible*	*Nil / not assessed* Study team assessment is *Negligible*	*Nil / not assessed* Study team assessment is *Negligible*	*Nil / not assessed* Study team assessment is *Negligible*
Barron River Flooding	*Moderate* *Possible/Rare*	*Moderate* *Major*	*Medium -* *High* *High*	*Nil / not assessed* Study team assessment is *N/A*	*Nil / not assessed* Study team assessment is *N/A*	*High*	*Moderate to High*	*Nil / not assessed* Study team assessment is *N/A*
Cyclone	*Almost Certain* *Likely/Rare*	*Catastrophic* *Minor/Major to Catastrophic*	*Extreme* *High* *Significant*	*Nil / not assessed* Study team assessment is *N/A*	*High*	*Low*	*Moderate*	*High*

HAZARD	RISK ASSESSMENT (LOCAL AREA)			RISK ASSESSMENT (PROJECT AREAS)				
	LIKELIHOOD (S,L)	CONSEQUENCE (S,L)	RISK (S,L,C)	CHANNEL	LANDSIDE	NORTHERN SANDS DMPA	NORTHERN SANDS PIPELINE	TINGIRA STREET DMPA
Storm tide	*Moderate* *Rare*	*Catastrophic* *Catastrophic*	*High* *High* *Significant*	*Nil / not assessed* Study team assessment is *N/A*	*High*	*Low*	*Moderate*	*High*

Source: Study team compilation based on the following references.

S: State Government Risk Assessment documented in Cairns DDMP (2014)

L: Local Government Risk Assessment documented in LDMP – CR (2016)

C: Commonwealth Government Risk Assessment documented in Granger *et. al* (1999)

NR: No risk assessment provided.

Note 1 Overall risk taken to be *Low* due to distance of the site from any steep land.

Note 2 Overall risk taken to be *Negligible* based on CairnsPlan Bushfire Risk Analysis Overlay.

B17.3.4 Geo-environmental Hazards

Geo-environmental hazards are those hazards that are associated with soils and ground generally and for this study are:

- acid sulfate soil
- contaminated land
- Unexploded Ordnance.

B17.3.4.a Acid Sulfate Soil and Contaminated Land

These issues are discussed in detail in **Chapter B1** (Land) where it is concluded that these matters are well understood and that impacts are readily managed by normal best practice as outlined in **Chapter C1** (Construction Environmental Management Plan)

B17.3.4.b Unexploded Ordnances

Risk Assessment

There are no known Unexploded Ordnances (UXOs) within the area proposed to be dredged. However, the Cairns area was occupied by the military in WWII, and it is possible, but unlikely, that UXOs may be encountered during dredging activities.

Hazard Management

There are no specific hazard management plans for UXO. However, there are a number of precautious that can be taken to reduce the risk and these are discussed in **Section B17.4.2** and **Chapter C2** (Dredge Management Plan).

B17.3.5 Animal Hazards

B17.3.5.a Birdstrike

Risk Assessment

Appendix AM prepared for **Chapter B8** (Terrestrial Ecology) addresses the possibility that the proposed activity at the existing lake site at the Northern Sands DMPA could constitute an attractive environment for birds of species known to be a problem for aircraft. On this basis, and due to the proximity of the project area to Cairns International Airport (less than 5 km distant and within the 3-8 km Wildlife Hazard Zone), **Appendix AM** recommends that the effect of the development on the risk of avifauna strikes (birds and mammals) on aircraft should be considered. CairnsPlan includes an *Airport environs overlay code – Wildlife hazards* designed to protect the existing and future safety, efficiency and operational integrity of Cairns Airport and associated avian facilities. Relevant performance requirements relate to wildlife hazards and the need to include measures to reduce the potential to attract birds and bats.

However, since **Appendix AM** was completed, design studies into the material placement campaign and recent technical analysis of settling behaviour have changed the placement concept and final land form. While the **Appendix AM** assessment was on the basis that the existing water-filled void (Lake Narelle) would be converted to a similar 'lake', only shallower, it is now designed to be completely filled with soft clay that will form a hard crust above the water table after a forecast period of several months (refer to **Section B17.4.1.f**). Such an environment is not attractive to birds and therefore birdstrike is not an issue.

Hazard Management

In the absence of suitable habitat for birds, the risk identified in **Appendix AM** will not occur and hazard management such as included in CairnsPlan is not required.

B17.3.5.b Wild Animals

Risk Assessment

All of the project areas are subject to the risk of hazardous wildlife, particularly crocodiles and marine stingers. Encounters with this wildlife can involve severe injury or death.

Chapter B8 (Terrestrial Ecology) states that although no estuarine crocodiles (*Crocodylus porosus)* were recorded during the site survey, they are known to use Lake Narelle A. variety of habitats suitable for crocodiles such as freshwater rivers and lakes, mangroves and brackish water are available in the area surrounding both the Northern Sands Project Area and the Tingira Street Project Area and in the waters adjacent to the Landside Works Project Area

Crocodiles are known to disperse from home areas in search of resources such as food or habitat and any individual(s) utilising the study area are likely to inhabit different areas depending on seasonal resource availability.

Hazard Management

The Queensland Crocodile Management Plan (QCMP) was published by EHP in 2017 (EHP 2017) and supports the Nature Conservation (Estuarine Crocodile) Conservation Plan 2007, which is made under the *Nature Conservation Act 1992 (Qld)* (NC Act). The QCMP assesses risk to public safety and is based, in part, on the size of the crocodile population in an area and whether they are resident or transitory. Both the Northern Sands Project Area and Tingira Street Project Area are mapped as 'Zone B' areas. In this area there is 'high likelihood of crocodiles entering the area from surrounding crocodile habitat'.

The management objective for this zone is to significantly reduce the number of crocodiles in close proximity to large urban areas, with a particular focus on large crocodiles. The CSD Project does not conflict with this management objective.

B17.3.5.c Biting Insects

Risk Assessment

Cairns has a tropical climate with high rainfall which contributes to ideal breeding conditions for mosquitoes and biting midges. Biting insects can cause minor irritation from stings or bites but mosquitoes can also be vectors of serious disease including Dengue fever, Ross River fever and malaria. These diseases are not endemic to Cairns but outbreaks can occur. These hazards involve a suite of workplace-related issues described in **Section B17.4.4**.

Hazard Management

Formal hazard management is undertaken by agencies such as Queensland Health, and Cairns Regional Council which undertake routine insect vector reduction works. Department of Agriculture and Water Resources, maintains a Seaport Mosquito Vector Control Program within 300 m of the main wharves utilised by overseas arriving vessels. Management typically focuses on removal of water with potential for facilitating biting insect breeding.

Exposure of workers to biting insects can be managed through the use of repellents and PPE and worksite management to reduce areas of standing water that can serve as mosquito breeding areas.

B17.3.6 Disease Outbreak / Pandemic

Risk Assessment

In the last decade there have been at least two influenza pandemics that posed a threat to Australia.

According to the World Health Organisation (Kelly 2011) the classical epidemiological definition of a pandemic, namely 'an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people'

- The avian influenza outbreak in 2003 and the human swine influenza outbreak in 2009 demonstrated how quickly a pandemic can develop. Cairns is a popular tourist destination and should a disease outbreak be detected, a response would need to be swift. The LDMP documents a risk assessment of a disease pandemic in the Cairns Region. It considers the likelihood of such an event to be Rare (ARI 1000 (0.1% AEP)) with the consequences considered to be Catastrophic. The risk of an outbreak at the resort could be conceived as being higher than in the general population as the majority of visitors will be direct from international flights arriving at Cairns international airport.
- Dengue and Ross River Fever are mosquito-borne viruses that occur in the Cairns area and have caused epidemics in other countries with tropical climates (e.g. India and Singapore). However, neither is transmissible between humans (Queensland Health 2013). Hence the rate of transmission through the general public and the resort will be slower and unlikely to cause the same level of threat as an influenza virus.

The risk of disease outbreak/pandemic is taken to be High. However, it has marginal relevance to the CSD Project as cruise ships could be expected to avoid Cairns should it be experiencing a pandemic. Similarly, should disease occur on-board cruise ships, quarantine and public health initiatives would be implemented such that the local community would not be at risk.

Hazard Management

The Council of Australian Governments COAG document titled Pandemic planning in the workplace (COAG 2009) was developed to assist businesses with developing contingency plans should a pandemic reach Australia. In it, COAG advises that it is not expected that a pandemic virus would originate in Australia. However, should a pandemic virus arrive in Australia, a staged response for Queensland would be implemented with Queensland Health as the lead agency and DES personnel providing support.

COAG (2009) uses the following six-stage approach:

- Alert – to the risk of a pandemic and preparing for a pandemic by increasing Australia's readiness and supporting overseas responses.
- Delay – the entry of the pandemic virus to Australia by applying border measures, supporting the overseas response and increasing surveillance (this may impact on operations at the resort).
- Contain – or slow the early spread of a pandemic virus once it emerges in Australia, including by strategic deployment of the National Medical Stockpile and strengthening public information campaigns to promote individual hygiene practices and community level measures such as social distancing.
- Sustain – the response while a customised vaccine is developed, including by supporting maintenance of essential infrastructure and services and strengthening community social distancing measures.
- Control – the pandemic with a customised pandemic vaccine when it becomes widely available.
- Recover – providing the necessary support and stimulus to help the Australian community return to normal living as quickly as possible following a pandemic.

This response was developed following the H1N1 influenza (human swine influenza) outbreak in 2009 and is now being considered as the appropriate response for any other human virus that can become a pandemic.

B17.4 Assessment of Potential Impacts

B17.4.1 Natural Hazards

B17.4.1.a Earthquake

Table B17-7 concludes that earthquake risks for the various project areas are as follows (converting risk ratings to the terms used for the CSD Project):

- Channel: N/A
- Landside: High
- Northern Sands DMPA: Low
- Northern Sands Pipeline: High
- Tingira Street DMPA: High.

B17.4.1.b Tsunami

Table B17-7 concludes that tsunami risks for the various project areas are as follows (converting risk ratings to the terms used for the CSD Project):

- Channel: Medium
- Landside: Medium
- Northern Sands DMPA: Medium
- Northern Sands Pipeline: Medium
- Tingira Street DMPA: Medium.

B17.4.1.c Landslide

Table B17-7 concludes that landslide risks for the various project areas are as follows (converting risk ratings to the terms used for the CSD Project):

- Channel: N/A
- Landside: Negligible
- Northern Sands DMPA: Negligible
- Northern Sands Pipeline: Negligible
- Tingira Street DMPA: Negligible.

B17.4.1.d Bushfire

Table B17-7 concludes that bushfire risks for the various project areas are as follows (converting risk ratings to the terms used for the CSD Project):

- Channel: N/A
- Landside: Negligible
- Northern Sands DMPA: Negligible
- Northern Sands Pipeline: Negligible
- Tingira Street DMPA: Negligible.

B17.4.1.e Barron River Flooding – District Level Assessment

Table B17-7 concludes that Barron River flooding risks for the various project areas are as follows (converting risk ratings to the terms used for the CSD Project):

- Channel: N/A
- Landside: N/A
- Northern Sands DMPA: High
- Northern Sands Pipeline: High
- Tingira Street DMPA: N/A.

B17.4.1.f Barron River Flooding – Assessment of Northern Sands DMPA Issues

A specialist study on Barron River flooding as it could affect the soft clay placement campaign is included in the Revised Draft EIS as **Appendix AD**. The analysis utilised an approved detailed full two dimensional flood model of the Barron River delta. Work includes consideration of impacts on flood levels external to the site, as well as consideration of remobilisation of the placed dredge material by floods. It also provides an assessment of the level of risk of adverse flooding impacts occurring during the limited duration when bunds will be in place to protect the dredge spoil from remobilisation due to flooding.

Key details of the selected option and its assessment are summarised below.

Project Concept

The concept proposal is shown on **Figure B17-8** below. Key elements relevant to flooding and remobilisation of placed material are as follows:

- The existing eastern portion of the sand pit east of Reedy and Snake Islands is excluded from the proposed placement zones, therefore no flood protection bunding is proposed around this area.
- The remainder of the placement pond has been expanded, generally to the north and east, with an enlarged potential dredged material storage of 2.6 million m^3.
- A perimeter earth bund is to be constructed around the placement area to a height of 7.5 m AHD (well above ARI 100 year (1% AEP) flood level as later described) for two purposes:
  - to provide additional temporary storage above the void while the dredge material settles (see **Chapter A3** (Project Description)
  - to provide a suitable degree of protection against remobilisation of material within the placement area during periods of Barron River flooding as discussed below.

It is assumed that initial placement will occur in the dry season, after which rapid settlement of the dredge spoil will occur. The bund will remain in place through one wet season following completion of placement. Hence, while the protection bund has the potential to interfere with flood flows and cause off-site flood level increases, the period of exposure is low. This is further considered below.

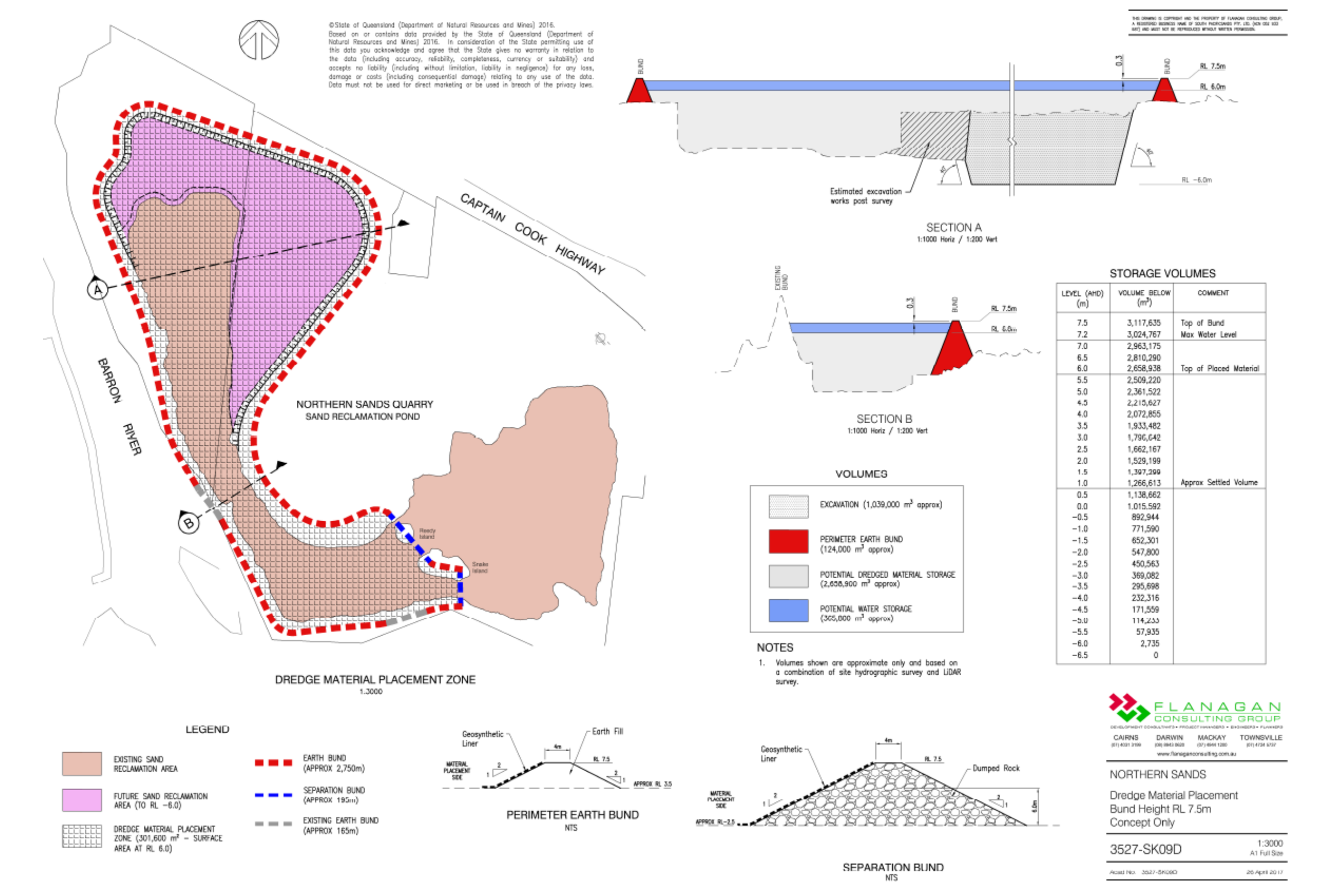

Figure B17-8 Northern Sands DMPA concept plan.

Flood Levels and Immunity

Table B17-8 lists the relationship between flood levels and their likelihood of exceedance based on detailed two dimensional modelling of the Barron River at the Northern Sands DMPA. The levels quoted are the existing situation (i.e. in the absence of the bunds).

TABLE B17-8 FLOOD LEVELS

LEVEL (m AHD)	IMMUNITY (ARI - YEARS)	LIKELIHOOD OF EXCEEDANCE (AEP)
4.0	2	39.3%
4.6	5	18.1%
4.8	10	9.5%
5.0	20	49.0%
5.3	50	20%
5.5	100	1%
7.5	200+	<0.5%

Source: Appendix AD (Table 4-1). Third column added for consistency with this chapter.

This analysis was used to guide the concept design. The adopted bund level is 7.5 m AHD which has an immunity of > 200 years (AEP <0.5%). This is 2 m above the 100 year ARI (1% AEP) level adopted for planning under CairnsPlan. Using **Table B17-4**, this corresponds to a likelihood of Highly Unlikely / Rare.

Effects of Bund on Flooding

While protecting the DMPA from flooding, the bund will cause the redistribution of floodwaters and create afflux (elevated water levels upstream) and changes to velocity (as the floodwaters pass around the bunded area). This was assessed in **Appendix AD** for a number of flood events with different likelihoods. The results of this assessment are summarised in **Table B17-9** below. Selected maps are presented on **Figure B17-9** (2 year ARI) and **Figure B17-10** (100 year ARI). The flood levels quoted below differ slightly from those in **Table B17-8** as the former are levels in the absence of the bunds while those in **Table B17-9** are for when the bunds are in place.

TABLE B17-9 IMPACTS FROM FLOODS OF VARIOUS LIKELIHOODS

IMMUNITY (ARI - YEARS)	LIKELIHOOD OF EXCEEDANCE (AEP)	LEVEL (m AHD)	EFFECTS
2	39.3%	3.811	Flood impacts beyond the Northern Sands site only affect flood-affected caneland north of the highway, with no buildings affected. The potential for actionable nuisance under such a flood event is low.
5	18.1%	4.496	Flood impacts beyond the Northern Sands site are at worst, 3 to 4 cm and these impacts occur over flood-affected caneland. The only building affected is a high set Queenslander house on Lot 3, RP800591, which is on an elevated fill platform, adjacent to the highway on the western site of Richters Creek. Over-floor flooding is not predicted to occur. The potential for actionable nuisance under such a flood event is low.
10	9.5%	4.747	Flood impacts beyond the Northern Sand site are generally less than 50 mm and these impacts occur over flood-affected canelands. The same high set Queenslander house is predicted to be affected by 40 to 50 mm; however, over-floor flooding is not predicted to occur. The potential for actionable nuisance under such a flood event is low.
20	49.0%	4.926	Flood impacts beyond the Northern Sands site are up to 100 mm and occur over flood-affected caneland only. The same high set Queenslander is predicted to be affected by 50 to 60 mm; however, over-floor flooding is not predicted to occur. No other buildings are impacted. The potential for actionable nuisance under such a flood event is low.
50	20%	5.164	Flood impacts beyond the Northern Sands site are up to 150 mm; however, these impacts occur over flood-affected caneland generally. The same high set Queenslander is predicted to be affected by up to 100 mm. There are lesser impacts on the go-cart site and prawn farm site to the north; however all buildings on these sites are on elevated fill platforms above flood. The potential for actionable nuisance under such a flood event is increased but still low.

(Continued over)

IMMUNITY (ARI - YEARS)	LIKELIHOOD OF EXCEEDANCE (AEP)	LEVEL (m AHD)	EFFECTS
100	1%	5.424	ARI 100 year flood impacts beyond the Northern Sands site are more extensive, although primarily over flood-affected caneland. The potential for actionable nuisance under such a flood event is increased but still low. Most of the flooded area will experience increases in flood levels of around 20 to 40 mm. There are positive benefits predicted, in terms of significant flood level reductions, in the Machans Beach township to the east of the Northern Sands site, with over 100 properties predicted to have 10 to 20 mm reduction in flood level for this event.

Source: Appendix AD (based on text in s6.1). Levels are from Table 5-1.

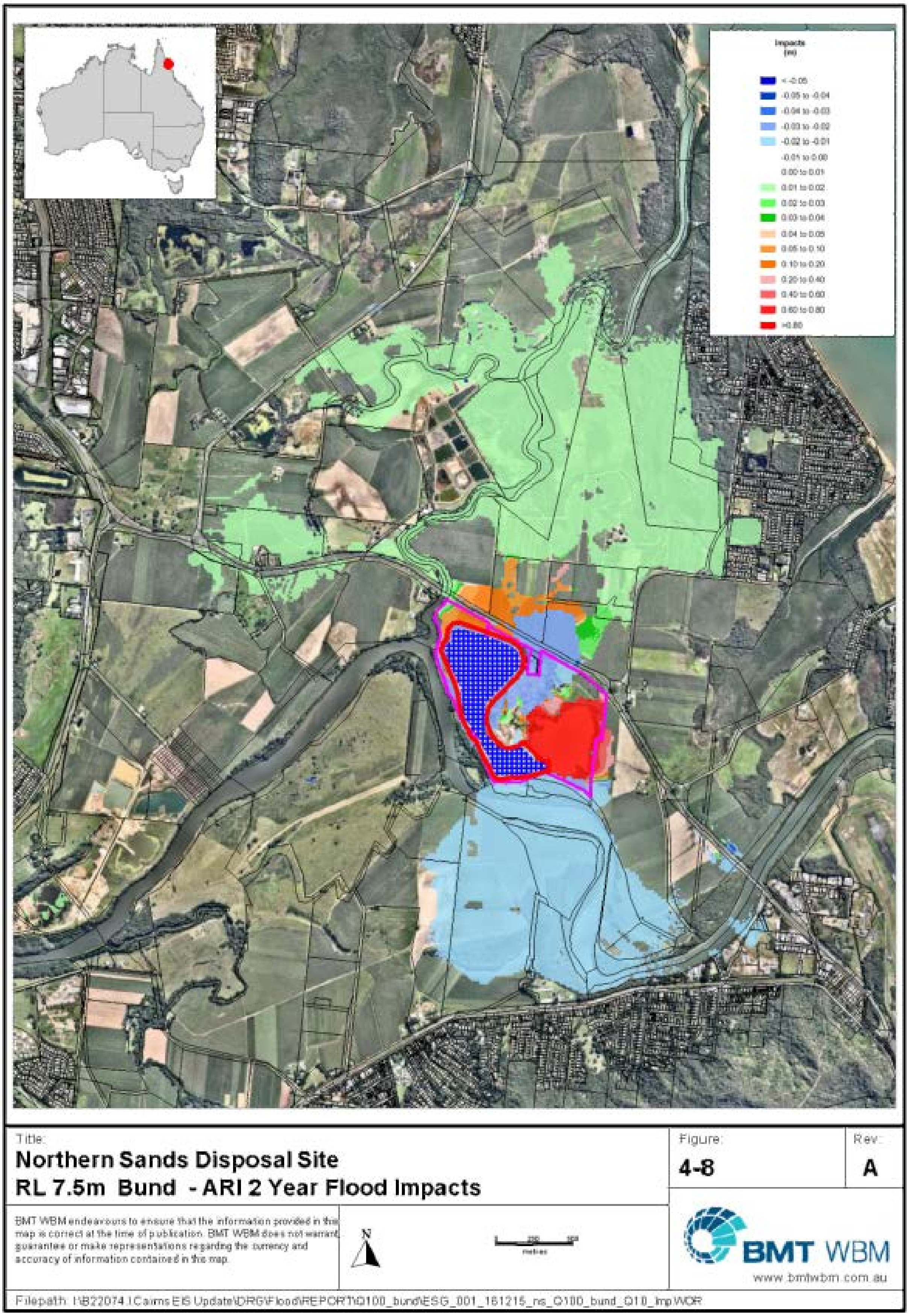

Figure B17-9 Afflux and extent of 2 year ARI flood.

Source: Appendix AD (Figure 4-8).

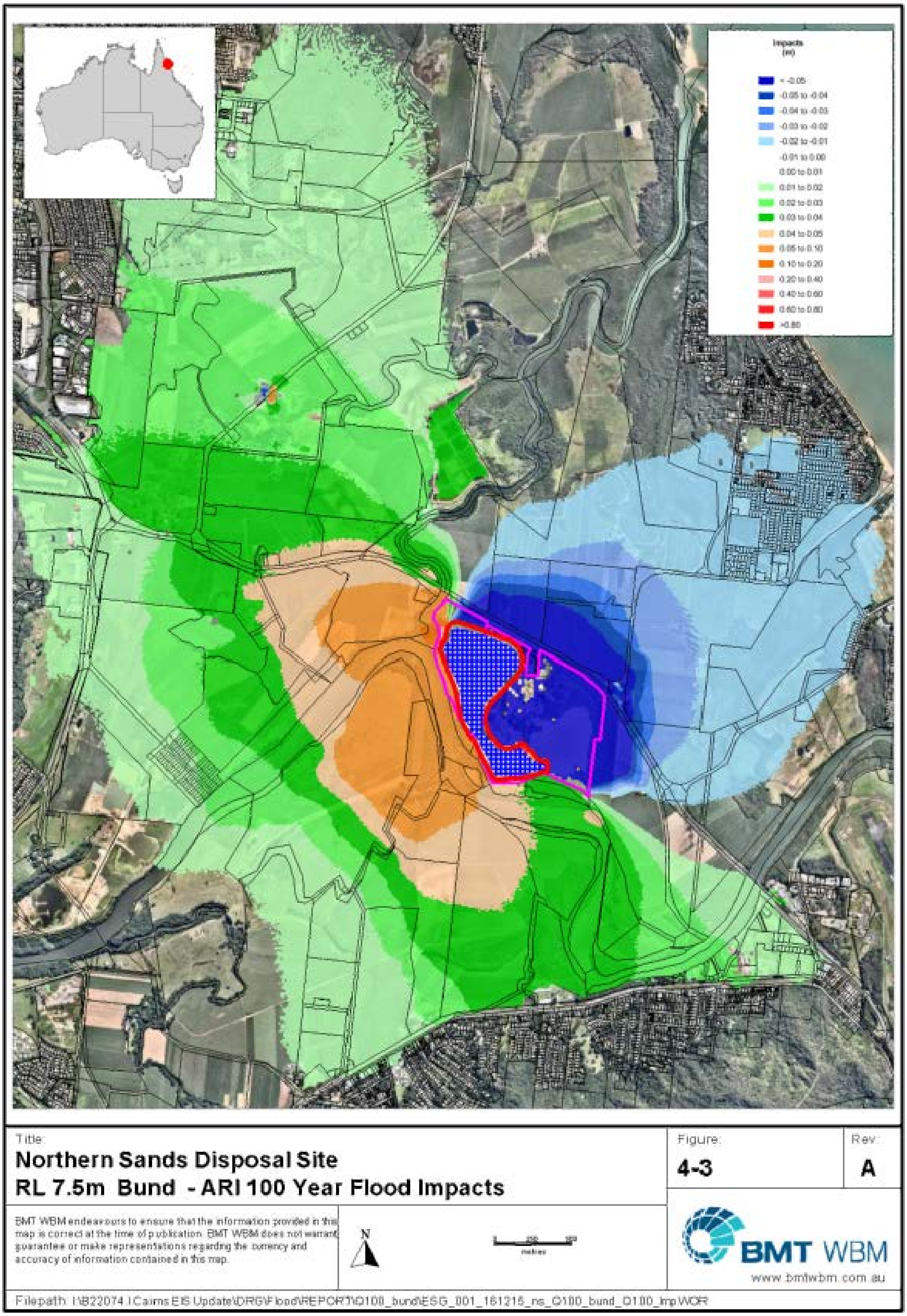

Figure B17-10 Afflux and extent of 100 year ARI flood.

Source: Appendix AD (Figure 4-2).

Remobilisation of Placed Material

Appendix AD also assesses the issue of remobilisation of placed material in the event of a flood. This event could take place during the placement process or at any time up until a stable crust forms on the soft clay (or it is covered with a stable material). There are three possible scenarios (all will apply):

- Scenario 1: Bund in place. While the bund is in place, the placed material is protected for all floods less than the height of the bund (this has been assessed as >200 year ARI (<0.5%AEP) as per **Table B17-9**). This means that there is no chance of remobilisation for floods lower than the bund. The chance of remobilisation for even greater (rarer) floods is influenced by the likelihood of the flood itself and that of remobilisation by the overtopping flood. For this scenario it is relevant to consider the period for which the bund is in place and whether or not this coincides with the wet season when floods are more likely. This is a short term duration in terms of **Table B17-3**.
- Scenario 2: Bund height progressively lowered as placed material densifies and becomes somewhat resistant to remobilisation. During this time, as the level of protection decreases, floods of progressively greater likelihood could overtop the lowered bund and inundate the placed material. The likelihood of the flood will determine the depth of inundation and this in turn affects the resistance of the placed material to remobilisation. This is a medium term duration in terms of **Table B17-3**.
- Scenario 3: Bund completely removed once placed material develops a crust and becomes more resistant to remobilisation. This is a medium to long term duration in terms of **Table B17-3**. It is possible that the owner of Northern Sands will choose to cap the placed material with that used to construct the bund and thereby reduce the likelihood of remobilisation even further.

Appendix AD approaches the remobilisation issue by undertaking a bed shear stress analysis of the disposal area to determine suitable depths of submersion with water above the top of the placed material that provides minimal risk of remobilisation during flood events. As noted above, consideration was given to a range of dredge material containment options. This resulted in several combinations of bund height and depth of inundation under various likelihoods of floods. **Appendix AD** details the modelling used and the basis of the shear strength calculations.

Based on literature research and direct experience undertaken by BMT WBM in the preparation of **Appendix AD**, it was determined that bed shear stress levels for remobilisation for the disposal area immediately after placement will range from 0.04 to 0.15 N/m^2 which reflects the *fine silt* to *coarse sand* range. These values are widely used in industry practice and have been accepted on several recent sand extraction pit approvals. With settlement, consolidation and surface drying and crusting in the dry season, it is expected that the critical bed shear stress for remobilisation will increase above these values.

The work concludes that, based on the modelling results and the known properties of the placed material, minimal remobilisation will occur during a Barron River flood that overtops the bund, provided that there is 3.8 m minimum submergence. At this level, the majority of the placement area has bed shear stress levels at or below the critical levels adopted. Due to the limitations of depth-averaging of velocity in 2D models, it is recommended that, as a component of the detailed design, full 3D modelling of bed shear stress within the placement area is conducted.

Simulations of the placement process (see **Chapter 3** (Project Description)) have established an adopted settling rate and tailwater release strategy that can be used to predict the depth of tailwater above the densifying solids. Integrating this with the '3.8 m minimum submergence' rule allows a calculation to be made of the minimum allowable water level in the DMPA at any time. The height of the bund can be successively lowered to this level (with an allowance for freeboard) to contain the water. A flood of any magnitude could pass through the site under these conditions and the placed material would not be remobilised.

This is a conservative estimate as the following discussion on crusting reveals.

Consideration of Dredge Spoil Re-Suspension after Drying and Crusting

With dredge spoil placement proposed in the dry season, drying and crusting of the surface of the dredge spoil above the water table will occur. **Appendix AD** refers to observations of crusting dredge material from previous projects, as well as on the red mud dams in Gladstone, that suggest that once crusting occurs, remobilisation potential is significantly reduced. With crusting, the material is expected to exhibit properties close to that of *loose to compacted clay*, which have a critical bed shear stress (threshold of movement) in the range of 1 N/m^2 to 14 N/m^2.

From interrogation of the various sensitivity test model runs, it is concluded that, provided that a minimum of 1.7 m (loose) to 0.7 m (compacted) depth submergence is in place when flood overtopping occurs, significant remobilisation of the placed material should not occur.

The crest of the bund will be progressively lowered to natural surface level once settlement of placed material and surface crusting occurs. The above minimum submergence criteria provides a guide as to the level of the top of dredge spoil, relative to minimum bunding height / natural surface level.

Risk Assessment

<u>Assessment Criteria</u>

Appendix AD includes a risk assessment based on consequence criteria as per **Table B17-10** below. This is a customisation of **Table B17-2**.

TABLE B17-10 CONSEQUENCE CRITERIA (BARRON RIVER FLOODING)

IMPACT CONSEQUENCE	DESCRIPTION OF CONSEQUENCE
Very High	The impact is considered critical to the decision-making process. Impacts tend to be permanent or irreversible or otherwise long term and can occur over large scale areas. Very high risk to people or of property damage. Very high risk of harm to receiving environment.
High	The impact is considered likely to be important to decision-making. Impacts tend to be permanent or irreversible or otherwise long to medium term. Impacts can occur over large or medium scale areas. High risk to people or of property damage. High risk to the receiving environment.
Moderate	The effects of the impact are relevant to decision making including the development of mitigation measures Impacts can range from long term to short term in duration Impacts can occur over medium scale areas or otherwise represents a significant impact at the local scale Moderate risk to people or of property damage. Moderate risk to receiving environment.
Minor	Impacts are recognisable/detectable but acceptable. These impacts are unlikely to be of importance in the decision making process. Nevertheless, they are relevant in the consideration of standard mitigation measures. Impacts tend to be short term or temporary and/or occur at local scale. (Low risk to people or of property damage. Low risk to receiving environment.
Negligible	Minimal change to the existing situation. This could include, for example, impacts which are beneath levels of detection, impacts that are within the normal bounds of variation, or impacts that are within the margin of forecasting error.

IMPACT CONSEQUENCE	DESCRIPTION OF CONSEQUENCE
Beneficial	Impacts have a positive outcome on the existing situation. This could include for example, an improvement in flood immunity as a result of the project.

Source: Appendix AD (Table 6-1).

Appendix AD also includes a risk rating legend as per **Table B17-11** below. This is a customisation of **Table B17-6**.

TABLE B17-11 LEVEL OF RISK LEGEND (BARRON RIVER FLOODING)

Extreme Risk	An issue requiring change in project scope; almost certain to result in substantial property damage, serious changes to river morphology, or remobilisation of a sufficient amount of placed material to cause a 'significant' impact
High Risk	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in substantial property damage, noticeable changes to river morphology, or remobilisation of a sufficient amount of placed material to cause a 'significant' impact.
Medium Risk	An issue requiring project specific controls and procedures to manage
Low Risk	Manageable by standard mitigation and similar operating procedures
Negligible Risk	No additional management required

Source: Appendix AD (Table 6-5), modified for Extreme and High risk ratings.

<u>Assessment Results</u>

Table B6-12 below shows the results of the risk assessment of the assessment of unmitigated impacts (flooding and remobilisation).

TABLE B6-12 ASSESSMENT OF UNMITIGATED IMPACTS (FLOODING AND REMOBILISATION)

PRIMARY IMPACTING PROCESSES	INITIAL ASSESSMENT WITH STANDARD (STATUTORY) MITIGATION MEASURES IN PLACE		
	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Increased flood levels beyond the Northern Sands site – minor flood (ARI 2, 5, 10 and 20 years). 5 to 50% chance in any year	Minor	Possible	Low
Increased flood levels beyond the Northern Sands site – major flood ARI 50 and 100 years). 1 to 2% chance in any year	Moderate	Unlikely	Low
Remobilisation of dredged material in extreme flood events	Minor	Highly Unlikely	Negligible

Source: Appendix AD (Table 6-6), modified for Extreme and High risk ratings.

Discussion

<u>Increased flood levels beyond the Northern Sands site</u>

The normal design event under CairnsPlan for assessing floods is the 100 year ARI (1% AEP) flood. For this event (bearing in mind the reduced likelihood of it occurring during the specific period when the bund will be at its full height), modelling shows a large area where there is some increase in flood level due to the bund. However, most of the land in question is already flood-affected caneland and the predicted level increase is of the order of 30 to 40 mm. This is conservatively described as a Moderate consequence in **Table B6-12** above. The likelihood of a smaller flood is greater, but the consequence is less (smaller afflux over smaller area).

This assessment shows that the unmitigated risk of increased flood level beyond the Northern Sands site as a result of the works is low. Mitigation is not required.

Remobilisation of dredged material in extreme flood events

The bund will have a crest level of 7.5 m AHD during the placement process. This will have a likelihood of exceedance by a Barron River (AEP) of <0.5%, ignoring the reduced likelihood of such a flood occurring in the period while the placement is in progress and the material is settling.

Assessment of the consequences of a rare flood overtopping the bund needs to consider the following issues (refer to **Figure B17-11** which is an enlargement of Section B of **Figure B17-8**):

- At the time of the overtopping, the bunded area will be likely to be full to the height of the bund due to rainfall.
- Under the worst conditions, the maximum level of the placed fill will be 6.0 m AHD (**Figure B17-8**) meaning that there will be a minimum depth of 1.5 m of water at this time.
- The bed shear test assessment concludes that 1.7 m of depth (loose – i.e. under the worst possible conditions and corresponding to a flood occurring in July / August when the DMPA is at its maximum level and the placed material is at its minimum density) is sufficient to prevent remobilisation.

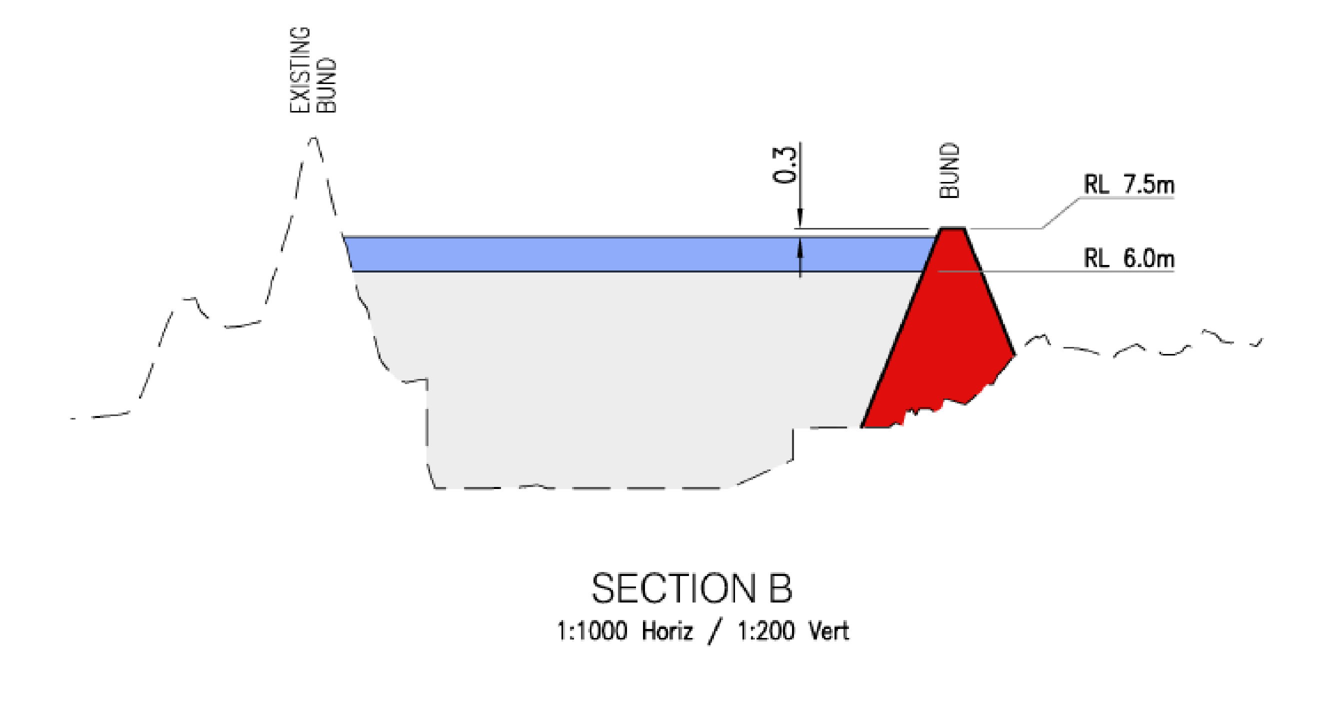

Figure B17-11 Fill levels and water levels.

Source: Figure B17-8 Section B.

So, while some remobilisation could possibly occur under these extreme circumstances, this will be at a time when the Barron River is experiencing a flood greater than 200 year ARI (<0.5% AEP) and will be carrying a large sediment load that will dwarf any losses from the DMPA should they occur. This is the justification for the ascribed consequence of Minor above for remobilisation of dredged material in extreme flood events.

This assessment shows that the unmitigated risk of remobilisation of placed material due to flooding is negligible. Mitigation is not required and is not feasible.

B17.4.1.g Trinity Inlet Flooding

Landside Works Project Area

As noted in **Section B17.3.3.h**, the Landside Works Project Area is outside the area mapped on the CairnsPlan (2016) Flood and Inundation Hazard Overlay area.

The risk of flooding at the Landside Works Project Area is therefore assessed as negligible and no mitigation is required or feasible.

Tingira Street DMPA

Also as noted in **Section B17.3.3.h**, Tingira Street Project Area is outside the area mapped on the CairnsPlan (2016) Flood and Inundation Hazard Overlay area. Although parts of the site are low lying and are known to be inundated on high tides (a review of levels suggests that this could be by as much as 0.3 m), flooding is not an issue in Trinity Inlet. In any case:

- As previously noted, the cyclone season officially runs from November to April. Given that the DMPA will be used for stiff clay placement outside that period, there is a very low likelihood of experiencing a cyclone (and hence a large flood) during the period during placement.
- The placement process will raise the area of the DMPA by some 1.5 m, meaning that only the lowest part of the site will be raised to 3.0 m AHD. This will further increase the site's immunity to flooding.
- At a later date, the DMPA will be further filled and use for industrial infrastructure. This will further increase its immunity to flooding.

The risk of flooding at the DMPA is therefore assessed as negligible and no mitigation is required or feasible.

B17.4.1.h Cyclone (Including Storm Tide)

Table B17-7 concludes that cyclone (wind and storm tide) risks for the various project areas are as follows (converting risk ratings to the terms used for the CSD Project):

- Channel: N/A (wind, storm tide)
- Landside: High (wind, storm tide)
- Northern Sands DMPA: Low (wind, storm tide)
- Northern Sands Pipeline: Medium (wind, storm tide)
- Tingira Street DMPA: High (wind, storm tide).

Wind is not discussed here as the design of structures for cyclonic winds is normal engineering practice.

Chapter B3 (Coastal Processes) documents an assessment of storm surges and storm tide levels in Trinity Bay based a study for the entire Cairns Regional Council coastline (BMT WBM 2013). In this study, design storm surge and storm tide levels were determined on a probabilistic basis utilising hydrodynamic modelling, as the data record of historical storm tide levels is insufficient for that purpose. **Table B17-13** sets out the tropical cyclone-generated storm tide probabilities in terms of ARI and AEP.

TABLE B17-13 STORM TIDE LEVELS

AVERAGE RECURRENCE INTERVAL (YEARS)	ANNUAL EXCEEDANCE PROBABILITY (%)	STORM TIDE LEVEL (m AHD)
100	1%	1.99
200	0.5%	2.24
500	0.2%	2.65
1000	0.1%	3.02

Source: Chapter B3 (Coastal Processes) Table 3-5. AEP column added for consistency with this chapter.

These levels represent the hazard due to storm tide for the general Cairns area. Wave setup and wave runup processes can increase these levels by about a metre under extreme circumstances.

Chapter B3 (Coastal Processes) concludes that the proposed channel expansion works will not increase or otherwise change surge propagation or increase the relative vulnerability of the locality to extreme water level impacts.

Northern Sands DMPA and Pipeline

Existing natural surface levels on the DMPA vary across the site, with the typical level being around 2.0 m AHD.

Figure B17-12 below shows the storm tide data derived from CairnsPlan for the Northern Sands Project Area.

This shows that part of the Northern Sands DMPA and almost all of the delivery pipeline corridor is mapped as having a high storm tide hazard. Some comments are relevant:

- Delivery pipeline. Storm tide is associated with tropical cyclones and, according to the BoM (2017), the Australian cyclone season officially runs from November to April, although very few have occurred in November. Given that the delivery pipeline will be constructed, used, and removed outside that period, there is a very low likelihood of experiencing a cyclone during the period when the infrastructure is present.
- DMPA. Ignoring the fact that storm tide attenuates as the event moves inland, the natural surface at the Northern Sands DMPA is at about the same level as the 1% AEP storm tide. It is planned that the perimeter bund will be in place over the cyclone season as defined above and it has a crest at 7.5 m AHD. This is well above the 0.1% AEP storm tide.
- DMPA. Soon after the one cyclone season during which the bund could be in place and the placed material is to some extent vulnerable to remobilisation, a crust is likely to form and/or the area capped. At that time it will not be at all vulnerable to storm tide.

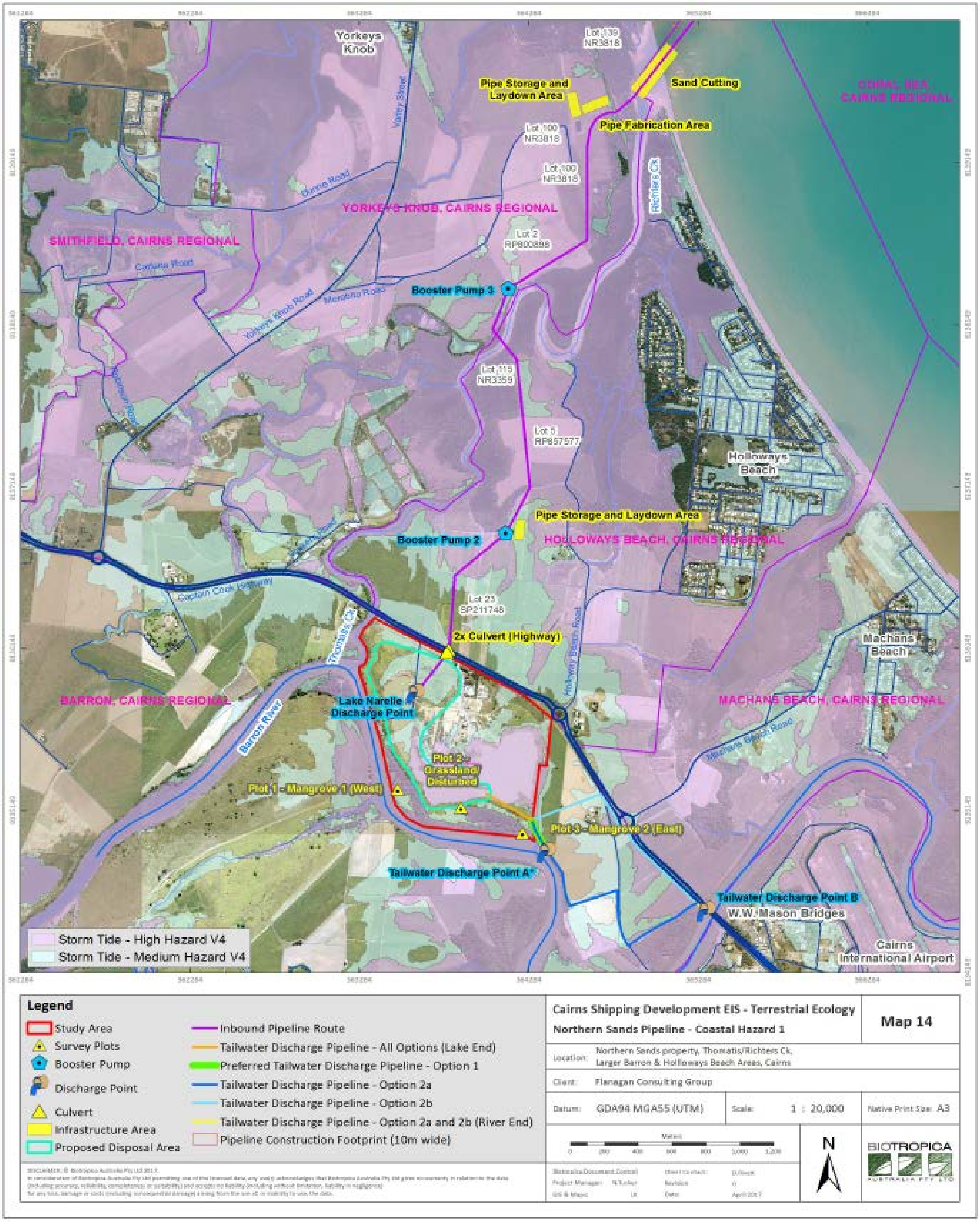

Figure B17-12 Storm tide (Northern Sands Project Area.

Source: Appendix AM.

Tingira Street DMPA

Existing natural surface levels on the DMPA vary across the site, with typical levels being:

- southern DMPA: 2.1 m AHD to 4.0 m AHD
- northern DMPA: approximately 1.5 m AHD.

An assessment of storm tide risk was undertaken of the Tingira Street DMPA during the preparation of **Appendix AL**. This was based on Cairns Regional Council's Cairns Regional Storm Tide Inundation Study (BMT WBM 2013). The peak storm surge levels nominated in the report for the Tingira Street DMPA are shown in **Table B17-13** and a depth map of the extent of inundation is shown on **Figure B17-13**, **Figure B17-14**, and **Figure B17-15** for the 1%, 0.5% and 0.2% AEP events respectively.

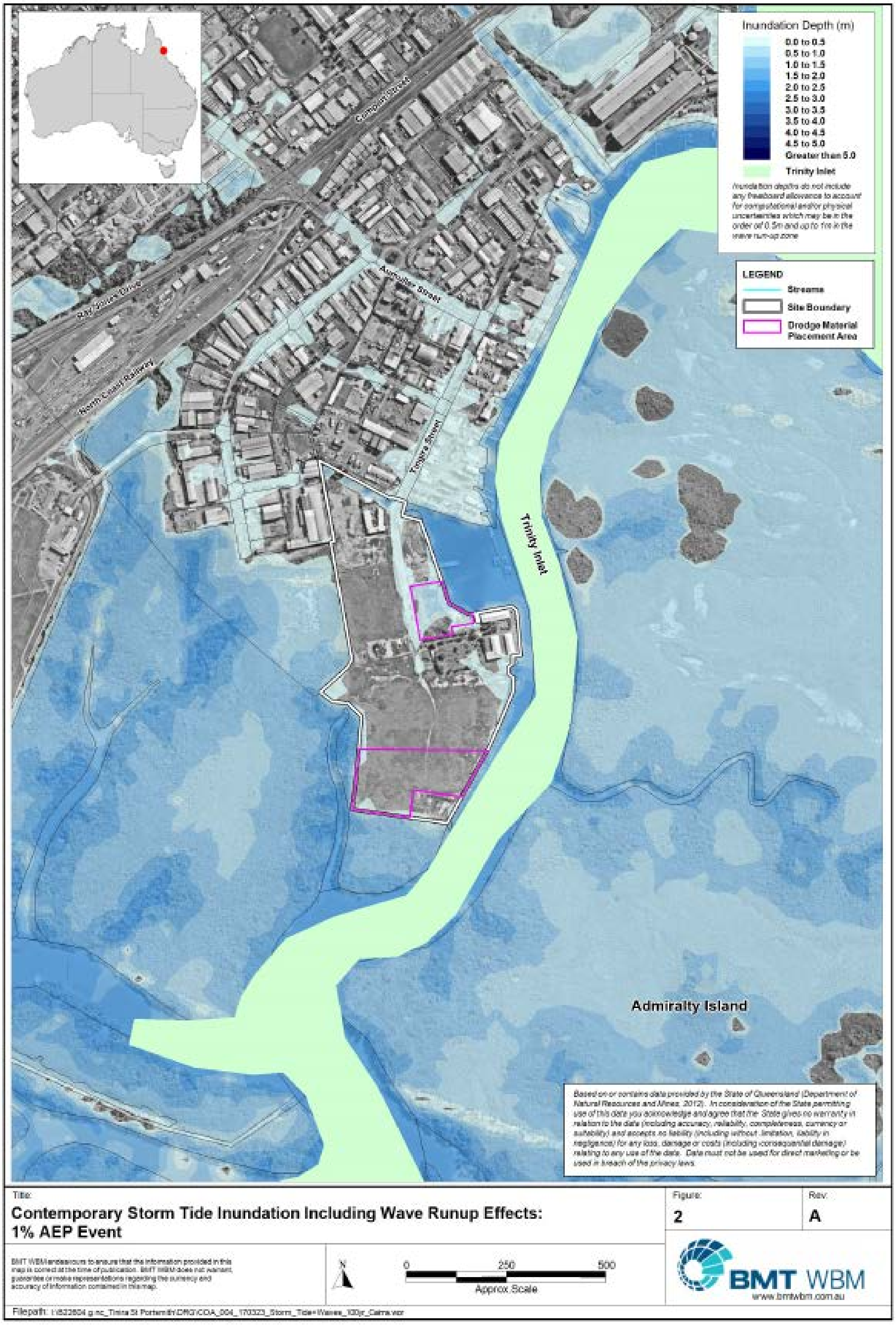

Figure B17-13 Contemporary storm tide inundation including wave runup effects: 1% AEP event.

Source: Appendix AL (Figure 2).

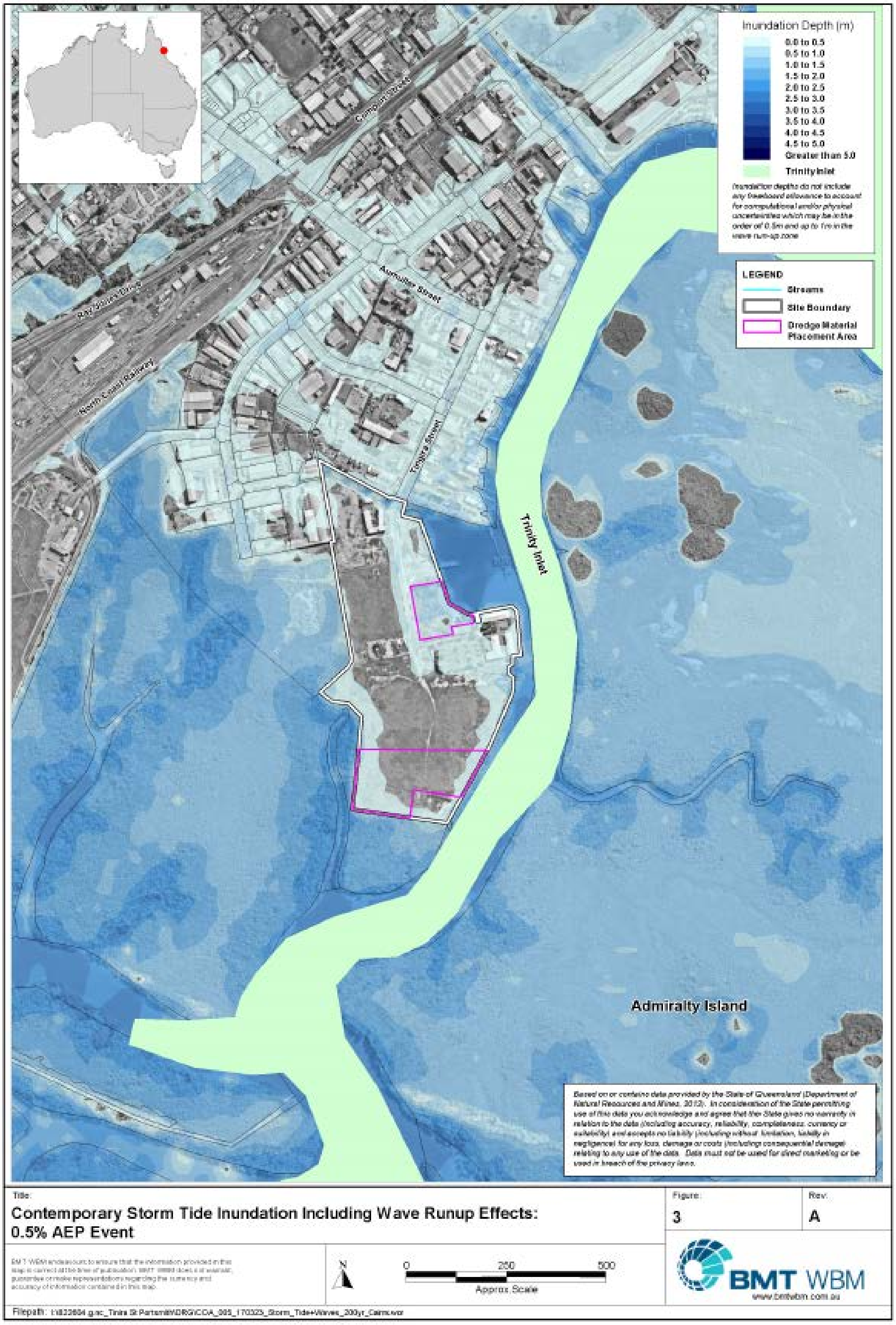

Figure B17-14 Contemporary storm tide inundation including wave runup effects: 0.5% AEP event.

Source: Appendix AL (Figure 3).

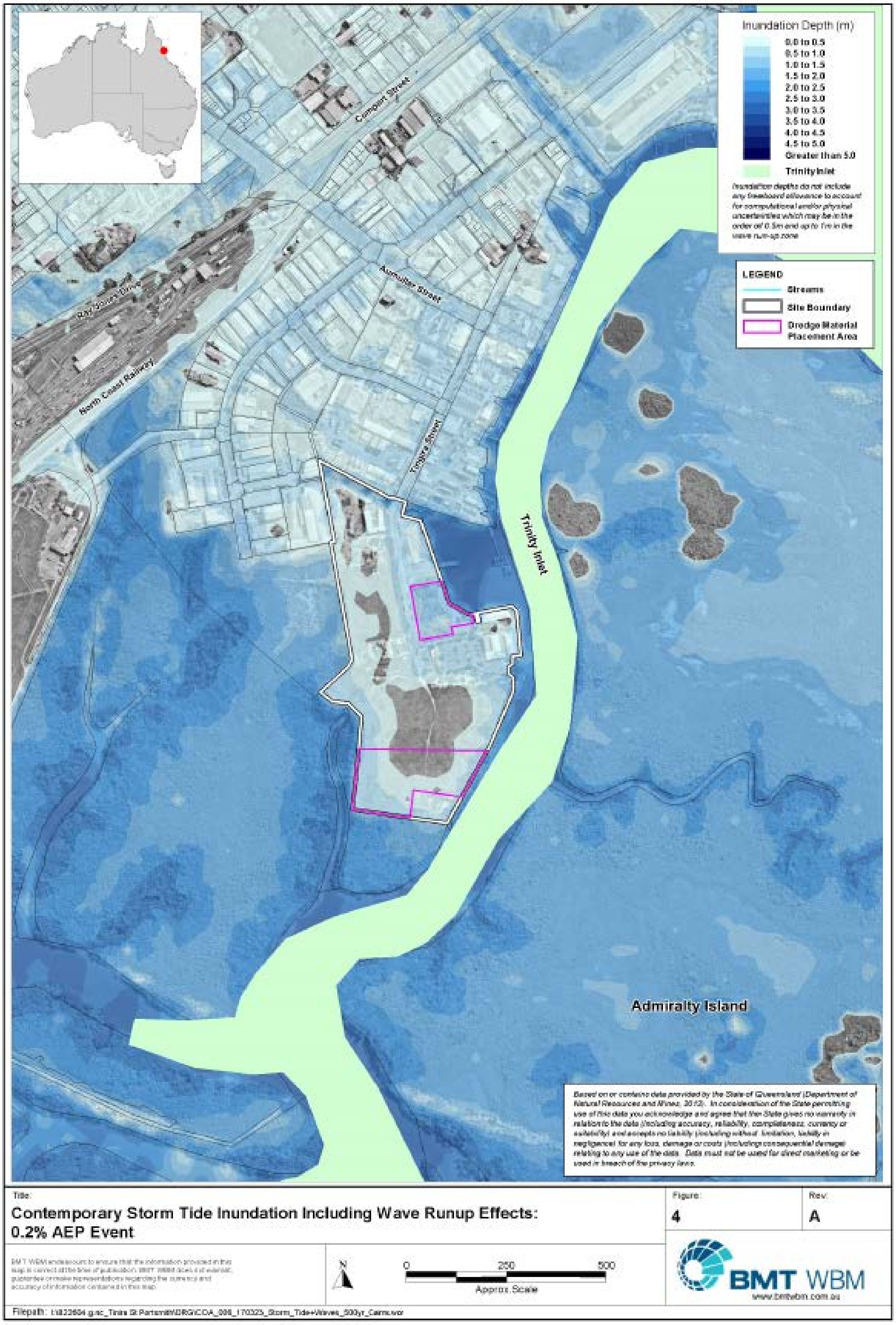

Figure B17-15 Contemporary storm tide inundation including wave runup effects: 0.2% AEP event.

Source: Appendix AL (Figure 4).

With reference to the above, the storm tide level will (i.e. without climate change) inundate the fringe of the Tingira Street DMPA in the 1% AEP and the existing low area adjacent to Queensland Government Maritime Safety site. Inundation is progressively increased in the 0.5% and 0.2% AEP with only portions within the centre of the DMPA in its current state being above the 0.2% AEP storm tide level. Some comments are relevant:

- As previously noted, the cyclone season officially runs from November to April. Given that the DMPA will be used for stiff clay placement outside that period, there is a very low likelihood of experiencing a cyclone during the period during placement.
- The placement process will raise the area of the DMPA by some 1.5 m, meaning that only the lowest part of the site will be raised to 3.0 m AHD. This is corresponds to a 0.1% AEP storm tide.
- At a later date, the DMPA will be further filled and use for industrial infrastructure. At this time it will be well above the 0.1% AEP storm tide level.

Risk Assessment

Assessment Criteria

Table B17-10 and **Table B17-11** are appropriate to assess storm tide effects.

Assessment Results

Table B6-14 below shows the results of the risk assessment of the assessment of unmitigated impacts (flooding and remobilisation).

TABLE B6-14 ASSESSMENT OF UNMITIGATED IMPACTS (STORM TIDE)

PRIMARY IMPACTING PROCESSES	INITIAL ASSESSMENT WITH STANDARD (STATUTORY) MITIGATION MEASURES IN PLACE		
	SIGNIFICANCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Storm tide impacts on Northern Sands DMPA and delivery pipeline during placement campaign (short term impact).	Minor	Highly Unlikely	Negligible
Storm tide impacts on Northern Sands DMPA after placement campaign (medium term impact).	Negligible	Highly Unlikely	Negligible
Storm tide impacts on Tingira Street DMPA during placement campaign (short term impact).	Minor	Highly Unlikely	Negligible
Storm tide impacts on Tingira Street DMPA after placement campaign (medium term impact).	Negligible	Highly Unlikely	Negligible

Discussion

This assessment shows that the unmitigated risk of stormtide to the DMPAs and associated infrastructure is negligible. Mitigation is not required and is not feasible.

B17.4.2 Geo-environmental Hazards

Table B17-15 is a copy of the risk evaluation on geo-environmental hazards undertaken in **Chapter B1** (Land). It is duplicated here as it has some relevance to hazard and risk. The assessment assumes that only standard mitigation i.e. statutory matters such as the following are in place:

- soil and water management (i.e. an Erosion and Sedimentation Control Plan will be prepared to guide all earthworks)
- other standard environmental management actions (i.e. control of construction traffic, dust, noise etc.)
- implementation of an ASS Management Plan to cover excavation
- investigation into land identified on the CLR or EMR and preparation and implementation of a management plan to ensure contaminated soils are not dispersed.

TABLE B17-15 RISK ASSESSMENT (GEO-ENVIRONMENTAL HAZARDS)

PRIMARY IMPACTING PROCESSES	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Landside Works Project Area			
Exposure of actual acid sulphate soils.	Negligible	Likely	Negligible
Disturbance and dispersal of contaminated soils.	Negligible	Likely	Negligible
Erosion and sedimentation resulting from excavation works.	Negligible	Likely	Negligible
Remediation of contaminated land	Beneficial	Almost certain	Beneficial
Northern Sands Project Area			
Instability on the banks of Richters Creek or the Barron River resulting in ground displacement into the waterway	Moderate	Possible	Medium
Instability on the banks of Richters Creek or the Barron River resulting in disturbance of PASS materials	Moderate	Possible	Medium
Erosion on the banks of Richters Creek or the Barron River resulting in sediment discharge into the waterway	Minor	Unlikely	Low
Earthworks required during construction of the pipeline resulting in disturbance of PASS materials	Minor	Possible	Low
Disturbance of PASS results in acidic water being generated	Moderate	Unlikely	Low
Settlement and/or failure of pipeline support foundations, possibly resulting in burst or leaking pipelines	Moderate	Unlikely	Low
Tingira Street Project Area			
Instability around the perimeter of the DMPAs during placement results in disturbance of PASS materials	Moderate	Possible	Medium
Instability along Smiths Creek during placement results in displacement of insitu and placed materials into the waterway	Moderate	Possible	Medium
Instability within the DMPA areas during placement results in disturbance of contaminated fill materials and/or PASS materials	Moderate	Possible	Medium
Breach of perimeter bunds results in discharge of water to the adjacent mangrove areas	Minor	Possible	Low
Dredged materials provide a source of fill for reclamation and surcharging	Beneficial	Almost certain	Beneficial

Source: Chapter B1 (Land) (Tables B1-17, B1-19, and B1-22).

All of the potential impacts are assessed as being temporary or short term. Mitigation of most of these impacts is possible.

B17.4.3 Biological and Animal Hazards

Disease risks during construction are largely linked to disease vectors such as mosquitoes which are addressed as a construction risk. See **Table B17-18** below.

B17.4.4 Construction and Operational Risks

B17.4.4.a Introduction

Construction and operational risks are relevant to the following critical health and safety risk receptors:

- any residents within close proximity to the Cairns Cruise Liner Terminal (CCLT) and the shipping channel
- recreation and commercial boats that utilise Trinity Inlet and the shipping channel
- construction workers and contractors
- Port of Cairns and cruise ship company staff
- visitors to the CCLT, including passengers.

The following assessment assesses key health and safety risks associated with the CSD Project on the public (particularly cruise ship visitors) and workforce during both construction and operational phases. Safety risks associated with movement of cruise ships and navigational hazards are detailed in **Chapter C4** (Maritime Operations Management Plan) and **Chapter C3** (Vessel Transport Management Plan).

Ports North currently safely manages operational hazards and risks through its operational management practices, protocols and plans. Therefore it is the expectation that current practices, protocols and plans will be built on if necessary to manage any newly identified operational hazards and risks generated by the project. While the following details hazards and risks within Port Limits and which the Port of Cairns has operational jurisdiction, it does not address any hazards or risks that are the responsibility of cruise ship operators or other operational vessels. Any hazards and risks that may reasonably be anticipated to occur beyond the Port Limits (e.g. within the Great Barrier Reef Marine Park Authority (GBRMPA) boundary) are addressed in **Chapter B18** (Cumulative Impacts Assessment).

For example, the potential for increased risk of shipping incidents and the potential impact on the Great Barrier Reef is addressed in the aforementioned chapter.

It is important to note that in most respects the CSD Project will facilitate a small growth in an existing industry. While there will be more and larger vessels, there will be no fundamentally new activities when compared with the existing situation. The dredging campaign is not fundamentally different from or more extensive than similar projects successfully completed in the past and landside works do not involve any out of the ordinary components or procedures.

B17.4.4.b Quantification of Construction and Operational Risk

Table B17-18 provides a qualitative assessment of potential health and safety hazards to the Port of Cairns and cruise ship staff, passengers and the general public during operation. This is based largely on the Draft EIS. The consequence of impact is based on **Table B17-2** while the risk rating legend as per **Table B17-16** below. This is a customisation of **Table B17-6**.

TABLE B17-16 LEVEL OF RISK LEGEND

Extreme Risk	An issue requiring change in project scope; almost certain to result in a death or serious injury to the public, a 'significant' impact on a Matter of National or State Environmental Significance (i.e. for environmental risks), or a serious legal sanction.
High Risk	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in a death or serious injury to the public, a 'significant' impact on a Matter of National or State Environmental Significance, or a serious legal sanction.
Medium Risk	An issue requiring project specific controls and procedures to manage.
Low Risk	Manageable by standard mitigation and similar operating procedures.
Negligible Risk	No additional management required.

B17.4.4.c Construction Risks

TABLE B17-17 CONSTRUCTION HAZARDS AND RISKS

ELEMENT	MITIGATION AND MANAGEMENT	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Slips, trips or falls at the wharf	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Work Procedures (JSAs) • Staff training and supervision • Use of Personal Protective Equipment (PPE) such as hard hats, safety glasses, vests, etc. • Drug and Alcohol Policy.	Moderate	Possible	Medium
Working over water (either during pile installation or aboard dredging equipment)	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Work Procedures (JSAs) • Staff training and supervision • Use of Personal Protective Equipment (PPE) and on-board safety equipment • Drug and Alcohol Policy.	Moderate	Possible	Medium
Construction Dust – public and workers at the land-based construction site may encounter wind-blown particles (e.g. from operating machinery, exposure of surfaces)	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Work Procedures (JSAs) • Staff training and supervision • Stop work procedures during adverse wind conditions • Dust suppression techniques • EMP.	Minor	Unlikely	Low

(Continued over)

ELEMENT	MITIGATION AND MANAGEMENT	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Construction Noise – public and workers may encounter noisy plant and equipment, particularly from piling or dredging machinery	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Work Procedures (JSAs) • Staff training and supervision • Use of PPE, including ear plugs if required • Use of licenced operators • Compliance with noise regulations • EMP.	Minor	Unlikely	Low
Working in confined spaces on-board dredging/piling equipment	• Training for working in confined spaces • Work Procedures (JSAs) • Use of licenced operators • Emergency procedures and training.	High	Unlikely	Medium
Vehicle accident or contact by moving vehicle or equipment	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Traffic Management Plans • Work Procedures • Exclusion zones around areas of operation • Use of Personal Protective Equipment (PPE) such as hard hats, safety glasses, vests, etc. • Speed restrictions.	High	Unlikely	Medium
Spill and subsequent inhalation or contact with hazardous substances e.g. oils, lubricants, paints etc.	• HAZOP studies • MSDS sheets at site • Health and Safety Management Plan • Staff and contractor training.	Moderate	Unlikely	Low
Fire originating from welding works, heat generating machinery, spark originating from welding and grinding	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Hot works permits.	High	Possible	Medium
Workers caught in moving machinery, particularly on piling rigs and dredges	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Work Procedures (JSAs) • Staff training and supervision • Use of PPE and on-board safety equipment • Drug and Alcohol policy.	High	Unlikely	Medium

(Continued over)

ELEMENT	MITIGATION AND MANAGEMENT	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Exposure to sun (dehydration, sunburn or heatstroke)	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan.	Minor	Possible	Low
Natural hazard (e.g. cyclone, storm surge) cause direct or indirect (through damage to machinery/ equipment) harm	• Emergency Management Plan, including evacuation procedures • Monitoring and early warning of hazardous events.	High	Highly Unlikely	Medium
Interactions with wildlife (e.g. crocodiles, snakes)	• Health and Safety Policy • Health and Safety Management Plan.	High	Highly unlikely	Medium
Introduction of disease, including human, other animal and plant disease.	• Security Management Plan • Port Procedures (TMR 2014), which includes quarantine arrangements • Ports North Pandemic Plan.	High	Highly Unlikely	Medium
Security incidents	• Security Management Plan • Emergency Management Plan • Provision of security fencing/site delineation and security personnel.	Moderate	Possible	Medium
Contact with Unexploded Ordinance (UXO) in Trinity Inlet and Bay, causing death or harm	• Magnetometer (or similar) survey undertaken prior to construction to identify UXOs in dredging area.	High	Highly Unlikely	Medium
Exposure and handling of acid sulphate soils	• Acid sulphate soil management plan, including testing and safe treatment • Staff and contractor training.	Minor	Unlikely	Low
Biting insects e.g. midges, mosquitoes	• Minimise creation of stagnant or ponding water • Regular monitoring for breeding sites • Liaison with health authorities to provide updates during Dengue outbreaks.	Moderate	Unlikely	Low
Electrical hazards	• Contractor Site Safety Management Plan and Safe Work Method Statements • Tag and testing all equipment as part of Site Safety Management Plan and Safe Work Method statements • Use of dial before you dig for locating underground services.	High	Highly Unlikely	Medium

(Continued over)

ELEMENT	MITIGATION AND MANAGEMENT	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Safe use of plant, equipment and power tools	• Contractor Site Safety Management Plan and Safe Work Method Statements • Tag and testing all equipment as part of Site Safety Management Plan and Safe Work Method statements • Contractor Site Safety Management Plan.	High	Unlikely	Medium
Safe operation of floating plant	• Use of licenced operators • Port of Cairns Operational Management Plans.	Moderate	Unlikely	Low
Refuelling of plant	• Contractor Site Safety Management Plan and Safe Work Method Statements • Use of licenced operators.	High	Highly Unlikely	Medium
Working at heights (piling rigs)	• Contractor Site Safety Management Plan and Safe Work Method Statements • Use of licenced operators.	High	Unlikely	Medium
Site demarcation/fencing (for public safety)	• Contractor Site Safety Management Plan.	High	Highly Unlikely	Medium
Working adjacent to railways	• Contractor Site Safety Management Plan and Safe Work Method Statements • Review of design and site plans with Queensland Rail prior to establishing site.	High	Highly Unlikely	Medium
Delivery pipeline issues including construction accidents vandalism and mechanical breakdown (see **Section B17.4.6**)	• Construction Environmental Management Plan • Dredge Management Plan	Minor	Possible	Low

B17.4.4.d Operational Risks

TABLE B17-18 OPERATIONAL HAZARDS AND RISKS

ELEMENT	MITIGATION AND MANAGEMENT	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Significant fuel, sewage or other chemical spill during cruise ship loading/unloading	• HAZOP studies • MSDS sheets at site • Health and Safety Management Plan • Existing Ports North Emergency Management Plans.	High	Unlikely	Medium
Fire associated with nearby buildings	• Application of safety in design principles • Emergency Management Plan • Work Instructions • Provision of fire-fighting equipment and hydrants (see **Chapter A3** (Project Description)) • QFRS response.	Very High	Unlikely	High
Fire associated with cruise ships	• Ships are responsible for their own fire-fighting systems and emergency management plans • Ships to leave berth in case of fires, wherever possible • Auxiliary fire-fighting capability available from Port tugs.	Very High	Unlikely	High
Natural hazard (e.g. cyclone, storm surge or flood) cause direct or indirect (through damage to wharf structure or other infrastructure) harm	• Disaster Response Plan • Cruise ships redirected/remain at sea should an event be predicted.	High	Unlikely	Medium
Slips, trips or falls at the wharf whilst passengers/ crew embarking and disembarking	• Health and Safety Policy • Health and Safety Management Plan.	High	Unlikely	Medium
Vehicle accident or contact by moving vehicle or equipment	• Application of safety in design principles • Health and Safety Policy • Health and Safety Management Plan • Traffic Management Plans – refer to **Chapter B14** (Transport)	High	Unlikely	Medium
Fire originating from refuelling operations, pipeline/storage incident (see **Section B17.4.5**)	• Application of safety in design principles • Design of infrastructure to meet Australian Standards • Emergency Management Plan • Staff/crew training.	Very High	Unlikely	High

(Continued over)

ELEMENT	MITIGATION AND MANAGEMENT	CONSEQUENCE OF IMPACT	LIKELIHOOD OF IMPACT	RISK RATING
Introduction of disease, including human, other animal and plant disease.	• Managed through the Australian Customs and Border Protection Service.	High	Unlikely	Medium

B17.4.5 Fuel Handling Issues

The following describes the existing situation and associated management of fuel (i.e. expands on issues raised above).

B17.4.5.a Situation Assessment

- The CCLT and vessels to be facilitated by the project are located some ~800 metres distant to the existing (and proposed upgraded IFO storage) fuel farm facilities that are in use for fuel storage and handling.
- The existing fuel farm(s) are operated by major fuel companies and operate within the requirements of the applicable environmental authorities, industry codes and prevailing WHS Act 2011 (Qld) requirements, and supporting systems such as an EMS which includes contingency and response plans.
- Fuel farm(s) are separated not only by distance noted above but also by the presence of other land uses between those sites and the CCLT/wharf facility, including more sensitive uses such as the Cairns Convention Centre and other industrial / warehouse type buildings.
- The CSD Project proposes to upgrade facilities at the existing fuel farm area, and new storage infrastructure is not proposed to be developed any closer to the CCLT than presently exists.
- Proposed upgrades to accommodate the provision of IFO storage are informed by prior studies around risk and contingency indicating the planning and development, and onsite controls for the respective fuel farms are in place to confine the effects of major emergency events to the immediate vicinity of the facility boundaries.
- The likelihood of interaction between refuelling operations and pax and emergency events that may occurring during such is reduced, given the low volatility of fuel type compared to the likes of aircraft refuelling operations and the minor separation distances seen there.
- Refuelling of passengers (i.e. cruise ships) is currently conducted using road tankers or lighter barge (*Pacific Eden*'s turnarounds first occasion to date).

B17.4.5.b Management Arrangements

- Ports North has well developed port procedures in place in respect of liquid fuel transfers, including refuelling of cruise vessels, and the attached form is completed prior to any refuelling operation and highlights the required standards, noting road tankers are used to refuel the same fleet of cruise vessels in other Australian port jurisdictions in the same manner.
- Ports North and the fuel companies are in regular consultation around any issues pertaining to refuelling operations within the port (including cruise vessels) whilst alongside, as refuelling in the port is conducted almost daily and the current procedures are well practiced, the requirements do not change regardless of the size of the vessel being refuelled or quantity of fuel. All fuel providers are regularly consulted on procedures, both formally through the Port Advisory Group (PAG) and informally.
- Dependant on where the operation is being conducted, road tanker refuelling operations conducted presently (and proposed to continue once project is enacted) include the placement of signage and advisory barriers to delineate a 'clearance zone for restricted entry' to be in place whilst refuelling operations are underway to indicate the boundary of the work area and restrict entry. It is understood that the International Oil Tanker and Terminal Safety Guide (ISGOTT) is a core reference for use and industry may also have others which guide their activities.
- Road tanker refuelling operations on the wharf are conducted consistent with industry best practice and are consistent with other locations including Whites Bay, Sydney (the busiest turnaround facility in Australia) in the same manner.

- Compatible/incompatible operations at any of Ports Norths wharf facilities is a consideration in risk assessment done at project planning stage and regularly reviewed and dealt with on a case by case basis.

B17.4.6 Security Incidents

Security incidents that may arise during construction include protests, terrorism, vandalism or unauthorised access to construction sites. These incidents may result in property damage and direct or indirect harm to workers or the public within the affected area. Security measures during construction are likely to be similar to those implemented as standard during wharf operation, and may include sign-in procedures for authorised personnel, identification, lock-up procedures for high risk areas, presence of security personnel after-hours, and if necessary, the involvement of police to manage more serious incidents.

Special attention should be given to the security of the delivery pipeline and associated infrastructure (e.g. boosters) to manage risk associated with vandalism, sabotage, and mechanical / structural breakdown. This is discussed in **Chapter C1** (Construction Environmental Management Plan).

B17.5 Recommended Mitigation Measures

B17.5.1 Introduction

Table B17-17 and **Table B17-18** outline several plans that will be applied to the project to mitigate or manage the risks associated with health and safety. This section provides more information on each.

B17.5.2 Port's North Commitments to Managing Hazard and Risk

Ports North has processes in place to identify, assess and manage risks to its operations in order to minimise the impact of unplanned events. This approach is articulated in its Risk Management Policy and Risk Management Framework which provides for structured risk assessments to be undertaken and the development of risk treatment plans. Under the Risk Management Framework (Ports North 2015):

> Risks are evaluated by first identifying the worst credible Consequence that could evolve from a risk event, and then evaluating the Likelihood of that event occurring. The combination of Consequence and Likelihood is represented in the risk matrix, and will determine the overall risk rating allocated to that risk. (p 6)

The Ports North Audit and Risk Committee oversees the implementation of the Risk Management and Internal Control Policy and Risk Management Framework and a strong internal control environment to protect Ports North's interests. Safety and Environmental Management Frameworks, Financial Risks Policy, Fraud Control and Corruption Policy and Security and Emergency Plans address the associated specific risks.

Ports North has established an Incident Management System (IMS) involving an integrated suite of emergency response, disaster management and business continuity plans. The Incident Management Systems reflects the management and operational control mechanisms that are able to be engaged to respond to an incident and ensure the hazard or risk are appropriately responded to.

Details of emergency response management, crisis management and business continuity are provided in **Section B17.5.10**.

B17.5.3 Safety in Design

Health and safety risks that manifest in the design phase are not considered as part of the scope of this chapter; however, there is potential that hazards may be generated due to the design process, and that these may result in impacts during construction, operation or decommissioning. Where design is occurring for the project (e.g. design of berthing structures or fuel storage and lines, and traffic management), a safety in design process will be followed in accordance with the Australian Safety and Compensation Council's Guidance on the Principles of Safe Design for Work (2006).

Design should include:

- Civil and structural engineering design in line with Australian and other standards to mitigate potential impacts from natural hazards, security threats and health and safety.
- Locating storage tanks away from other potential hazards or in a dedicated fuel storage facility.
- Leak detection, overfill prevention, failure detection and alert systems in-built to the new IFO.
- Provisions to allow emergency shutdown during bunkering and sewerage pumping.
- Provision of safety signage in line with Australian and other standards.
- Provision of new fire-fighting infrastructure. This is designed to adequately provide for the risk of fires at the wharves, including fires at the terminal and fuel fires associated with bunkering or fuel storage. Design includes fire hydrant pillars along the face of wharves 1 to 3 (as detailed in Chapter A4, Project Description); and will also include other fire safety systems as required.

Hazard and risk management at each of the fuel farm facilities is under the management of each of the operators and the respective development approvals maintained for each facility; with any new storage tanks at the fuel farm designed, built and managed in compliance with the relevant legislation, guidelines and standards and existing management procedures.

B17.5.4 Health and Safety Management Plans and Policy

Health and Safety Management Plans will be implemented for all project phases in line with the Ports North Health and Safety Policy, and all contractors will be required to meet the high standards specified by Ports North. Plans will reference and integrate measures from the appropriate Australian standards as per the Guide to Standards for Occupational Health and Safety (SAI Global 2013).

B17.5.5 Traffic Management Plan

A Traffic Management Plan will be implemented for construction, operations and decommissioning to reduce risks associated with road transport. The plan will be prepared in line with the Code of Practice for Traffic Management for Construction or Maintenance Work (Workplace Health and Safety 2008) and be submitted for review and approval by CRC and the Department of Transport and Main Roads, where required.

Traffic management measures during operations will be considered during design. This is further discussed in **Chapter B14** (Transport).

B17.5.6 Vessel Traffic Management Plan

The Vessel Traffic Management Plan contains mitigation and management measures designed to reduce impacts from the dredging campaign. Management of health and safety aspects related to the dredging campaign are also within the scope of the plan. The plan is provided in **Chapter C3** (Vessel Transport Management Plan).

B17.5.7 Maritime Operations Management Plan

A Maritime Operations Management Plan has been prepared to reduce the potential for negative impacts on the environment, vessel safety and operational efficiency with the changes in maritime operational activities (operational shipping) as a result of the project. The Maritime Operations Management Plan is contained in **Chapter C4** (Maritime Operations Management Plan).

B17.5.8 Acid Sulfate Soils Management Plan

During construction and decommissioning, an Acid Sulfate Soils (ASS) Management Plan will be in place to treat any ASS that is identified. Due to the minimal excavations that are required for all of the landside elements of the CSD Project, the risk that ASS will cause damage to property or the environment is low and can be managed using standard construction and geotechnical management measures.

B17.5.9 Security Management Plan

The Port of Cairns is a Regulated Port under the *Maritime Transport and Offshore Facilities Securities Act 2003* (Cwlth) and has an approved security plan in place. This will be in place for all phases of the project.

B17.5.10 Emergency Management Planning

‘Emergency Response’ typically addresses the first three to ten hours of an incident. In addressing incident control, it is focused on ensuring the safety of people, containing damage to the environment and limiting damage to business assets. Once the incident is controlled and the situation made safe, the emergency phase ends and recovery processes can commence.

The current Emergency Management Plan forms part of the Ports North Critical Infrastructure Protection program and details the arrangements for control and coordination of the response to and the recovery from an emergency involving vessels or port facilities. It provides timely and coordinated responses to emergencies and procedures to assist in restoring operations to normal.

The Operational Emergency Management Plan also references Port's North Seaport Risk Register which details the risks and locations that are covered in the plan. The following risks are assessed in the risk register:

- Security – evacuation, bomb threat, maritime fire or explosion, land fire or explosion, inadequate emergency response (RP).
- Assets infrastructure – Wharf 10, Reef Fleet Terminal, workshops, CCLT, city administration office, impact (RP), ship grounding or collision (RP).
- Environment – fuel and oil spill, vessel collision or grounding.
- Natural events – tsunami, cyclone.

Within the Emergency Management Plan, emergency procedures are detailed for oil spills, fires or explosions, collisions or groundings, cyclones and tsunamis. A Quick Response Emergency Action Plan Guide has also been developed as part of the Emergency Management Plan. The guide is designed as a flip page book that can be carried in all vehicles/vessels and covers the following events:

- oil, fuel or other chemical spill
- land-based/maritime fire or explosion
- vessel collision
- vessel sinking
- unlawful seizure of a vessel/vehicle
- suspicious item
- cyclone warnings
- tsunami warnings
- bomb threats
- injured persons
- media inquiries.

Ports North also has in place a CCLT Workplace Emergency Manual. This outlines the emergency procedures in place to facilitate safe, orderly and timely evacuation if necessary.

The current Emergency Management Plan as well as associated plans and procedures will be updated to reflect hazards and risks associated with the project prior to the commencement of operations.

B17.5.11 Magnetometer Survey

Possible UXOs within Trinity Inlet and Bay have been identified as a risk to the construction and operational capacity of the port and in order to reduce this risk and the associated likelihood of impacts a magnetometer survey will be undertaken by Port North. Refer **Chapter C2** (Dredge Management Plan).

B17.5.12 Environmental Management Plan

An Environmental Management Plan for construction, operations and decommissioning will be prepared based on the plan supplied in **Chapter C1** (Construction Environmental Management Plan). The Environmental Management Plan will contain management and mitigation measures to minimise the impact upon the environment. It will include measures to reduce the impact of noise and vibration, manage ASS, UXO and minimise the risk of unintended release of dredged material, fuel, oil or other chemical spills.

B17.5.13 Work Procedures

Work procedures will be implemented by Ports North and contractors during all phases of the project to enable safe and efficient work practices. Each work procedure will cover a different activity (e.g. trenching, fuel bunkering, and providoring) and with implementation being the responsibility of which ever business undertakes the activity.

B17.5.14 Port Procedures and Information for Shipping

This document outlines the standard procedures to be followed in the pilotage area of the port. It contains information and guidelines to assist ship's masters, owners, and agents of vessels arriving at and traversing the area. It also provides details of the services and the regulations and procedures to be observed (TMR 2014). Although they are not directly prepared by Ports North, part of the purpose of the procedures is to reduce risks associated with operations within the port, and Ports North is required to comply with the procedures.

The document outlines procedures for:

- quarantine and customs
- dangerous goods
- vessel security reporting
- communications (e.g. VHF)
- compulsory pilotage, port navigation and movement restrictions
- work permits (e.g. for hot works, diving operations and bulk liquids)
- dangerous cargo
- safety procedures, including requirements for fire response and wharf evacuation
- emergency plan responsibilities
- marine incidents
- environmental incident reporting requirements
- security requirements for notification prior to entering the port, security zoning and reporting.

B17.6 Residual Impacts and Assessment Summary

B17.6.1 Introduction

It is concluded from the assessment documented above that there are three main areas of risk associated with the CSD Project, namely:

- natural hazards that exist in the Cairns district and for which established management and response systems or design standards are in place
- project-specific elements and activities that have required detailed assessment and will require targeted management
- construction and operational risk that would apply to any similar project in the Cairns area and that are routinely dealt with by Ports North and its likely contractors.

Brief summaries of findings are presented below.

B17.6.2 Natural Hazards

Considering the timing of the construction process (dredging and placement), the major natural hazards that could affect the CSD Project are discussed below. Only risks of medium or above are included.

- Earthquake. This is assessed in local disaster management planning as high risk for the Landside Works Project Area, the Northern Sands delivery pipeline, and the Tingira Street DMPA. Realistically, the consequences of an earthquake for the two DMPAs and the pipeline are quite minor, and the risk is reduced due to the short time for which these elements are exposed. The landside works will have a long term exposure, but as noted in **Section B17.3.3.c**, there are well developed engineering processes and design standards in place.
- Tsunami. This is assessed in local disaster management planning as medium risk for all project areas. As for earthquakes, the risk is reduced due to the short time for which the two DMPAs and the pipeline elements are exposed. In common with many other parts of Cairns, the landside works will have a long term exposure to tsunami risk. No mitigation is feasible.
- Barron River flooding. This is assessed in local disaster management planning for the Northern Sands DMPA and delivery pipeline as high. Again, the duration of exposure is relevant as most of the works will be undertaken and then demobilised outside of the cyclone season. See **Section B17.6.3**.
- Cyclonic winds. This is assessed in local disaster management planning as high risk for the Landside Works Project Area and Tingira Street DMPA and medium for the Northern Sands delivery pipeline. Risk for the latter project areas can be discounted on seasonal (low exposure) grounds and because winds would have little effects on the works. The landside works will have a long term exposure, but as noted in **Section B17.3.3.i**, there are well developed engineering processes and design standards in place to cope with cyclonic winds.
- Cyclone-induced water level. This is assessed in local disaster management planning as high risk for the Landside Works Project Area and Tingira Street DMPA and medium for the Northern Sands delivery pipeline. Risk for the latter project areas can be discounted on seasonal (low exposure) grounds and because storm tide would have little effects on the works. In common with many other parts of Cairns, the landside works will have a long term exposure to storm tide risk. No mitigation is feasible.

B17.6.3 Project-specific Elements and Activities

The only project-specific elements and activities that are involve risk management are associated with the operation of the Northern Sands DMPA as detailed in **Section B17.4.1.f**. Conclusions are as follow (these are essentially as stated in **Section B17.4.1.f**).

B17.6.3.a Increased flood levels beyond the Northern Sands site

The normal design event under CairnsPlan for assessing floods is the 100 year ARI (1% AEP) flood. For this event (bearing in mind the reduced likelihood of it occurring during the specific period when the bund will be at its full height), modelling shows a large area where there is some increase in flood level due to the bund. However, most of the land in question is already flood-affected caneland and the predicted level increase is of the order of 30 to 40 mm.

This is conservatively described as a moderate consequence. The likelihood of a smaller flood is greater, but the consequence is less (smaller afflux over smaller area).

This assessment shows that the unmitigated risk of increased flood level beyond the Northern Sands site as a result of the works is low. Mitigation is not required and is not feasible.

B17.6.3.b Remobilisation of dredged material in extreme flood events

The bund will have a crest level of 7.5 m AHD during the placement process. This will have a likelihood of exceedance by a Barron River (AEP) of <0.5%, ignoring the reduced likelihood of such a flood occurring in the period while the placement is in progress and the material is settling. Assessment of the consequences of a rare flood overtopping the bund needs to consider the following issues:

- At the time of the overtopping, the bunded area will be likely to be full to the height of the bund due to rainfall.
- Under the worst conditions, the maximum level of the placed fill will be 6.0 m AHD meaning that there will be a minimum depth of 1.5 m of water at this time.
- The bed shear test assessment concludes that 1.7 m of depth (loose – i.e. under the worst possible conditions and corresponding to a flood occurring in July / August when the DMPA is at its maximum level and the placed material is at its minimum density) is sufficient to prevent remobilisation.

So, while some remobilisation could possibly occur under these extreme circumstances, this will be at a time when the Barron River is experiencing a flood greater than 200 year ARI (<0.5% AEP) and will be carrying a large sediment load that will dwarf any losses from the DMPA should they occur. This is the justification for the ascribed consequence of Minor above for remobilisation of dredged material in extreme flood events.

This assessment shows that the unmitigated risk of remobilisation of placed material due to flooding is negligible. Mitigation is not required and is not feasible.

B17.6.4 Construction and Operational Risks

As detailed in **Table B17-17** and **Table B17-18** above, the Construction Hazards and Risks identified have a Low to Medium residual risk rating whilst the Operational Hazards and Risks that are identified as being High are existing risks and not additional risks introduced by the delivery of the CSD Project. Those existing High risk activities are well established and actively managed by Ports North as part of existing management and operational practices, protocols and plans.

The geo-environmental hazards are included in this category as they are essentially construction-related and well understood by Cairns designers and contractors.

B17.7 References

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