Ports North

VOLUME 3

Draft : Environmental Impact Statement

Chapter B16 Climate Change and Greenhouse Gases

B16.1 Introduction

The purpose of this chapter is to outline the potential effects of climate change on the Cairns Shipping Development Project (the project) as well as determining the Greenhouse Gases (GHG) that the project is likely to generate.

This assessment is intended to:

- Provide a summary of the potential effects of climate change on the project, based on current understanding of climate change science
- Provide a carbon footprint calculation for both construction and operation
- Outline design and operational control measures to minimise the impacts of climate change and the amount of GHG emissions produced.

The project is proposed to accommodate cruise ships over a planning horizon to 2041 (assuming a minimum 25-year planning horizon for the purposes of this assessment). Given the coastal location of the port, it is expected to be vulnerable to sea level rise and storm surge events in particular. Therefore projected changes in climate need to be taken into consideration for the design operation and maintenance of the project. As construction will occur prior to significant alterations to the climate, no adaptation measures are considered necessary for this phase. The project is also likely to produce an increased amount of greenhouse gas emissions in comparison to the current situation.

This chapter explores potential climate change impacts related to proposed infrastructure and shipping operations, as well as considering the impacts of construction and operational activities on climate change by accounting for the production of greenhouse gas emissions.

It should be noted that **Chapter 18, Cumulative Impacts Assessment** considers potential climate change impacts on the Great Barrier Reef and whether the project may impact the resilience of the marine habitat.

B16.2 Background

The Intergovernmental Panel on Climate Change (IPCC) has previously indicated that climate changes are linked to increased emissions of GHG caused by human activity. *"Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial era values determined from the testing of ice cores spanning many thousands of years. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture"* (IPCC, 2007).

At the current high levels of GHG in the atmosphere, warming of the climate will continue even if emissions are dramatically reduced. Even if emissions from human sources were to cease, slower heat loss from the ocean means temperatures would not drop significantly for at least 1,000 years.

In the 2007 *Fourth Assessment Report*, the IPCC recognised that "warming of the climate system is unequivocal"; however, there are degrees of uncertainty associated with its associated impacts (when and to what extent the impact will manifest). This uncertainty is associated with the anticipated rate of GHG emissions in the future and correlations between temperature increases and its associated impact on sea levels, rainfall, extreme weather, etc. The latest 2013 report (IPCC, 2013) confirms scientists are more certain that warming since 1950 has been primarily been caused by humans and that the period between 2001 and 2010 was the hottest decade on record. This is causing an increase in the frequency and severity of extreme weather events.

The latest IPCC report, the *Fifth Assessment Report*, known as AR5 (IPCC, 2013) on climate change observations states that stabilising the climate will require substantial and sustained reductions in GHG emissions. The report provides a view of the current state of global scientific knowledge relevant to climate change. Major findings include:

- The period 2001-2010 was the hottest decade on record, with many regions, including Australia, experiencing longer and more intense heat waves. If emissions continue to track at the top of IPCC scenarios, global temperature could rise by up to 5.4° C by 2100, relative to pre-industrial levels
- The frequency and severity of extreme weather events is increasing and rainfall patterns are changing with an increase in the intensity or amount of heavy precipitation events
- Sea level has risen by 19cm over the 1901-2010 period, and at an increased rate over the period since 1993 and the oceans are becoming more acidic. If emissions continue to increase unabated, sea level is predicted to rise by nearly 1m by 2100, compared to its average level between 1986-2005.

Three reports have since been released by the IPCC:

- The approved IPCC Working Group I, The Physical Science Basis: Summary for Policymakers report
- The approved IPCC Working Group II, Impacts, Adaptation and Vulnerability: Summary for Policymakers report
- The approved IPCC Working Group III, Mitigation of Climate Change, Summary for Policymakers report (currently as a final draft version, accepted but not approved in detail, on the 12th of April 2014)

As part of AR5, one additional report is to be released; the Synthesis Report (24-31 October 2014).

The Working Group III report updates global climate change projections; however, this data has yet to be translated into regional projections for the Cairns region.

In their 2014 report on the State of the Climate, the CSIRO reports the following changes to Australia's climate, based on the most recent observations:

- Australia's climate has warmed by 0.9°C since 1910, and the frequency of extreme weather has changed, with more extreme heat and fewer cool extremes
- Rainfall averaged across Australia has slightly increased since 1900, with the largest increases in the northwest since 1970
- Rainfall has declined since 1970 in the southwest, dominated by reduced winter rainfall. Autumn and early winter rainfall has mostly been below average in the southeast since 1990
- Extreme fire weather has increased, and the fire season has lengthened, across large parts of Australia since the 1970s
- Global mean temperature has risen by 0.85°C from 1880 to 2012
- The amount of heat stored in the global oceans has increased, and global mean sea level has risen by 225mm from 1880 to 2012
- Australian temperatures are projected to continue to increase, with more extremely hot days and fewer extremely cool days
- Average rainfall in southern Australia is projected to decrease, and heavy rainfall is projected to increase over most parts of Australia
- Sea-level rise and ocean acidification are projected to continue.

The Australian Maritime College (2009), held a workshop in 2009 to report on climate change risks for ports.
It concluded that the major potential impacts on ports are:

- Increases in wind speeds and storm frequency which can damage infrastructure and affect berthing ability of vessels
- Sea level rise – while it was agreed that sea level rise will occur gradually, allowing sufficient time to adapt, concerns about conditions outside of ports (e.g. road/rail/electricity supply) were raised as an issue for access/supply of ports.

The project will need to take this information into account to ensure that:

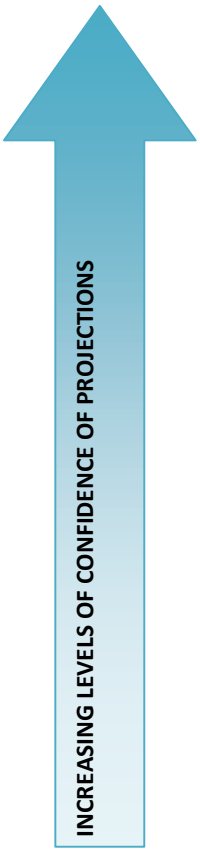
- The design allows for a changing climate
- Measures to minimise the GHGs produced through its construction, operation and maintenance are identified and implemented.

B16.3 Methodology

B16.3.1 Climate change

With reference to climate change projections, there is uncertainty on exact specifics when particular forecasts will eventuate or even if they will eventuate. For example, while there are varying levels of confidence regarding the projections for tropical cyclones, the impact of their occurrence will be significant thus necessitating an extreme potential risk rating. Based on the information provided within the relevant climate change literature and guidance a summary of the levels of confidence in the climate change projections used for this report is provided below in **Figure B16.3.1a**.

Figure B16.3.1a Levels of Confidence in Climate Change Projections used for Climate Change Adaptation Assessment



VERY HIGH

- Higher regional (and global) temperatures
- Sea level rise

HIGH

- Decreasing regional rainfall and increase likelihood of drought
- Increased regional evaporation levels and decreased humidity

MEDIUM – HIGH

- Storm tide inundation
- Increased wind speeds

MODERATE

- Increased likelihood of bushfires (number of high Forest Fire Danger Index days)
- Increased rainfall intensity

LOW

B16.3.1.1 IPCC Emissions Scenarios

To estimate future climate change, the IPCC Special Report on Emissions Scenarios (SRES, 2000) prepared 40 GHG and sulfate aerosol emission scenarios for the 21st century that combine a variety of assumptions about demographic, economic and technological driving forces likely to influence such emissions in the future. They do not include the effects of measures to reduce greenhouse gas emissions, such as the Kyoto Protocol.

Each scenario represents a variation within one of four "storylines": A1, A2, B1 and B2. The experts who created the storylines were unable to arrive at a most likely scenario, and probabilities were not assigned to the storylines.

Table B16.3.1.1a provides an overview of each of the presented emissions scenarios. For the purpose of this assessment an A1FI storyline has been assumed. As described in the table below, the A1FI storyline describes a fossil fuel intensive economy – it should be noted that the current trends of fossil fuel emissions are tracking the IPCC emissions projections under A1FI.

Table B16.3.1.1a Overview of IPCC Emissions Scenarios

IPCC Emissions Scenarios	Definition
A1	The A1 storyline describes a world of very rapid economic growth in which the population peaks around 2050 and declines thereafter and there is rapid introduction of new and more efficient technologies. The three sub-groups of A1 are fossil fuel intensive (A1FI), non-fossil fuel using (A1T), and balanced across all energy sources (A1B).
A2	The A2 storyline depicts a world of regional self-reliance and preservation of local culture. In A2, fertility patterns across regions converge slowly, leading to a steadily increasing population and per capita economic growth and technological change is slower and more fragmented than for the other storylines.
B1	The B1 storyline describes a convergent world with the same population as in A1, but with an emphasis on global solutions to economic, social and environmental sustainability, including the introduction of clean, efficient technologies.
B2	The B2 storyline places emphasis on local solutions to economic, social and environmental sustainability. The population increases more slowly than that in A2. Compared with A1 and B1, economic development is intermediate and less rapid, and technological change is more diverse.

B16.3.1.2 Climate Change Projections for Cairns

It is assumed that the Port of Cairns will continue to be an operational port to service the city of Cairns and surrounds, and remain a key cruise ship destination until at least 2041 (assuming a minimum 25-year planning horizon in relation to climate change). As a precautionary measure, climate change scenarios for 2050 have been identified for application (**Table B16.3.1.2a**). In some instances, projections are only available for the year 2100.

For the purpose of this assessment, projections within the 50th percentile have been used, this reflects the best estimate data available.

Table B16.3.1.2a presents the climate change projections used to inform this adaptation assessment and recommendations. Effort has been made to apply locally relevant projections. For instance ***Climate Q: toward a greener Queensland*** provides a number of projections specifically relevant to the Far North Queensland region, however, this level of detail is not available for all projections applied and as such, other widely used and well-respected sources have been used to understand relevant parameters for potential impact.

The latest report from the IPCC (AR5) provides further details regarding confidence levels, these descriptions of confidence levels and likelihood are included in Table B16.2b. The descriptions of the impacts are based on the IPCC AR5 Working Group II, Chapter 25 Australasia.

B16.3.1.3 Risk Assessment – Description of Climate Change Significance Criteria

Australian Standard/New Zealand Standard 5334-2013: Climate Change adaptation for settlements and infrastructure - a risk based approach, outlines a process for the identification and management of risks that infrastructure face from climate change. It provides risk criteria that will be utilised in this study to determine the potential risks to the project from climate change, as shown in **Table B16.3.1.3a**.

Table B16.3.1.2a Climate Change Projections for the Far North Queensland area and for Australia

Climate Change Variable	Projection for Far North Queensland Region			Projection for Australia (AR5 WGII)	
	Description of Projection	Projected Timeframe	Source	Description of Impact	Confidence Levels / Likelihood
Temperature (annual average)	Annual increase of 1.8°C (50th percentile, IPCC high projections) There is little variation in projections across the seasons	2050	Climate Q	Warming is projected to continue	Virtually certain
Sea level rise	Increase of 0.5m	2070	Queensland Coastal Plan/State Planning Policy	Regional seal level rise to exceed the historical rate (1971-2010)	Very likely
Sea Level Temperature Rise	Sea water temperature increases 2.2°c to 2.5°C	2070	CSIRO & BoM	Warming oceans	High confidence
Ocean Acidification	pH reduction of 0.14 to 0.35	2100	IPCC 2007	Storage of carbon by ocean will increase acidification in the future	Virtually certain
Rainfall	Annual decrease of up to two percent (median, IPCC high scenario)	2050	Climate Q	Annual average rainfall expected to decrease	High confidence
Rainfall Intensity	Five per cent increase in intensity per °C temperature rise	2070	DEHP	Increasing extreme rainfall related to flood risk	Medium confidence
Storm Tide Inundation	Increase in inundation levels of between three and10 percent	2100	DEHP	Flood risk projected to increase due to more intense extreme rainfall events	Medium confidence
Tropical Cyclones	10 percent increase in the intensity of tropical cyclones	2100	Queensland Coastal Plan	Tropical cyclones are projected to increase in intensity	Low confidence
Drought	Up to 40percent increase in the number of drought months	2070	CSIRO & BoM	More intense and frequent droughts	High confidence

Climate Change Variable	Projection for Far North Queensland Region			Projection for Australia (AR5 WGII)	
	Description of Projection	Projected Timeframe	Source	Description of Impact	Confidence Levels / Likelihood
Bushfires	Increase in number of high Forest Fire Danger Index days	2070	OCC 2010	Fire season length will be extended	High confidence
More days over 35°C	Annual increase to 13 days (50th percentile, IPCC High projections)	2050	Climate Q	-	-
Humidity	Decrease of between one and two percent	2070	CSIRO & BoM	-	-
Evaporation	Annual increase of six percent (50th percentile, IPCC high scenario)	2050	Climate Q	-	-
Wind speeds	Annual increase of between five and 10 precent.	2070	CSIRO & BoM	-	-

Table B16.3.1.3a Recommended Risk Criteria, Australian/New Zealand Standard 5334-2013: Climate change adaptation for settlements and infrastructure

Consequence	Adaptive Capacity	Infrastructure, Service	Social / Cultural	Governance	Financial	Environmental	Economy
Negligible	No change.	No infrastructure damage, no change to service.	No adverse human health effects.	No changes to management required.	Little financial loss or increase in operating expenses.	No adverse effects on natural environment.	No effects on the broader economy.
Minor	Minor decrease to the adaptive capacity of the asset Capacity easily restored.	Localised infrastructure service disruption. No permanent damage. Some minor restoration work required. Early renewal of infrastructure by 10-20 percent Need for new/ modified ancillary equipment.	Short-term disruption to employees, customers or neighbours Slight adverse human health effects or general amenity issues.	General concern raised by regulators, requiring response action.	Additional operational costs Financial loss small, <10 percent.	Minimal effects on the natural environment.	Minor effect on the broader economy due to disruption of service provided by the asset.
Moderate	Some change in adaptive capacity. Renewal or repair may need new design to improve adaptive capacity.	Limited infrastructure damage and loss of service Damage recoverable by maintenance and minor repair Early renewal of infrastructure by 20-50 percent.	Frequent disruptions to employees, customers or neighbours Adverse human health effects.	Investigation by regulators Changes to management actions required.	Moderate financial loss 10-50 percent.	Some damage to the environment, including local ecosystems. Some remedial action may be required.	High impact on the local economy, with some effect on the wider economy.

Consequence	Adaptive Capacity	Infrastructure, Service	Social / Cultural	Governance	Financial	Environmental	Economy
High	Major loss in adaptive capacity. Renewal or repair would need new design to improve adaptive capacity.	Extensive infrastructure damage requiring major repair Major loss of infrastructure service Early renewal of infrastructure by 50-90percent.	Severe adverse human health effects, leading to multiple events of total disability or fatalities. Total disruptions to employees, customers or neighbours Emergency response at a major level.	Major policy shifts Change to legislative requirements Full change of management control.	Extreme financial loss >90 percent.	Very significant loss to the environment. May include localised loss of species, habitats or ecosystems Extensive remedial action essential to prevent further degradation Restoration likely to be required.	Major effect on the local, regional and state economies.
Very High	Capacity destroyed, redesign required when repairing or renewing asset.	Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service Loss of infrastructure support and translocation of service to other sites Early renewal of infrastructure by 90 percent.	Severe adverse human health effects, leading to multiple events of total disability or fatalities Total disruption to employees, customers or neighbours Emergency response at a major level.	Major policy shifts Change to legislative requirements.	Extreme financial loss > 90 percent.	Very significant loss to the environment. May include localised loss of species, habitats or ecosystems Extensive remedial action essential to prevent further degradation Restoration likely to be required.	Major effect on the local, regional and state economies.

B16.3.2 Carbon Emissions

The carbon footprint of the proposed project was calculated based on the assumption that it be constructed and fully operational by 2016 . Dredging will take approximately 23 weeks to complete and the land-based infrastructure will take up to approximately 12 months to complete. Refer to **Chapter A2, Project Description** for further details.

B16.3.2.1 General Approach to Emission Calculation

GHG Accounting Standards

This assessment has used two international accounting standards:

- World Business Council for Sustainable Development/World Resources Institute Greenhouse Gas Protocol; A Corporate Accounting and Reporting Standard (the GHG Protocol)
- AS ISO 14064.1 – 2006: Specification with guidance at the organisation level for quantification and reporting of greenhouse gas emissions and removals (AS ISO 14064).

It should be noted that AS ISO 14064 cross references the GHG Protocol, so these two standards are complimentary.

The *National Greenhouse and Energy Reporting (Measurement) Technical Guidelines* (Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education, 2013) references these two international standards. Therefore, the selection of these methodologies is consistent with International and Australian practice.

As a subsidiary protocol to the United Nations Framework Convention on Climate Change, the Kyoto Protocol was agreed in 1997 in Kyoto, Japan. The Protocol sets binding targets for 37 industrialised countries and the European community in reducing GHG emissions. Australia ratified the Kyoto Protocol in 2007 and it came into effect for Australia in March 2008. It committed Australia to ensuring its average annual GHG emissions from 2008 to 2012 are no more than eight percent above 1990 levels.

GHG's are gaseous constituents of the atmosphere that influence energy flows by absorbing infra-red radiation. For the purposes of this report, GHG's are the six gases listed in the Kyoto Protocol: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF_6).

As different GHGs have different Global Warming Potentials (GWP), the carbon dioxide equivalent (CO2-e) is used as the universal unit of measurement to evaluate GHGs against a common basis. CO_2-e indicates the global warming potential expressed in terms of the GWP of one unit of carbon dioxide. For that reason CO_2 is used as a reference as it always has the GWP of one.

The GWP of a GHG is the radiative forcing impact contributing to global warming relative to one unit of CO_2. Sourced from the Intergovernmental Panel on Climate Change's Fourth Assessment Report (2001) the GWP of several GHG's are listed in **Table B16.3.2.1a** below and are consistent with the *Australian Government's National Greenhouse and Energy Reporting Technical Guidelines* (DIICSRTE, 2013).

Table B16.3.2.1a GWP of several GHG's

GHGs	Chemical Formula	Global Warming Potential (100 Years)
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxides	N_2O	310
HFC-23	CHF_3	11,700
HFC-134a	CH_2FCF_3	1,300
Sulphur hexafluoride	SF_6	23,900

[1] The current estimated date for the project to be operational is 2017 due to program slippage, however, this delay does not have a significant effect on the predicted outcomes of this investigation.

Once data is collected, emissions from an organisation's activities are quantified by multiplying activity data (e.g. kilowatts of electricity used) with the appropriate emission factor (e.g. kg CO_2-e/kWh of electricity).

Emission factors are activity specific and thus the activity determines which emission factor is used. Identifying the relevant emission factor can depend on several aspects including whether consumption of the input results in GHG emissions directly or indirectly, how the input creates emissions (i.e. consumption or generation) and the location of the activity. For example, the emission factor for the generation of electricity varies from state to state as electricity is generated by various processes using various sources (e.g. Victoria predominantly uses brown coal while Tasmania electricity is generated by hydropower).

Emission Factors

Emission factors used in this report are generally from the National Greenhouse Accounts Factors 2014 (July). The ***NGER Technical Guidelines (2013)*** contain the latest methods for estimating emissions and are based on the ***National Greenhouse and Energy Reporting (Measurement) Determination 2008*** as amended by the N***ational Greenhouse and Energy Reporting (Measurement) Amendment Determination 2010.***

Fuel Consumption Factors

As a large proportion of carbon emissions will be associated with the direct burning of fuel (particularly in ship engines and for dredging tasks), a range of fuel consumption factors were assumed. **Table B16.3.2.1b** below details the fuel consumption factors assumed.

Table B16.3.2.1b Fuel Consumption Factors for ship types

Ship / Vehicle Type	Reference	Fuel Consumption		
		Fuel	Factor	Units
Trailer Suction Hopper Dredger	Fuel consumption based on similar-sized ship: • 2008-built Trailing Suction Hopper Dredger W/Shore Pump Out, with total installed power of 3,135kW, and total fuel consumption at 450 l/hr. Fuel usage pro-rated by total installed power for quoted TSHD make and model: • 5,580m^3 type, Marieke (Dredging International), with total installed power of 6,826kW.	HFO	980	l/hr
Backhoe Dredger	Fuel consumption based on similar-sized ship: • 2014-built Excavator Dredger, with total installed power of 3,040kW. Fuel usage quoted as 540 l/hr Fuel usage pro-rated by total installed power for quoted Backhoe Dredger make and model: • 1,600kW Hippopotes of Van Oord, with total installed power at 1,985kW	HFO	353	l/hr
Tugs (for construction dredging)	CA EPA (1999) ***Source Inventory - Tugs and Towboats, Dredge Vessels and Others***, '1501-2000 HP Tug'	HFO	164.7	l/hr
Support vessels	CA EPA (1999) ***Source Inventory - Tugs and Towboats, Dredge Vessels and Others***, '1001-1500 HP Tug'	Diesel	119.9	l/hr
Concrete trucks (15t)	National Ready Mixed Concrete Association NRMCA (2012) 2012 NRMCA ***Fleet Benchmarking and Costs Survey, Table 5***	Diesel	11.1	l/hr
Site vehicles	Assume a Holden VF SIDI Utility Evoke, Urban fuel consumption, as per http://www.greenvehicleguide.gov.au/	Petrol	12.5	l/100km

Explanation of Scopes 1, 2 and 3

The separation of emissions into direct and indirect is fundamental to both the GHG Protocol and AS ISO 14064 accounting standards. To help distinguish between direct and indirect emission sources, provide transparency and avoid double counting, the proposed project's emissions are categorised as follows:

Scope 1 – Direct GHG emissions owned or controlled by Ports North which include:

- Fuel combustion in plant and dredge equipment and site vehicles

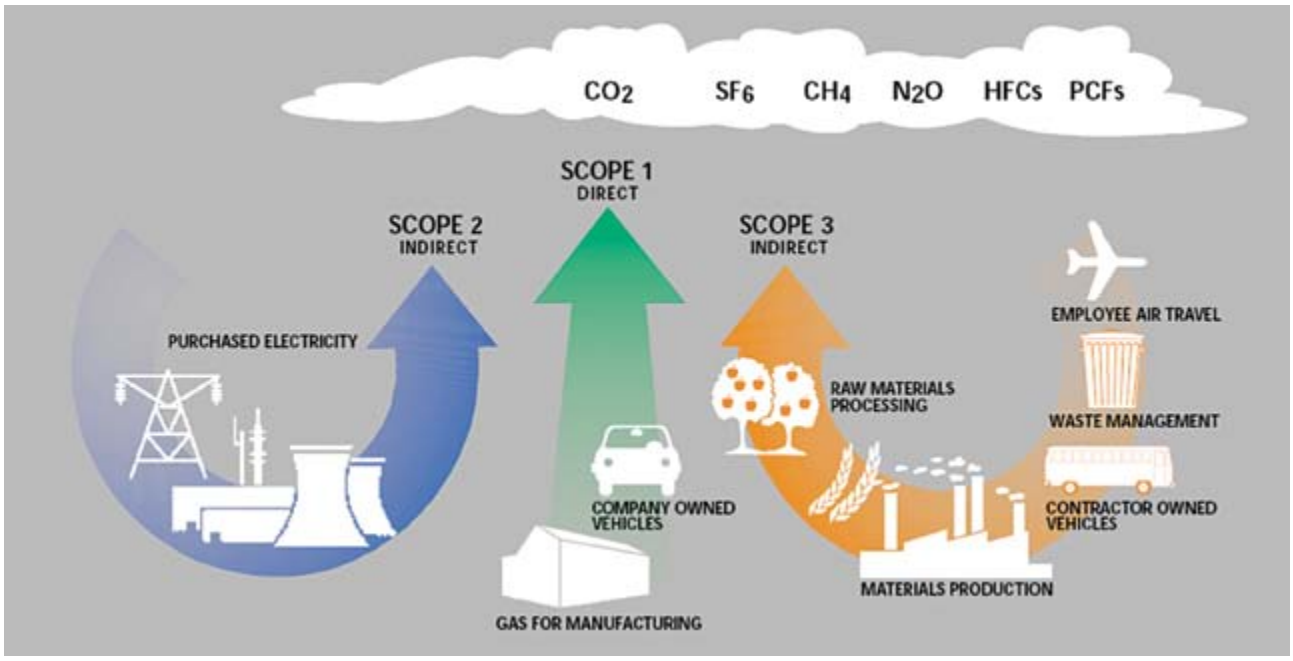
Scope 2 – Indirect GHG emissions associated with electricity supplied from external sources.

Scope 3 –Indirect GHG emissions not owned or in control of Ports North which include:

- Embodied energy of materials
- Transport of materials and equipment to and from site
- Extraction, production and supply of fossil fuels.

Figure B16.3.2.1a provides a visual representation of Scope 1, 2 and 3 emissions categories and the types of activities that can contribute to their creation.

Figure B16.3.2.1a Explanation of Emissions Categorised as Scopes[2]



Operational Boundaries

The GHG Protocol uses this term to describe the parts of the proponent's activities that are to be included in an inventory. Establishing boundaries from the outset is important to ensure consistency is maintained across the footprint and to ensure the boundary is restricted to GHG emissions that are within the control of the proponent.

Spatial Boundaries

All activities and components considered to be occurring outside of the scope of the EIS process are excluded from the carbon footprint. For this investigation, fuel consumption of ships travelling to and from the port is excluded as these emissions are the responsibility of the relevant cruise company.

[2] New Zealand Business Council for Sustainable Development (2002) *The Challenge of Greenhouse Gas Emissions*

Temporal Boundaries

The construction carbon footprint represents an approximation of the total GHG emissions associated with construction activities. This allows for a 23-week dredging campaign and an eight month construction timeframe for the installation of land-based infrastructure. The operational carbon footprint is based on the approximate GHG emissions generated at the port for the period 1 January – 31 December 2026, the end year for the Demand Study forecasts and a reasonable horizon year for this analysis. (Refer to **Appendix D6, Cairns Cruise Shipping Development - Demand Study**).

Table B16.3.2.1c and **Table B16.3.2.1d** outline the main facilities/infrastructure included for the construction and operational carbon footprints respectively, along with the likely emission sources from the construction/operation of the facilities.

Table B16.3.2.1c Construction carbon footprint scope summary

Facilities/Infrastructure	Emissions Scope	Sources
Capital dredging and placement of material Construction of the wharf berthing infrastructure Installation of cruise ship services e.g. water.	Scope 1 (direct)	Fuel combustion in dredge plant and other construction equipment e.g. piling barge, piling rigs.
	Scope 2 (indirect)	Purchased electricity for use during the land side infrastructure construction.
	Scope 3 (indirect)	Scope 3 emissions are not included in this assessment, as they will be addressed by third parties.

Table B16.3.2.1d Operational carbon footprint scope summary

Facilities/Infrastructure	Emissions Scope	Sources
Tugs Electricity consumed by cruise ships while alongside at port or general operations e.g. lighting Maintenance dredging.	Scope 1 (direct)	Fuel combustion in plant equipment and vessels. Note that pumping of fuel for IFO supply is excluded based on materiality.
	Scope 2 (indirect)	Electricity consumed on-site i.e. lighting and electricity use within the CCLT.
	Scope 3 (indirect)	Scope 3 emissions are not included in this assessment, as they will be addressed by third parties.

The projected emissions for the project will be compared against the current base case for the number of vessels that use the existing CCLT and Yorkeys Knob.

Uncertainty

The carbon footprint analysis is based on equipment and usage data provided by Ports North and its sub-consultants. No direct measurements or site surveys were conducted. In undertaking GHG accounting, there is inevitably some uncertainty in emissions data resulting from any causal factor, such as the application of non-representative factors or methods and incomplete data on emission sources. The collection of accurate activity data is generally the largest challenge facing the development of comprehensive and representative GHG inventories.

Materiality

Materiality is defined as to whether an error or omission in the calculation of the carbon footprint is a material discrepancy or not. Emission sources that contribute less than five percent to either the construction or operational footprint are considered immaterial. These include emissions associated with refrigerant gas usage (Scope 1).

Data Sources

All equipment and usage data provided for the calculation of this carbon footprint was sourced through published literature, reports, Ports North and its sub-consultants.

B16.3.2.2 Risk Assessment – Description of Carbon Emissions Significance Criteria

For the purpose of quantifying the likely impact and risk of the proposed project as a result of generated carbon emissions (in construction and operation), significance criteria has been developed to allow a ranking of impacts and risks in order of severity. The significance criteria have been based on the reporting thresholds set by the ***National Greenhouse and Energy Reporting Act 2007*** (NGER Act).

It should be noted that the GHG emissions generated from current facilities at the Port of Cairns (due to electricity usage of facilities or fuel use from fleet) do not trigger the NGER Act and its reporting requirements. However, for the purposes of developing criteria for the risk assessment of carbon emissions, the NGER Act reporting thresholds have been adopted. This is presented in **Table B16.3.2.2a**.

Table B16.3.2.2a Risk Criteria, based on NGER Act reporting thresholds

Significance	Description
Very High	Carbon emissions from a particular activity exceed the NGER Act corporate group threshold of 50 kilotonnes of carbon dioxide equivalence CO_2-e.
High	Carbon emissions from a particular activity exceed the NGER Act facility threshold of 25 kilotonnes of carbon dioxide equivalence CO_2-e.
Moderate	Carbon emissions from a particular activity are at least 50 percent of the NGER Act facility threshold of 25 kilotonnes of carbon dioxide equivalence CO_2-e.
Minor	Activity generates carbon emissions, but is below 50 percent of the NGER Act facility threshold of 25 kilotonnes of carbon dioxide equivalence CO_2-e
Negligible	Activity generates has negligible carbon emissions (less than 1ktCO_2e).
Beneficial	Activity sequesters or offsets carbon emissions, such as generating renewable energy.

Table B16.3.2.2b Risk Matrix

Likelihood	Significance				
	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

Table B16.3.2.2c Risk Rating Legend

Extreme Risk	An issue requiring change in project scope; almost certain to result in a 'significant' impact on a Matter of National or State Environmental Significance
High Risk	An issue requiring further detailed investigation and planning to manage and reduce risk; likely to result in a 'significant' impact on a Matter of National or State Environmental Significance
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

B16.4 Relevant Legislation and Policy

B16.4.1 National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* provides for the reporting and dissemination of information related to greenhouse gas emissions, greenhouse gas projects, energy production and energy consumption. It sets out and regulates the National Greenhouse and Energy Reporting (NGER) Scheme to provide data and accounting in relation to GHG emissions and energy consumption and production. The scheme's legislated objectives are to:

- Underpin the carbon price mechanism
- Inform policy-making and the Australian public
- Meet Australia's international reporting obligations
- Provide a single national reporting framework for energy and emissions reporting.

The assessment of GHG emissions for construction and operational components of the project will comply with all relevant provisions outlined in the *National Greenhouse and Energy Reporting Act 2007*.

The Department of the Environment has prepared and published the *National Greenhouse Accounts (NGA) Factors* (DCC, 2014), which are designed for use by companies and individuals to estimate GHG emissions.

The methods described in the NGA Factors have a general application to the estimation across the range of GHG emissions relevant to the project.

B16.4.2 Carbon Pricing Mechanism

The Federal Government has recently repealed the existing *Clean Energy Act 2011* (which sets up the requirement for a carbon tax on liable entities (the largest carbon polluters)). Liable entities must still meet their carbon price obligations for the 2013-14 financial year, including reporting their emissions number to the Clean Energy Regulator under section 22A of the *National Greenhouse and Energy Reporting Act 2007* by 31 October 2014, and acquitting their final carbon price liability for 2013-14 by 2 February 2015. The carbon price is proposed to be replaced by a 'Direct Action Plan', which would include an Emissions Reduction Fund to provide incentives for abatement.

Ports North and its operations at the Port of Cairns, was not considered a Liable Entity under the previous Act, and has therefore not been required to pay a carbon tax.

B16.4.3 Coastal Protection and Management Act 1995

This Act provides for the protection, conservation, rehabilitation and management of the Queensland coastal zone, including its resources and biological diversity.

The Queensland Government has mapped coastal hazard areas along the Queensland coast. The maps indicate the extent of coastal areas projected to be at risk from coastal hazards to the year 2100. Each map shows areas at risk from:

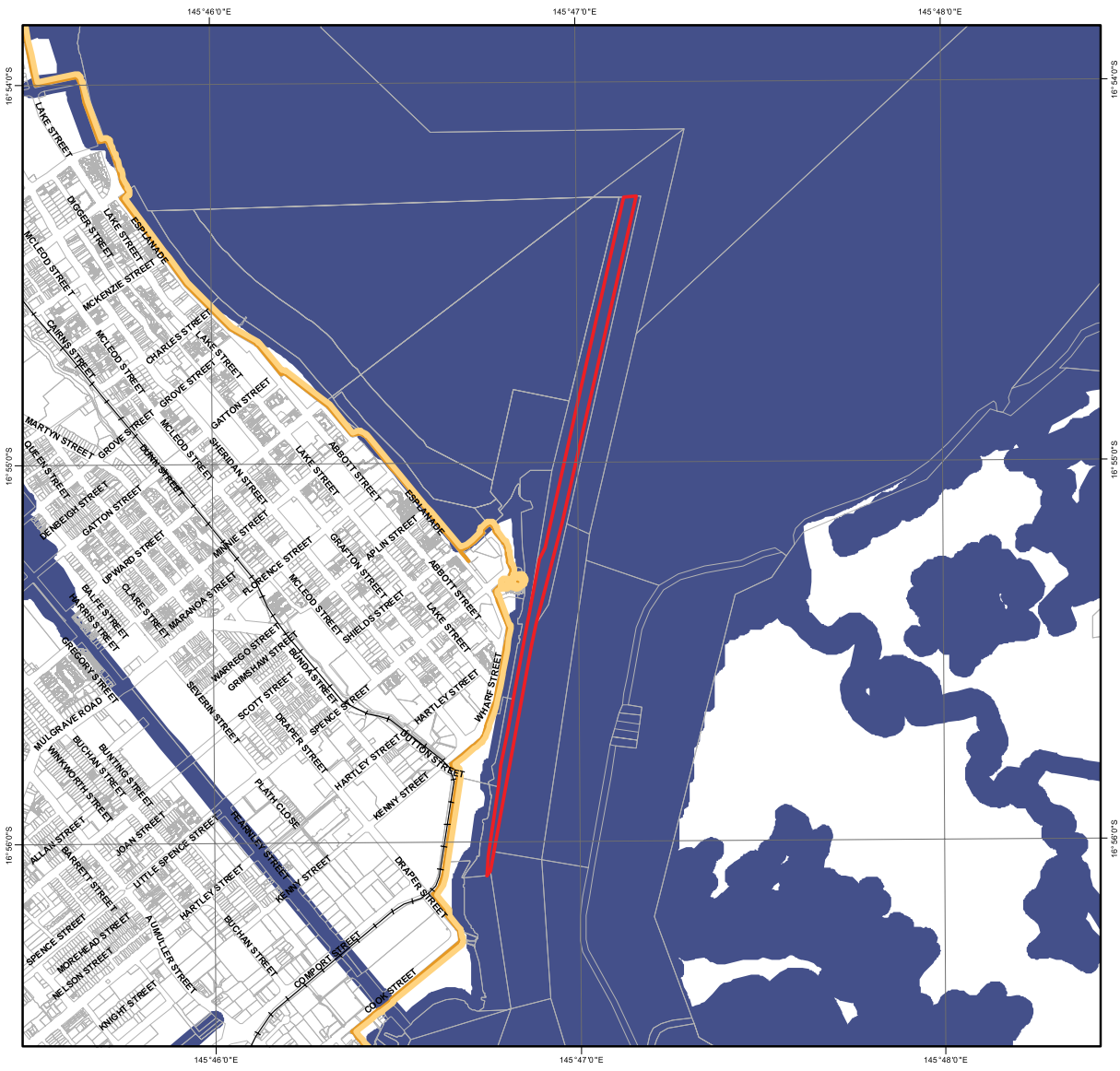
- Coastal erosion and permanent inundation by sea level rise
- Storm tide inundation for medium hazard and high hazard inundation.

The maps incorporate a sea level rise of 0.8m and a 10 percent increase in the maximum potential intensity of cyclones by the year 2100. A default storm tide inundation level of 2.0m HAT has been utilised. These factors are based on the projections released by the IPCC in its *Fourth Assessment Report (2007)*. These factors are likely to be reviewed based on the outcomes of the *Fifth Assessment Report*.

Figure B16.4.3a shows areas subject to erosion and permanent tidal inundation due to sea level rise, in accordance with the Act. **Figure 16.4.3b** further illustrates the project area is likely to be subject to storm tide inundation of greater than 1.0m in depth.

The existing wharves receiving cruise ships have a deck level of 4.9m LAT. Allowing for a sea level rise of 0.8m above the current HAT level (3.5m LAT) by the year 2100, the wharves' deck has a 0.6m freeboard above the HAT with the projected sea level rise. Storm surge inundation may occasionally exceed the freeboard allowance at the wharves.

Figure B16.4.3a Indicative Erosion Prone Area (State of Queensland, 2013)



Coastal Hazard Areas Map

Erosion Prone Area

Requested By: LUKE.BERTINI@ARUP.COM
Date: 31 Oct 14 Time: 17.47.28

Centred on Lot on Plan:
40 SP113657

Selected Land Parcel

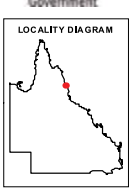
Indicative Erosion Prone Area

Erosion due to storm impact and long term trends of sediment loss and channel migration

Coastal Management District

Queensland Government

LOCALITY DIAGRAM



0 280 560 840 1120 1400 m

This product is projected into GDA 1994 MGA Zone 55

Notes

1. The areas shown on this map are indicative of the extent of erosion and permanent inundation defined by erosion prone area plans declared under the Coastal Protection and Management Act 1995. Only the declared erosion prone area plans should be used for development assessment. To determine the actual position of the erosion prone area a registered surveyor or geotechnical consultant may be required if there is any doubt.

2. Erosion prone area plans for each local government area and a comprehensive description of their determination are available from the Department of Environment and Heritage Protection website at www.ehp.qld.gov.au

Version 3 - April 2014

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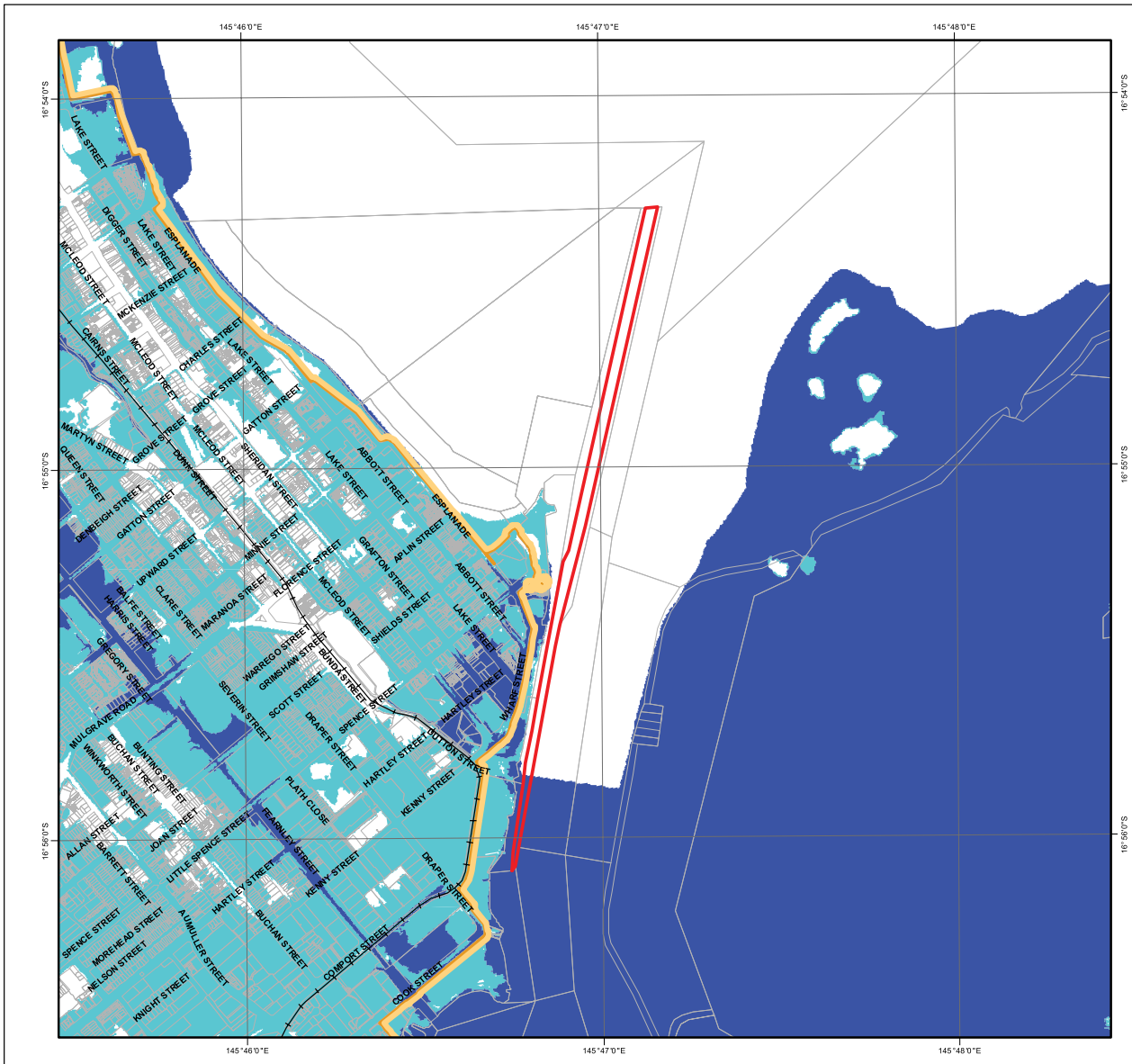
Figure B16.4.3b Storm Tide Inundation Area



Coastal Hazard Areas Map

Storm Tide Inundation Area

Requested By: LUKE.BERTINI@ARUP.COM
Date: 31 Oct 14 Time: 17.47.37

Centred on Lot on Plan:
40 SP113657

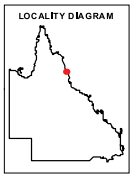
Selected Land Parcel

Storm Tide Inundation Area

- **High hazard area (greater than 1.0m water depth)**
- **Medium hazard area (less than 1.0m water depth)**
- **Coastal Management District**
- **Coastal hazard data not available in this area Refer to note 1 to determine**

Queensland Government

LOCALITY DIAGRAM



0 280 560 840 1120 1400 m

Notes
1. A default storm tide inundation level of 0.7 m HAT in South East Queensland regional planning area and 1.2 m HAT for the remainder of Queensland is used where projected storm tide inundation levels have not been determined locally.

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

Version 3 - March 2014

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B16.5 Existing Environment

B16.5.1 Climate Change

As described in **Section 16.3.4**, the existing wharves at the Port of Cairns are situated above the current projected sea level rise (0.8m by 2100), but the port may be occasionally subject to inundation from storm surge. Given the port's location in a cyclone-prone area, it already has an Extreme Weather and Cyclone Contingency Plan in place that establishes arrangements for managing the channel, wharf and vessel operations under extreme weather conditions (rainfall, wind, cyclone, storm surge) that will be updated to take account of the latest climate change data.

B16.5.2 GHGs

Ports North does not currently undertake a formal annual assessment of its GHG emissions for the Port of Cairns, however, it has implemented a number of measures to reduce the carbon emissions footprint which include offsetting staff air travel through Queensland Government's travel policy requirements, switching its workshop fleet to lower emission fuels, installing energy efficient lighting and air-conditioning plant in offices, recycling construction and demolition waste and purchasing products with a low carbon intensity where possible.

B16.6 Impact Assessment

B16.6.1 Climate Change

Table B16.6.1a below provides an assessment of the potential impacts of climate change on the project. The table considers the potential impacts to new or refurbished infrastructure only, without mitigation measures being applied.

Table B16.6.1a Potential Climate Change Impacts

Asset/ Service	Climate Variable	Potential Climate Change Impact	Significance of Impact	Likelihood	Likelihood Overall Risk
Construction	Various	As construction is scheduled to occur in 2016, the impacts of climate change are unlikely to be sufficient to cause disruption to construction	Negligible	Highly Unlikely	Highly Unlikely Negligible
Maintenance Dredging	More intense and frequent cyclones/ storm events	Maintenance dredging is delayed. The impact of cyclone/storm surge data is not easily assessed on the current available data. This impact is therefore not currently rated. However, it will be monitored as further information becomes available. It should also be noted that maintenance dredging is normally not undertaken during the cyclone season.	Unrated due to low certainty of projections		
Inner and Outer Channel	More frequent cyclones/ storm events	Altered sediment transport patterns and infill of the channel. The impact of cyclone/storm surge data is not easily assessed on the current available data, which has a low level of certainty. This impact is therefore not currently rated, however, will be monitored as further information becomes available.	Unrated due to low certainty of projections		

Asset/ Service	Climate Variable	Potential Climate Change Impact	Significance of Impact	Likelihood	Likelihood Overall Risk
DMPA	More intense and frequent cyclones/ storm events	Re-suspension of dredge material at a more rapid rate than predicted. The impact of cyclone/storm surge data is not easily assessed on the current available data. This impact is therefore not currently rated, however, will be monitored as further information becomes available.	Unrated due to low certainty of projections		
Berthing Structure	Storm Surge	More rapid deterioration of infrastructure over time and requirement for frequent maintenance. Temporary flood/cyclone/ storm surge damage to berthing infrastructure.	Minor	Possible	Low
	More frequent cyclones/ storms events				
	Changes to ocean temperatures		Negligible	Possible	Negligible
	Increase in annual mean temperature and days over 35°C				
Terrestrial Ecological Values	Various	Loss or degradation of terrestrial ecological values due to leaks/ breakages to services in extreme events	Minor	Highly Unlikely	Negligible
Marine Ecological Values	Various	Loss or degradation of terrestrial ecological values due to leaks/ breakages to services in extreme events	Moderate	Highly Unlikely	Low
Ship Berthing	Increase in annual average wind speed	Temporary delays or obstruction of cruise ship berthing.	Minor	Possible	Low
	More frequent cyclones/ storms events		High	Highly Unlikely	Medium
	Sea level rise	Permanent inundation of ship berthing infrastructure.			
Disruption to services/ supply	Increase in annual mean temperature and annual number of hot days over 35°C	Temporary decreased access to the wharf may disrupt ship providing and ability to embark/disembark. In the event of loss of temporary access, Ports North can provide alternative locations. Disru ption of water/sewer/power networks.	Minor	Unlikely	Low
	More frequent cyclones/ storm events				

The key findings from the risk assessment suggest the highest risk posed to the area is from the potential impact of increased intensity of tropical cyclones and storm surge. It should be noted that the climate science around cyclone intensity has a high degree of uncertainty, and further study is required to confirm the impact of climate change on cyclone frequency in Queensland. Cairns is already in a cyclone prone area, and the existing jetty and wharf are designed to withstand such an event. Nevertheless, the proponent will continue to monitor the latest available climate change projections, and review cyclone/storm event procedures on a regular basis. Surrounding infrastructure, including power and transport networks, may be disrupted however, which may in turn impact the ability to service incoming ships until repairs can be made.

In the event of a cyclone, Maritime Safety Queensland (MSQ) and the Regional Harbour Master direct shipping traffic, including cruise ships. An ***Extreme Weather Event Contingency Plan*** (MSQ, 2013) has recently been prepared, which sets out cyclone response procedures. Large vessels, such as cruise ships, are directed out to sea and the port is closed. It will not reopen until the Regional Harbour Master is satisfied that the pilotage area is safe for vessels to re-enter. Structural assessments of wharf infrastructure are undertaken before the port is declared reopened.

The berthing infrastructure and wharf may be subject to occasional inundation during a storm tide event.

Based on current climate change projections the berthing infrastructure has sufficient redundancy to allow for sea level rise and the wharf will not experience permanent inundation.

B16.6.2 GHGs

B16.6.2.1 Construction

GHG emissions for the construction phase of the project will predominantly be produced through diesel fuel use for equipment and vehicles including dredging machinery, piling equipment and smaller plant used for infrastructure upgrades. Emissions generated from diesel usage are direct emissions and fall under Scope 1 emissions.

The range of diesel-fuelled plant likely to be used during the construction phase is detailed in **Chapter A4, Project Description**, and includes:

- Trailer Suction Hopper Dredge
- Backhoe Dredge
- Tugs
- Piling crane and hammer
- Work boats
- Work vehicles
- Construction plant
- Concrete trucks
- Excavators, trucks and rollers for installation of IFO pipeline.

Mains electricity is not expected to be utilised (or very minor usage only) for construction activity, therefore there are no Scope 2 emissions for the project.

Approximately 987kl of diesel fuel will be used in plant, equipment and vehicles through the construction period. Based on the data provided, approximately 6,125kl of heavy fuel oil will be used for dredging barges (and associated tugs) as part of the dredging works, which contributes to 95 percent of the construction-related emissions.
The consumption of fuel as a result of construction and dredging contributes to an overall estimated GHG emissions of 20,448t CO_2e. A summary of GHG emissions for the construction phase of the project is provided in **Table B16.6.2.1a**.

Table B16.6.2.1a Estimated Construction Phase GHG Emissions

Emission Source	Est. fuel consumption (kl)	Fuel type	GHG emissions (tCO_2e)	% of construction emissions
Concrete Trucks	94	Diesel	252	1.2
Site vehicles (utility, 4WD, etc.)	20	Diesel	55	0.3
Construction Plant e.g. excavators	35	Diesel	95	0.4
Dredging – Trailer Suction Hopper Dredger	2,601	Heavy fuel oil	7,553	37.1
Dredging – Backhoe Dredger	1,209	Heavy fuel oil	3,511	17.3
Dredging – Hopper barges, including tugs	2,124	Heavy fuel oil	6,166	30.3
Dredging – Support, survey and crew boats	812	Diesel	2,192	10.8
Construction (piling) – Pile driving rig	26	Diesel	71	0.3
Construction (piling) – Pile delivery barge	190	Heavy fuel oil	553	2.7
Total	**7,111**		**20,448**	

B16.6.2.2 Operations

Energy use during operational activities will include both Scope 1 and 2 emissions, as follows:

- Scope 1 emissions will result from fuel usage in port-related equipment, including tugs, maintenance dredging equipment and port vehicles
- Scope 2 emissions will be generated through the use of electricity in common user areas provided by the port for passengers (such as wharf lighting, CCLT electricity supply).

The following estimated operational emissions contain the following assumptions:

- Emissions from maintenance dredging are proportional to construction-related dredging, based on the amount of material dredged per year
- The port facilities (such as wharf lighting and the terminal electricity supply) contribute to 10 percent of the Port of Cairns electricity consumption in the baseline year of 2016. This remains constant regardless of project or year, as the facilities operate at consistent hours.

Table B16.6.2.2a below provides a breakdown of operational emissions for three scenarios:

1. A baseline condition (2016) without any port improvements
2. A future condition (2026) without any port improvements
3. A project scenario (2016) and future project scenario (2026).

Table B16.6.2.2a Estimated Operational Carbon Emissions

Emission Source	Baseline Condition		Project Scenario	
	2016	2026	2016	2026
	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)
Scope 1 emissions				
Dredging maintenance	4,647	4,647	4,647	5,974
Scope 2 emissions				
Port facility electricity	636	749	654	1,043
Total	**5,283**	**5,396**	**5,301**	**7,017**

Estimated operational carbon emissions are expected to increase as a result of the project. In 2026, the project scenario compared to a no-project scenario, a 25 percent increase in emissions is expected, mostly from the additional maintenance dredging that is to be carried out.

B16.6.2.3 Carbon Emissions – Significance of Impacts

Table B16.6.2.3a provides a summary of the significance of impacts, based on the criteria described in **Section 16.3.2.2**. The table assesses the significance of each emission source and its projected carbon emissions, during construction, or during the 2026 operational year with the project.

The table highlights that there is no single activity or carbon emission source that is assessed as a high risk rating. However, in total, for construction and operational emissions, these indicate a medium risk rating. It should be noted that the operational carbon emissions for the port with the project does not exceed the NGER Act facility threshold (refer to **Section B16.4.1**) as they are estimated to be less than 25ktCO_2e in a given year, and hence below the reporting thresholds, indicating the activities are a low emission source.

Table B16.6.2.3a Summary of Carbon Emission Impact Significance

Emission Source	Carbon emissions ($ktCO_2e$)	Significance of impact	Likelihood of impact	Risk Rating
Construction	20.4	Moderate	Likely	Medium
Operational Activities (2026 with project)	7.0	Minor	Likely	Medium

B16.7 Mitigation Measures

B16.7.1 Climate Change

A risk assessment analysis identified potential medium risks to the physical and natural assets within the port.

Generally there are four possible approaches in responding to climate change:

- Avoid – e.g. avoid locating assets in vulnerable areas
- Adapt – e.g. design and/or design standards to operate in predicted climate conditions
- Defend – e.g. install defences at or around critical infrastructure
- Retreat – e.g. develop and implement plans to relocate from the vulnerable area.

It is considered that risks identified in this assessment can be readily managed under existing operating procedures at the port, therefore it is appropriate to consider adaptation measures, as opposed to avoid, defend or retreat measures. In order to address potential impacts and inform further design and operational considerations, the following mitigation measures will be applied:

- Sea levels and other climate change related data will continue to be monitored, and a review of the berthing and wharf infrastructure will be undertaken should sea level rise exceed current predictions
- The berthing structure has been designed to current cyclone requirements under Australian Standards and to withstand a storm surge event. It is not considered that further mitigation measures are necessary
- Regular inspections of infrastructure will be undertaken; should excessive deterioration be identified, minor or more regular maintenance activities may be required within the design life of the project
- Inspection of infrastructure after cyclone/storm events to determine damage and appropriate maintenance requirements and/or altered design
- Regular review and update of the Port of Cairns existing Cyclone Contingency Plan.

B16.7.2 Carbon Emissions

The assessment of GHG emissions for the Port of Cairns has been conducted for the construction phase, and from operation. Although there are no activities that cause a significant amount of impact from carbon emissions (as described in **Table B16.6.2.3a**), both construction and operational activities do contribute to an in increase in carbon emissions above the existing baseline.

There is opportunity in both the construction and operation phase to reduce the impact of carbon emissions from activities. The following hierarchy of principles, based on EPA Victoria's carbon management principles (EPA Victoria, 2014), have been adopted for the outlining of mitigation measures:

- Measure and set objectives – a process of measuring, setting objectives (or targets) and reviewing carbon emissions to identify further opportunities to manage emissions
- Avoid – avoid undertaking activities that generate carbon emissions
- Reduce – modify activities to reduce carbon emissions, or undertake actions to reduce the intensity of activities
- Switch – changing fuel or energy sources that are less GHG intensive
- Sequester – undertake options to sequester carbon emissions
- Offset – purchase or undertake projects that offset residual carbon emissions (after mitigation actions have been undertaken).

Based on these principles, a range of mitigation measures will be implemented for construction and operational activities.

Construction

As per the summary of estimated construction carbon emissions shown in **Table B16.6.2.1a**, the major source of construction emissions is from dredging activities. Activities to reduce GHG emission impacts, for particular construction activities are as follows:

- *Energy and fuel management* – Undertake periodic energy and fuel audits to monitor energy and fuel use to identify areas for reduction or more efficient energy or fuel use
- *Carbon management* – Develop an on-going carbon emission inventory for the construction stage to monitor, report and identify opportunities to reduce emissions
- *Dredging activities* – Select or purchase equipment with newer or more efficient engines. Ensure that engines are regularly maintained to perform optimally for fuel consumption

  It should be noted that as part of refining the dredging methodology for the construction, efficiencies have been gained in the dredging process, leading to fuel efficiencies and therefore greenhouse gas emission reductions
- *Landside construction large vehicles (e.g concrete trucks)* – Identify and provide routes that minimise haul distances for trucks. Provide driver and employee training to ensure fuel-efficient practices, such as efficient driving practices and the turning off of engines when not in use or on standby

  Select or prefer more fuel efficient vehicles that are fit-for-purpose, and identify opportunities to use less carbon intensive fuels. Ensure vehicles are regularly maintained to perform optimally for fuel consumption
- *Landside construction small vehicles (e.g utilities and personnel cars)* – Select fit-for-purpose vehicles that are more fuel efficient, or use less carbon intensive fuels
- *Construction equipment maintenance* – Regularly inspect and maintain equipment to ensure optimal energy or fuel efficiency.

Operation

Regarding operational carbon emissions, the major source of emissions is from maintenance dredging.

It should be noted that for the operations, the Port of Cairns will only have operational control (or the ability to manage) common areas, such as port lighting and office areas. The port will have limited control on the extent and usage of generators used to power cruise ships while docked. Therefore, the following mitigation measures focus on activities for which the Port of Cairns has operational control.

- *Port facilities* – Continue to install energy-efficiency measures, such as lighting controls and sensors for office spaces. Replace inefficient lamps with energy efficient alternatives Identify opportunities to generate renewable energy and offset the use of grid electricity from non-renewable sources
- *Maintenance dredging activities* – Consider the selection or purchasing of equipment with newer or more efficient engines within contractual negotiations. Ensure that engines are regularly maintained to perform optimally for fuel consumption. Refine maintenance dredging routes to ensure efficient use of fuel. Provide training to staff to minimise energy and fuel consumption where practical
- *Fuel Supply* – Provide training or awareness programs to berthed ships on energy-efficient practices, particularly regarding energy usage.

B16.8 Residual Risk

Following implementation of the identified mitigation measures in response to the potential impacts identified, impacts for the project were reassessed, as summarised in **Table B16.8a**, for climate change impacts and **Table B16.8b**, for carbon emissions.

Table B16.8a Residual risks– Climate Change

Climate Variable	Asset/ Service	Potential Climate change Impact	Significance of Impact	Likelihood	Overall Risk	Mitigation Measure	Significance of Impact	Likelihood	Overall Risk
Various	Construction	Unlikely to cause disruption to construction.	Negligible	Highly Unlikely	Negligible	-	Negligible	Highly Unlikely	Negligible
More intense and frequent cyclones/ storm events	Maintenance Dredging	Maintenance dredging is delayed.	Unrated	Low certainty	Unrated	On-going monitoring of climate change related data and sea level rise Undertake channel survey after cyclone events to identify maintenance requirements.	Unrated	Low certainty	Unrated
More frequent cyclones/storm events	Inner and Outer Channel	Altered sediment transport patterns and infill of the channel.	Unrated	Low certainty	Unrated		Moderate	Low certainty	Unrated
More intense and frequent cyclones/ storm events	DMPA	Re-suspension of dredge material at a more rapid rate than predicted.	Unrated	Low certainty	Unrated		Moderate	Low certainty	Unrated
More frequent storm surge	Berthing Structure	More rapid deterioration of infrastructure over time and requirement for frequent maintenance Temporary.	Minor	Possible	Low	Berthing structure designed to cyclone requirements under Standards	Minor	Unlikely	Low
More frequent cyclones/ storms events						Undertake channel survey after cyclone events to identify maintenance requirements.			
Changes to ocean temperatures									
Increase in annual mean temperature and days over 35°C		Flood/cyclone/ storm surge damage to berthing infrastructure.	Negligible	Possible	Negligible		Negligible	Possible	Negligible

Climate Variable	Asset/ Service	Potential Climate change Impact	Significance of Impact	Likelihood	Overall Risk	Mitigation Measure	Significance of Impact	Likelihood	Overall Risk
Various	Terrestrial Ecological Values	Loss or degradation of terrestrial ecological values due to leaks/ breakages to services in extreme events.	Minor	Highly Unlikely	Negligible	-	Minor	Highly Unlikely	Negligible
Various	Marine Ecological Values	Loss or degradation of terrestrial ecological values due to leaks/ breakages to services in extreme events.	Moderate	Highly Unlikely	Low	-	Moderate	Highly Unlikely	Low
Increase in annual average wind speed	Ship Berthing	Temporary delays or obstruction of cruise ship berthing. Damage to infrastructure.	Minor	Possible	Low	Regular inspections of infrastructure will be undertaken.	Minor	Possible	Low
More frequent cyclones/ storms events						Regular review and update of the Port of Cairns Cyclone Contingency Plan.			
Sea level rise		Permanent inundation of ship berthing infrastructure.	High	Highly Unlikely	Medium		High	Highly Unlikely	Medium
Increase in annual mean temperature and annual number of hot days over 35°C	Disruption to services/ supply	Temporary decreased access to the wharf may disrupt ship providing and ability to embark/ disembark	Minor	Unlikely	Low	Regular inspections of infrastructure will be undertaken.	Minor	Unlikely	Low
More frequent cyclones/ storm events		Disruption of water/ sewer/ power networks.							

Table B16.8b Residual risks – Carbon Emissions

Potential Impact	Significance of Impact	Likelihood	Overall Risk	Mitigation Measure (summary of Section 16.6)	Significance of Impact	Likelihood	Overall Risk
Construction activities (total)							
Construction Activities (total)	Moderate	Likely	Medium	Efficient energy and fuel practices and training, selection of efficient or lower emission vehicles Selection of efficient or lower emission vehicles, regular maintenance of equipment and engines	Minor	Likely	Medium
Operational activities							
Operational Activities (2026 with project)	Minor	Likely	Medium	Selection of efficient or lower emission vehicles, regular maintenance of equipment and engines, review of dredging routes Training and awareness for berthed ships on energy efficient practices Install energy-efficient appliances and measures, replace inefficient lighting, identify opportunities for renewable energy on-site	Minor	Likely	Medium

B16.9 Conclusion

The assessment of both climate change impacts and carbon emissions from construction activities and resulting operational impacts have been undertaken, and no high risk impacts have been identified. However, some low and medium risks have been identified as follows:

- Due to potential increase in storm surges, cyclones and weather impacts, there may be increased deterioration or damage on berthing infrastructure or water, sewer and power networks. This may lead to more frequent maintenance or temporary delays (note that alternative berths may be available) or obstruction of cruise ship berthing
- Moderate levels of carbon emissions as a result of dredging during the construction and maintenance stage, which is due to the amount of fuel usage required to undertake dredging activities.

Overall, the risks presented are low to medium regarding potential climate change impacts, and from the generation of carbon emissions. There are, however, opportunities to reduce or manage these impacts as outlined in the above section on Mitigation Options.

Regarding climate change impacts, the infrastructure has been and will continue to be designed to current cyclone requirements under Australian Standards. Other actions to reduce risks are to undertake regular inspections of infrastructure to assess any deterioration or damage. Furthermore, relevant climate data should be kept up-to-date and regular reviews and update of the Port of Cairns Cyclone Contingency Plan can assist.

Regarding carbon emission impacts, it should be noted that the project capital dredging activities could be refined to improve campaign duration, cycle optimisation and hence fuel efficiency, leading to the reduction in potential carbon emissions. Further actions can be undertaken, such as selecting newer or more fuel efficient engines or equipment, and undertaking regular maintenance and inspections on this equipment.

B16.10 References

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