PORT OF TOWNSVILLE LIMITED
PORT EXPANSION PROJECT
CHANNEL UPGRADE

Townsville Port Expansion Channel Upgrade Project

Inshore Dolphin Monitoring Plan

February 2020

Document Control Sheet

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Document approval

Approval of the Inshore Dolphin Monitoring Plan was granted by a delegate of the Minister for the Environment on 26 February 2020.

The Inshore Dolphin Monitoring Plan is published on the CU Project's website on 11 March 2020.

This document has been prepared to meet the Commonwealth Government's EPBC Approval No. 2011/5979 Conditions and the Queensland's Coordinator General's Conditions for the Port of Townsville Limited's Port Expansion Project.

DECLARATION OF ACCURACY

EPBC Number	2011/5979
Project Name	Port of Townsville Port Expansion Project
Approval Holder	Port of Townsville Limited
ACN / ABN	130 077 673 / 44 411 774 236
Approved Action	To expand the Port of Townsville, in Townsville Queensland. The action is for dredging, land reclamation and construction of infrastructure.
Location of the Action	Townsville, Queensland

In making this declaration, I am aware that section 491 of the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed

_____

Full name (please print)

Marissa Wise

_____

Organisation (please print)

Port of Townsville Limited

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Date 25 / 02 /2020

GLOSSARY

AEIS	Townsville Port Expansion Project: Additional Information to the Environmental Impact Statement - Final (June 2017).
Capital Dredge Material	Material (clays, silts and sands) derived from capital dredging
Capital Dredging	As defined in the NAGD, being 'dredging for navigation, to enlarge or deepen existing channels and port areas or to create new ones'
CEMP	Construction Environmental Management Plan
CNRF	*Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins* (Department of the Environment, 2015).
CSSPPP	Construction Ship-Sourced Pollution Prevention Plan
CU Project	Channel Upgrade Project
CVTMP	Construction Vessel Traffic Management Plan
Department / DAWE	The Australian Government Department of Agriculture, Water and the Environment, or any other agency administering the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) from time to time
DMP	Dredge Management Plan
EIS	PEP Environmental Impact Statement
EMP	Environmental Management Plan
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
IDMP	CU Project Inshore Dolphin Monitoring Program as designed by Flinders University
ITAC	Independent Technical Advisory Committee
Listed Dolphin Species	Australian snubfin dolphin (*Orcaella heinsohni*) and Indo-Pacific humpback dolphin (*Sousa chinensis*)
Marine Fauna	Listed turtle species, Dugong (*Dugong dugon*), listed dolphin species, and all other Cetaceans
Mechanical Dredge	A dredger that removes sediments via mechanical methods. Can include grab dredges (clamshells and buckets) or backhoe dredges.
MEMP	Marine Environmental Management Plan
Minister	The Minister administering the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) and includes a delegate of the Minister
MNES	Matters of National Environmental Significance: In the context of this approval: Great Barrier Reef World Heritage Area, Great Barrier Reef National Heritage place, listed turtle species, listed dolphin species and all other Cetaceans, Dugong (*Dugong dugon*), Commonwealth marine area and the Great Barrier Reef Marine Park
PEP	Port Expansion Project
POTL	Port of Townsville Limited
Site	Strategic Port Land at the northern extent of the Eastern Reclaim Area at the Port (Lot 791 on EP2348) and the new reclamation area (not yet a declared lot)
TSHD	Trailer Suction Hopper Dredge – a self-propelled ship with a hold (hopper), and a dredging mechanism comprised of suction pipes connected to draghead(s), by which it can fill the hopper with dredge material

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1 INTRODUCTION

Port of Townsville Limited (**POTL**) is a Government Owned Corporation established under the *Government Owned Corporations Act 1993*, which manages the Port of Townsville (**the Port**). The Port is located on Cleveland Bay, approximately three kilometres east of the city centre in Townsville, North Queensland. It is a multi-purpose port that handles predominantly bulk and general cargo with a land and sea jurisdiction in excess of 450 km^2. The Port is situated in the Great Barrier Reef World Heritage Area, outside of the Great Barrier Reef Marine Park. Surrounding the Port of Townsville is Cleveland Bay and the community of Townsville. Townsville is a long-established township with a history of urbanisation and industrial activities in the Ross River and Ross Creek drainage system.

The Townsville Port Expansion Channel Upgrade Project (**CU Project**) is Stage 1 of POTL's long-term Port Expansion Project (**PEP**). The PEP (**Figure 1**) aims to create a series of strategic assets, which will address current capacity constraints and accommodate future growth in trade over a planning horizon to 2040. It includes development of port infrastructure and work to "top of wharf" facilities, namely, capital dredging; reclamation; breakwaters and revetments; berths; access roads; rail loop; and trunk services and utilities. It does not include the development of "above wharf" infrastructure such as terminal pavements; ship-loaders and unloaders; product conveyors; storage buildings for products; rail loaders and unloaders; stacking and reclaiming equipment; storage tanks; and pipelines, which will be subject to separate statutory assessment and approval requirements prior to the start of their operations.

The CU Project involves:

- Supply and haulage of marine-grade armour rock required for rock walls and revetments at the Port;
- Creation of a ~62 hectare reclamation area (Figure 2) via the construction of rock walls and revetments forming receival ponds for beneficial reuse of all material dredged from the channel widening works;
- Capital dredging on the western side to widen the Platypus Channel (Figure 3) from 92 metres width to 180 metres (at the harbour entrance) tapering to 135 metres (at the seaward end); and
- Capital dredging on the eastern side to widen the Sea Channel (Figure 3) from 92 metres to 120 metres along its length.

For the purposes of this monitoring plan the Project area relates to all seabed and waters across the footprint of all project construction areas. The Project Area lies within the Study Area, which for Inshore Dolphin Monitoring will involve all of Cleveland Bay (including north of Magnetic Island), the southern regions of Halifax Bay and the northern region of Bowling Green Bay.

The capital dredging, construction activities and infrastructure development for the CU Project will occur inside the existing port limits; the designated water areas in which navigation falls under the control of the Regional Harbour Master. The land-based construction activities will occur on the new reclamation area, namely Lot 794 on SP308904, adjacent to the northern extent of the East Port Area, namely Lot 791 on EP2348 (**the site**), which is current strategic port land (Figure 1).

The capital dredge campaign will last approximately 2 to 3 years and dredge approximately 3.9 million cubic metres predominantly using a mechanical dredge, with support from a trailer suction hopper dredge (**TSHD**). All the capital dredge material will be placed within the new revetment bunds as part of land reclamation activities. Dewatering and ground improvement of emplaced sediments will also be undertaken.

Inshore Dolphin Monitoring is required to be completed across all phases of the PEP; this plan has been developed with focus of monitoring relevant to the CU Project activities across dredging, reclamation and other Stage 1 works.

Figure 1: Locality Plan of the Port of Townsville and PEP

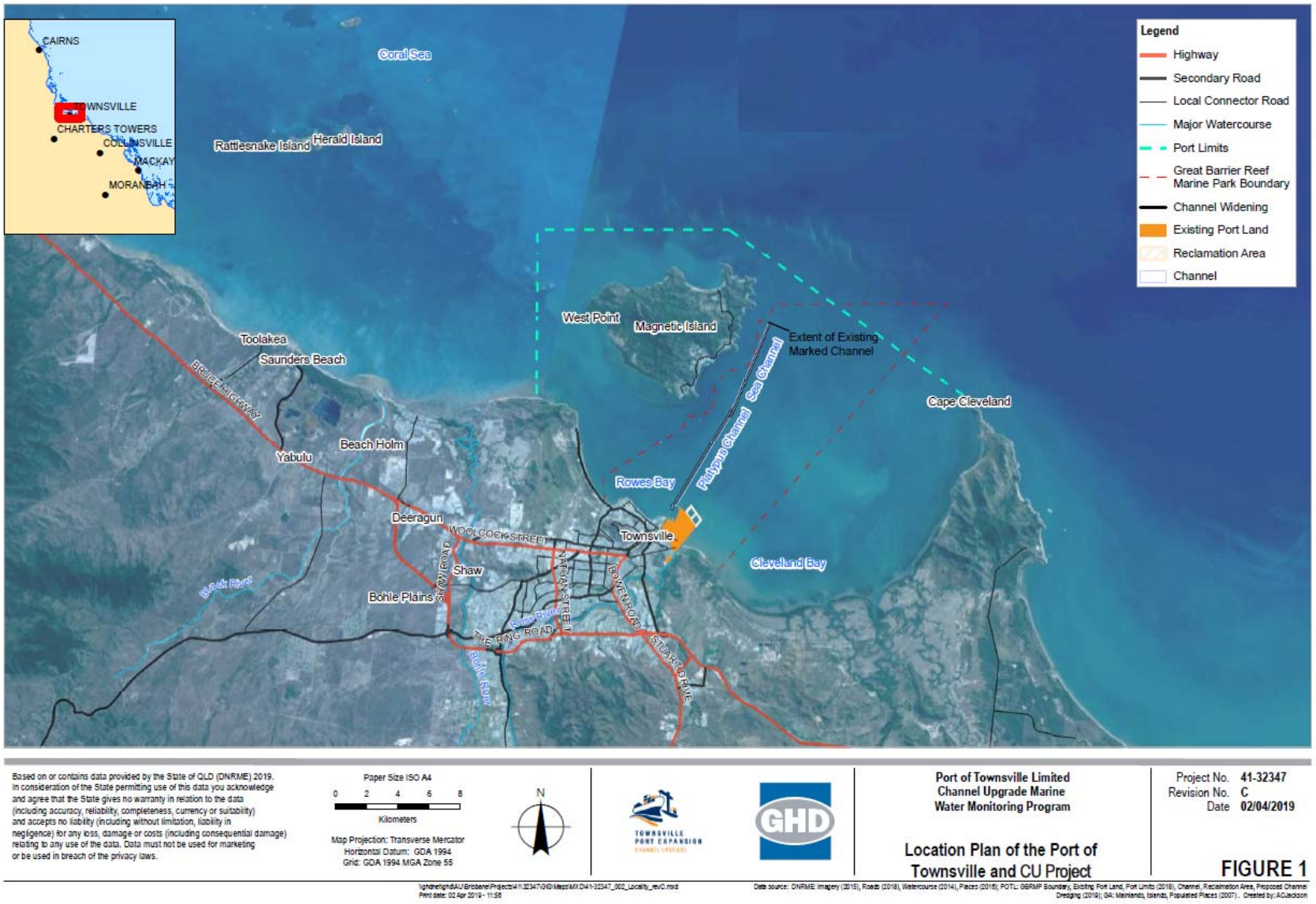


Figure 2: Lot Plan for CU Project Rock Wall Construction & Reclamation Activities

Figure 3: Site Plan for CU Project Capital Dredging Activities

2 EXISTING ENVIRONMENTAL VALUES

Cleveland Bay is a natural embayment located adjacent to Townsville. While significant coastal changes have occurred due to anthropogenic development, Cleveland bay continues to support a broad range of marine ecological values and functions. Cleveland Bay contains significant feeding areas and other important habitat for marine turtles, dugongs and dolphins, which are listed as threatened and/or migratory under Commonwealth and/or State legislation. It also supports a range of other threatened or otherwise listed marine megafauna species, including whales and sharks protected under the *Environment Protection and Biodiversity Act 1999*.

Listed Inshore Dolphins in Northern Queensland are the Australian snubfin dolphin *Orcaella heinsohni* (formerly *Orcaella brevirostris*) and the Australian humpback dolphin *Sousa sahulensis* (formerly *Sousa chinensis* – as detailed in http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=87942). Both species are classified as Vulnerable species (previously Near Threatened) under the Queensland *Nature Conservation Act 1992* and are listed Migratory and Cetacean species under the *Environment Protection and Biodiversity Conservation Act 1999*.

These species of inshore dolphin have a geographic distribution that is restricted to tropical and subtropical waters of the Sahul Shelf from Northern Australia to the southern waters of the island of New Guinea (Jefferson & Rosenbaum, 2014; Beasley, Robertson & Arnold, 2005). They inhabit riverine, estuarine and coastal waters and generally occur in waters less than 15 m deep, within 10 km of the coast and within 20 km of a river mouth (Parra et al, 2002; Parra, Corkeron, & Marsh, 2004). Work to date indicates these species live in small populations of approximately 50-200 individuals, exhibit low genetic diversity, fine-scale genetic population structure and have relatively small home ranges (Parra, G. J., and D. Cagnazzi. 2016.; Parra, G. J., and D. Cagnazzi. 2017). These biological characteristics render these coastal dolphins vulnerable to anthropogenic threatening processes, including habitat degradation, fishery bycatch and vessel strikes.

Inshore dolphins have an opportunistic generalist diet, feeding on fish and cephalopods (octopus, squid etc.) from coastal, estuarine and nearshore reef habitats (Parra & Jedensjö, 2014).

Coastal waters off Townsville and adjacent waters, including Cleveland Bay, surrounding bays to the north and south and the Townsville Port Limits, support important populations of the snubfin and humpback dolphin (Parra, Corkeron & Marsh, 2006). Surveys in Cleveland Bay between 1999–2002 indicated less than 100 individuals of each dolphin species use the coastal waters of Cleveland Bay regularly from year to year (Parra, Corkeron & Marsh, 2006). These studies also showed that the areas most often used by snubfin and humpback dolphins were located close to river mouths (i.e. Bohle River and Ross River) and modified habitat such as dredged channels and breakwaters close to the Port of Townsville (Parra, 2006).

The areas around the Ross River mouth and Port of Townsville are locally important for foraging snubfin and humpback dolphins, given the recurrent usage of the areas by feeding adults and calves of both species. In the broader Townsville region, Parra (2006) found two core use areas for this species: one west of Cape Pallarenda, around the mouth of the Black and Bohle Rivers; the other around the Port of Townsville, including around highly modified habitats such as breakwaters.

Recent surveys (Beasley et al., 2016) indicate that the populations are stable or slightly increasing in numbers. These surveys also confirm that snubfin and humpback dolphins' main areas of use are still around the Townsville Port entrance and associated channel and near the river mouths and creeks further North West (Bohle and Black rivers and Bluewater Creek).

On this basis, the CU Project land reclamation area is located within the dolphins' high use areas around the Ross River mouth and Port of Townsville. This brings potential to impact upon these listed species.

2.1 Project impacts on Existing Environment

The PEP AEIS identified potential impacts to inshore dolphins (as part of assessment for all marine megafauna) resulting from the Project and proposed mitigation measures as listed in the table below. Only those marine megafauna impacts relevant to Inshore Dolphins have been included.

Table 1: EIS/ AEIS Summary of Marine Megafauna/Inshore dolphin Impacts and Mitigation Measures

Element	Primary Impacting Process	Risk Assessment*			Mitigation Measures	Mitigated Risk Rating
		Consequence	Likelihood of Impact	Risk Rating		
Impacts to marine megafauna	Increase in rubbish production increasing the risk of entanglement and/or ingestion of marine debris by turtles and marine mammals	Serious	Possible	Medium	Implement waste management mitigation measures during construction and operations	Low (Rare)
	Increase in noise during construction leading to marine fauna temporarily avoiding affected area (displacement)	Serious	Likely	Substantial	Implement standard mitigation measures as per the CU Project's Marine Environmental Management Plan (MEMP) Conduct visual checks for marine megafauna Implement strategies to avoid interactions with marine megafauna	Medium (Possible)
	Injury/mortality to marine megafauna resulting from the use of dredge plant or noise generated by construction activities	Serious	Possible	Medium	Implement standard mitigation measures as per the MEMP Install tickler chains on TSHD dredge head Ensure suction on TSHD is ceased prior to hoisting the dredge head Conduct visual checks for marine megafauna Implement strategies to avoid interactions with marine megafauna	Low (Highly Unlikely)
	Loss of food resources and habitat as a result of construction and port facility operation leading to displacement of marine megafauna	Serious	Likely	Substantial	Implement standard mitigation measures as per the CU Project's Dredge Management Plan (DMP) Implement additional mitigation measures (where relevant), including:	Medium (Likely) *Based on CU Project specific risk*

Element	Primary Impacting Process	Risk Assessment*			Mitigation Measures	Mitigated Risk Rating
		Consequence	Likelihood of Impact	Risk Rating		
					• Avoidance of capital dredging using TSHD late spring and summer months to minimise potential impacts to key life-history functions • Develop and implement a Receiving Environment Monitoring Program (RMP) with appropriate triggers and corrective actions	
	Increased potential for hydrocarbon or other contaminant spill from vessels or on-site facilities, potentially leading to direct effects to marine megafauna or their prey (construction, operation)	Major	Unlikely	Medium	Implement hazardous material handling mitigation measures Implement emergency response procedure in general accordance with the *Queensland Coastal Contingency Action Plan* Conduct spill response training for employees	Medium (Unlikely)
	Increase in vessel traffic during construction phase potentially leading to an increase in vessel strike risk or habitat disturbance due to prop wash	Major	Possible	Substantial	Implement standard mitigation measures as per the MEMP Conduct visual checks for marine megafauna Implement strategies to avoid interactions with marine megafauna Implement “go slow” zones for construction vessels	Medium (Unlikely)
	Increase in vessel traffic during operational phase potentially leading to an increase in vessel strike risk or habitat disturbance due to prop wash	Major	Possible	Substantial	Nil	Medium (unlikely)

Element	Primary Impacting Process	Risk Assessment*			Mitigation Measures	Mitigated Risk Rating
		Consequence	Likelihood of Impact	Risk Rating		
Impacts on Ramsar site	Dredge plumes leading to loss of seagrass and subsequent reduction in the abundance of marine megafauna supported by the site	Worse case / Expected case scenario: Minor (No impact)	Highly Unlikely	Low	Implement standard mitigation measures as per the DMP Implement additional mitigation measures, including: • Avoidance of capital dredging using TSHD during coral spawning period (i.e. late Spring and Summer months) to minimise potential impacts to key life-history functions • Develop and implement a RMP with appropriate triggers and corrective actions	Low (highly unlikely)
Impacts to Great Barrier Reef World Heritage Area (**GBRWHA**) Outstanding Universal Values (**OUV**) (marine ecology)	Noise generated by capital dredging, piling and construction activities is also likely to result in the temporary avoidance of construction areas by megafauna and fish	Major	Unlikely	Medium	As per mitigation measures detailed above	Medium (unlikely)

* Risk rating descriptions and risk analysis headings from AEIS have been revised to align with POTL Risk Management Guidelines (POT442) risk categorisation.

3 PROGRAM REQUIREMENTS

3.1 Legislative Requirements

The PEP was the subject of an Environmental Impact Statement (EIS) and a further Additional Information to the Environmental Impact Statement (AEIS), submitted in support of Commonwealth and State project approval applications. The key environmental values likely to be affected by the construction activities associated with the CU Project were identified in the **EIS** and re-assessed in the **AEIS**. Potential impacts assessed as low to medium range risks for PEP (not just Stage 1 Channel Upgrade) include: potential modification and loss of habitat and food resources, slight increase in vessel traffic and potential for animal strikes, increase in potential release of rubbish and contaminants from vessels and increased noise generated by capital dredging, piling and construction activities. Additional detail regarding these is provided in the following table.

Commonwealth approval (EBPC 2011/5979) under the Environment Protection and Biodiversity Conservation Act 1999 for the PEP was granted on 5 February 2018. This approval prescribes conditions relevant to the development and implementation of an Inshore Dolphin Monitoring Plan, including detailing the required aspects that must be included in the Plan (provided by Appendix A).

This document provides the Inshore Dolphin Monitoring Plan (IDMP) to address the prescribed conditions. Results of this monitoring will be used to better understand the populations of inshore dolphins within and adjacent to Cleveland Bay, to monitor changes in species population and behaviour in association with the CU Project activities and to provide recommendations on keys areas of adverse impact and/or mitigation measures should it occur.

3.2 Program Objectives

A Construction Environmental Management Plan (CEMP), a Marine Environment Management Plan (MEMP), a Construction Vessel Traffic Management Plan (CVTMP) and a Construction Ship-Sourced Pollution Prevention Plan (CSSPPP) will be implemented detailing appropriate and preferred environmental management controls in relation to the construction of maritime structures such as breakwaters, marine pile driving or other land-based aspects of the reclamation and non-dredging related in-water aspects associated with the capital dredging and construction vessel movements of the CU Project. A Dredge Management Plan (DMP) will address environmental matters and controls associated with capital dredging (and associated dredge vessels). Information from the Inshore Dolphin Monitoring Program will inform actions outlined in plans discussed above.

Due to the potential impact on inshore dolphins from this project, this IDMP will be implemented to monitor the actual impacts of the CU Project on the listed inshore dolphin species (the Australian snubfin dolphin (*Orcaella heinsohni*) and Australian humpback dolphin (*Sousa sahulensis*).

It should be noted that other marine megafauna (as defined by the EPBC Act approval), will be the subject of alternate Monitoring Programs and are not included in this Monitoring Plan.

The objectives of the IDMP are to:

- To provide consistent and scientifically valid monitoring methodologies to be able to determine trends and identification of stressors with the potential to cause adverse impacts for these species

as consistent with the *Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins* (Department of the Environment, 2015).

- Provide a baseline assessment on the distribution, abundance and habitat use of the Australian snubfin dolphin and Australian humpback dolphin species in areas of Cleveland Bay that may be directly or indirectly impacted by the CU Project and adjacent non-impacted sites.
- Monitor and report on changes, beyond natural spatial and temporal variation, to the population and behaviour of the Australian snubfin dolphin and Australian humpback dolphin species throughout construction, pile driving operations and dredging activities for the CU Project, and a sufficient period of time post-construction to identify any changes in population and behaviour of the identified dolphin species as a result of the said activities.
- Provide recommendations on key areas of adverse impact and potential mitigation measures, including the identification of residual adverse impacts in Cleveland Bay.

It should be noted that monitoring and determining the impacts of human activities on marine mammals is challenging for a variety of reasons. Although this monitoring program has been designed to address these challenges where possible, separating "changes, beyond natural spatial and temporal variation" requires robust ecological understanding of the population of interest and large datasets spanning over decades. The proposed monitoring program is likely to only detect catastrophic effects (e.g. large declines in population size), and it will be very difficult to separate construction impact effects (e.g. dredge related) from natural spatial and temporal changes in the environment (e.g. thermal stress). However, given the limited detailed understanding of these populations in Cleveland Bay and surrounding bays, the data to be collected under this plan will provide trends and further add to the knowledge of these species.

The monitoring study has been designed to take into account known seasonal variability of dolphins in the area, timing of planned construction activities, and potential movements of animals to adjacent sites. The inclusion of adjacent non-impacted control sites in the monitoring program assists to separate impacts from natural variation and movements. To separate whether any observed changes are attributable to the activities of the CU project or natural variation and/or animal movements given the mobility of dolphins and the complexity of ecological and environmental variability in marine ecosystems.

The monitoring study includes capture-recapture methods based on the capture histories of individuals identified by photographs of their dorsal fins from boat-based surveys are commonly used for estimating demographic parameters (i.e. abundance, survival, temporary emigration) of dolphin populations. This methodology is recommended for long-term (multi-year) monitoring of inshore dolphins at key sites (impacted and non-impacted) by the Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins.

Simulation studies were undertaken to inform overall capture probability in the development of a statistically robust monitoring design which uses photoidentification, and multi-site Pollock's robust capture-recapture models to monitor abundance, survival, and movement patterns of snubfin and humpback dolphins in Cleveland Bay and in two adjacent sites of similar size (Halifax Bay and Bowling Green Bay). These sites are part of the home range of local snubfin and humpback dolphins, so monitoring of these three areas will allow us to monitor changes in abundance, survival and movement patterns of dolphins in relation construction activities and/or natural events.

By comparing demographic parameters and species distribution patterns across pre-, during and post-construction and across the three bays (Cleveland, Halifax, and Bowling Green Bays) the program will be able to report changes while taking into account natural spatial and temporal variation. Furthermore, by looking at the dolphin patterns of attendance and behaviour within the CU project area for land reclamation and widening of the channel at the harbour entrance the monitoring program will be able to assess the response of dolphins to CU construction activities.

This monitoring program has been designed to monitor the environmental impacts of the construction activities in the marine environment, as well as providing background information prior to the commencement of construction activities. Information from this monitoring program will be used to assist with improving the control measures associated with the CU Project to minimise impacts on Inshore Dolphin populations. Additionally, monitoring of the local dolphin populations may continue as part of the broader PEP project, however this Plan is focused on the CU Project monitoring program only.

While this Monitoring Plan is an approved Plan under the EPBC Act approval specifically targeting conditions pertaining to the Inshore Dolphins, it will also form part of the Marine Environment Management Plan (**MEMP**) for the project. The MEMP provides the environmental management requirements for Matters of National Environmental Significance (MNES) from project activities in the marine environment. Once the DMP is developed, the MEMP will also incorporate a number of the strategies and actions detailed in the DMP which addresses impacts specifically from the dredging operations.

This Inshore Dolphin Monitoring Plan is Appendix E of the *CU Marine Environmental Management Plan (POT 2135).* As this plan specifically covers the monitoring of inshore dolphin populations; this document is to be read in conjunction with the MEMP to ensure all management actions and controls are captured to prevent potential impacts to inshore dolphins.

3.3 Monitoring Stages

Inshore Dolphin monitoring for the CU Project is comprised of three separate stages:

- Pre-construction (baseline / trend assessment);
- During construction; and
- Post construction (initially for approx. 12 months, subject to review*).

** note the years of post-construction monitoring to be reviewed by ITAC mid construction.*

This IDMP details the monitoring program to be implemented across all three stages of the CU Project. As noted in Section 1, this Plan covers Stage 1 of the PEP project only; it is not designed to cover the monitoring plan for further stages of the PEP. Monitoring requirements for latter stages of the PEP will be described in future versions as an amended Inshore Dolphin Monitoring Plan relevant for the applicable stage.

Full details of the CU Project IDMP is provided at Appendix B.

The following section summarises the details of the IDMP, including monitoring locations, methodology, timing and analysis.

4 INSHORE DOLPHIN MONITORING PROGRAM

The program has been designed to provide a scientifically robust assessment of inshore dolphin populations, including demographic and behavioural characteristics.

A desktop assessment of existing literature on these species (including grey literature) was completed in early 2019 to provide baseline understanding of the populations in Cleveland Bay and to confirm the survey design. The Information in this literature review will include a synthesis of existing information on the distribution, abundance, habitat use, behaviour, movement patterns and potential vulnerability of Australian snubfin and humpback dolphins to impacts from construction activities associated with the CU Project.

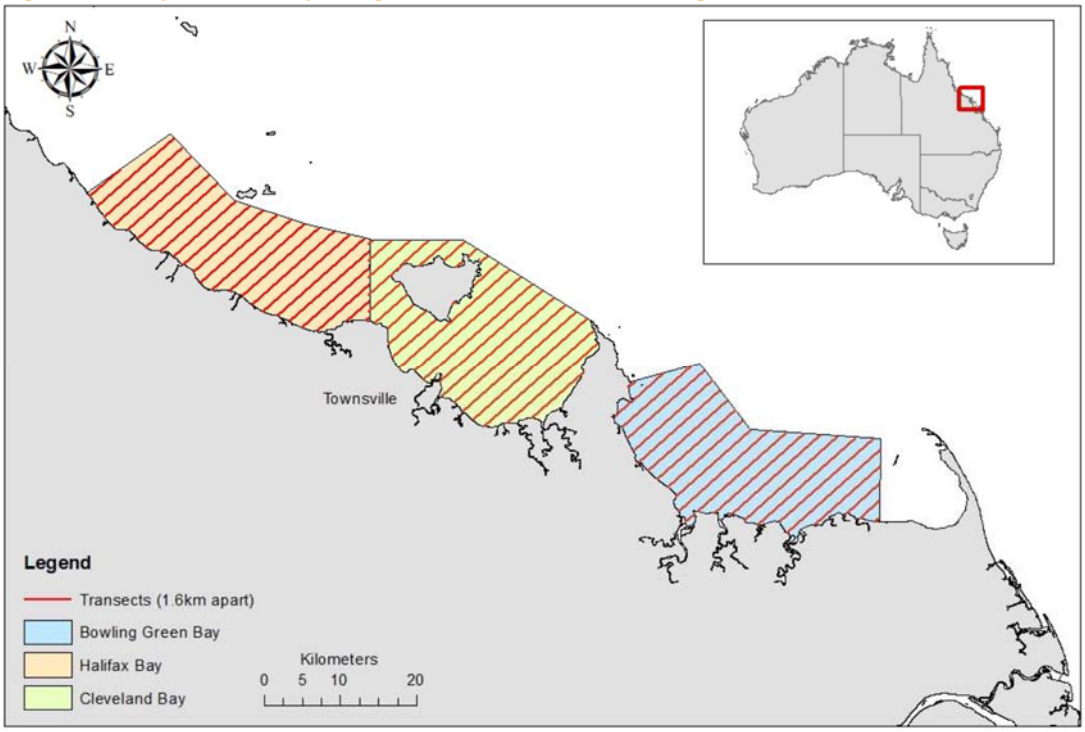
4.1 Monitoring Locations

Monitoring of inshore dolphins will be undertaken via boat based visual surveys across all of Cleveland Bay and in two adjacent sites (Halifax Bay and Bowling Green Bay) – see Figure 4. These three bays represent the 'impact' or direct area of interest site (Cleveland Bay), and adjacent non-impacted sites (Halifax Bay and Bowling Green Bay). The survey area covers inshore and offshore areas across the three bays (including waters to the north of Magnetic Island).

These sites are part of the home range of local snubfin and humpback dolphins and include past and recent areas identified as core habitat for these species within and Cleveland (Ross River mouth and Port of Townsville) and Halifax Bay (Mouths of the Bohle and Black rivers and Saunders Beach). Monitoring across these three areas will allow trends in potential changes in abundance, survival and movement patterns of dolphins in relation construction activities and/or natural events to be documented.

The proposed survey design does not include all of Halifax and Bowling Green Bay - the northern area of Halifax Bay and southern area of Bowling Green Bay are large, more open and more exposed to the weather than Cleveland Bay. As such, the spatial footprint to be surveyed in the 'non-impacted' bays will not cover the entire bay; but will be over a similar area as to be surveyed in Cleveland Bay for comparability of data.

Figure 4: Proposed survey design and extent of Monitoring under the IDMP



4.2 Methodology & Equipment

'Capture-recapture' photo methodology will be employed as part of the IDMP. This process involves the taking of photographs of individual dolphin dorsal fins via boat-based surveys and provides the ability to document demographic parameters (e.g. abundance, survival, behavior potential trends) of dolphin populations. By identifying individuals, a wider extent of demographic parameters (not just abundance) can be estimated which provides valuable information for population understanding and impact monitoring. These methods have been successfully used to monitor populations of Australian Snubfin and humpback dolphins in the past (Brooks *et al.*, 2017; Parra *et al.*, 2006; Cagnazzi *et al.*, 2011; Palmer *et al.*, 2014). This is also the methodology recommended for long term monitoring of inshore dolphins at key sites (impacted and non-impacted) by the Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins.

The data collected through the IDMP will be used in the estimation of abundance, life history parameters (e.g., apparent survival, population rate of change), home range, movement patterns, site fidelity, habitat use and social structure. The IDMP will employ a statistically robust monitoring design using a multi-site Pollock's robust capture-recapture model to increase knowledge on abundance, survival, and movement patterns of snubfin and humpback dolphins in Cleveland Bay, Halifax Bay and Bowling Green Bay.

The boat-based surveys will be completed using a systematic random line transect survey with regular line spacing (1.6 km apart and at 45º to the shore) within each of the three study areas/bay. Systematic line spacing results in even spatial distribution of sampling effort, uniform coverage probability and better information on dolphin's spatial distribution and environmental variables than random designs (Du Fresne, Fletcher & Dawson, 2006; Thomas, Williams & Sandlilands, 2007). Transect lines in offshore areas extend out to the Townsville Port limits, which includes waters beyond Magnetic Island.

Sampling methods will follow standard procedures applied in capture-recapture studies of inshore dolphin studies, including that surveys are conducted only in good sighting conditions (Beaufort Sea State ≤3 and no rain) and daylight hours (limited to between 07:00 and 18:00). A crew of three observers and a skipper will systematically search for dolphins forward of the vessel (with the naked eye and 7 x 50 binoculars); once a group of dolphins is sighted, on-transect effort will be suspended, and dolphins will be approached slowly to record data (parameters described in Section 4.4).

Photographs of individual animals will be taken using digital SLR cameras fitted with telephoto zoom lenses. This will provide visual records of individuals within the population to support abundance estimates.

Data on environmental variables will be collected in situ at the location of every group of dolphins encountered, at set points along the transect line and at the beginning and end of each transect leg.

The program will employ one primary sampling period per year comprised of six secondary periods (a complete survey of each bay) at each of the three study sites. To enable estimates of movement between the sites (bays), sampling dates across the three bays (Cleveland, Halifax and Bowling Green Bays) will be aligned through using three boats to complete each of the six secondary periods as fast as possible across each bay before moving onto the next bay.

To complement data collected from boat based surveys, visual observations of dolphins will also be undertaken from land-based locations around the Townsville Port, given it is a local high use area for these species. These land based observations will record the presence and behaviour of dolphins in relation to the presence or absence of active dredging and or piling operations and vessel traffic associated with the CU project.

Visual observations will be conducted from land within the port by a team of three trained observers during good weather conditions (i.e. Beaufort sea state <3 and no rain). Each observer will be the primary observer

for one-three-hour shift per day (multiple observers present throughout the day) and conduct visual scan sampling of the area adjacent to the port every 10 minutes to record the presence of dolphins (including group size), number and type of boats traversing the area, and the presence or absence of CU construction activities. Once a group of dolphins is detected, two observers will conduct focal follows observations of the behavioural state of the dolphin group using focal group scan sampling until animals are lost, out of sight or weather and/or daylight deteriorate.

These observations will be conducted over the same months/periods as the boat surveys will be running each year to provide complementary data.

Data collected through the IDMP will be analysed using standard ecological modelling approaches to understand trends in the distribution, abundance, habitat use and behaviour of dolphins over the duration of the CU Project. In particular, capture-recapture modelling will be used to assess population trends. Distribution modelling techniques will be used to estimate and compare snubfin and humpback dolphin distributions prior to, during and post-construction activities based on dolphins' presence and correlations with environmental conditions. Additionally, observations will be made regarding the response of snubfin and humpback dolphins to dredging and pile driving activities by assessing patterns of attendance to impact areas over consecutive years using data collected via land based visual observations. It is noted that the CU Project does not include significant wharf construction, therefore has limited pile driving compared to the future stages of PEP.

4.3 Frequency & Timing

Boat based surveys under the IDMP will be undertaken during June and July each year. This timing has been chosen as it represents the best time of the year for monitoring as it combines more favorable weather conditions (low rain and low winds) and peaks in the number of sightings/ activity of both dolphin species. Timing the surveys to peak periods of activity will improve the quality of data captured and ability to compare results as it will strengthen the robustness of the data collected.

Surveys each year will be conducted at the same time of the year throughout the CU project to minimize the confounding effect of season and minimize the risks of not being able to complete the required sampling due to influences such as inclement weather.

It is estimated that 20 days of survey effort will be required to achieve the six secondary survey periods each year. Taking account of down time associated with bad weather etc., a window of 40 days have been allocated to achieve the annual survey effort.

Annual surveys were conducted prior to construction (baseline assessment) in 2019 and will be undertaken during construction activities (2020-2022) and post construction period from 2023.

Due to the works program for this stage, a one year post construction is proposed; the adequacy of post construction monitoring will be reviewed by the ITAC mid construction (e.g. following results of the 2nd survey during the construction period). If the ITAC recommends additional post construction monitoring, POTL will revise this IDMP to extend the post construction monitoring in accordance with ITAC recommendations for post construction monitoring.

As noted above, land based observations will be conducted over the same months/periods (June-July) that the boat surveys will be running each year.

A baseline survey utilizing this methodology was implemented across June and July 2019. This survey covered all planned effort across Halifax and Cleveland Bay.

4.4 Parameters

Information to be collected via the boat-based surveys are as follows:

- GPS location,
- species identification,
- group size,
- group age composition (calf, juvenile, adult),
- predominant group behavior; and
- photo-identification.

Additionally, environmental (e.g. sea surface temperature, salinity, turbidity, water depth, distance to river mouth, benthic habitat type, chlorophyll a concentration) and anthropogenic variables (e.g. distance to port, distance to land, distance to dredge channel) known to affect the dolphins and/or their prey will be collected or derived from spatial data layers to inform population distribution assessments.

The collected information will be utilized to assess and / or model the following demographic parameters:

- distribution;
- abundance/population size (number of animals in the study area);
- habitat use;
- behavior.

Additional parameters to be modelled include:

- capture probability;
- apparent survival rate (probabilities of being alive and present in the sample site);
- transition probability (the probability of moving from one site to another); and
- temporary emigration (probability that an animal is absent from the total sampling area (all 3 sites) for the duration of a primary sample).

Habitat use will be categorized (where sufficient data allows) into core areas of habitat use (i.e. areas of intensive use) and representative ranges (i.e. areas of presence) of snubfin and humpback dolphins. Kernel density estimates will be undertaken to estimate Kernel ranges of 50% (core area) and 95% (representative range) probability of occurrence for each primary period across the different study areas.

Assessments will be undertaken, where enough animals are observed within a primary period, to investigate the environmental and anthropogenic factors affecting species distribution. This can help elucidate which areas constitute potential or priority habitat for a species and where potential conflicts with human activities may occur. Based on the presence−absence of dolphins during surveys, explanatory variables will be used to model dolphin distribution based around environmental or anthropogenic variables.

4.5 Limitations

There are two key limitations to the IDMP proposed outcomes, these are Weather conditions, and the ability to detect population change.

Weather:
Given the focus of the survey effort is boat based surveying, the state of the weather and having suitable meteorological conditions to support effective monitoring is key. The contracted team identified this risk in their program development, identifying that a survey period of June – July each year would be the most suitable climatic conditions (low rain and low winds) for conducting dolphin surveys, this period is when sightings of both species tend to peak.

Ability to detect population change:
The biggest challenge for the IDMP is having the statistical power in the population and behavioural data collected to detect any impact. Given the mobility of marine mammals and the small populations within the survey area, there is the real possibility that the dolphin monitoring will be limited in its ability to detect impact with any statistical robustness. Further to this limitation, given the complexity of ecological and environmental variability in marine ecosystems, separating the effects of human activities on coastal dolphins from natural ecological and environmental variability will be additionally difficult.

To minimise this impact of this limitation, the dolphin monitoring program includes:

- a survey design that considers the mobility of populations by the inclusion of the primary site (Cleveland Bay) and adjacent bays to the north and south. This will assist in distinguishing movements between sites and temporary emigration between primary samples, from demographic changes in Cleveland Bay that otherwise might be attributed to other factors (i.e., decrease in survival).
- Surveying being conducted at the same time every year to remove the confounding effect of ecological and environmental/seasonal variability; and
- a study design with the intention of assessing abundance estimates with a high level of precision (CV ~0.1).

4.6 Quality Assurance/Quality Control

The project team established to deliver the IDMP is a diverse, multidisciplinary, proven team with strong experience in implementing scientific monitoring programs in the marine environment and/or with dolphin species. The project team consists of recognised leading experts on Australian humpback and snubfin dolphins who have extensive experience in conducting monitoring of these species, including impact assessments. The team also includes experienced applied statisticians to ensure the research and statistical analysis design will provide robust data. The extensive experience of this project team will ensure quality outcomes from the program.

The IDMP has been designed to ensure the highest levels of precision, a noted issue given the relatively low population numbers of dolphins within the study area. Additionally, a number of quality control steps will be implemented as part of the data collection process, including the application of a strict quality and distinctiveness grading protocol for dolphin identification images before matching and cataloguing to minimise misidentification. Only high-quality photographs of distinctive individuals will be used in analyses.

Further, the IDMP will be undertaken under the following required permits obtained by Flinders University:

- Great Barrier Reef Marine Park Permit;
- Queensland Marine Park permit; and
- Flinders University Animal Ethics approval.

No monitoring will be undertaken without these permits being in place.

The data collection, analysis and reporting will occur under the Flinders University quality management system. This system covers:

- Work health and safety management system;
- Risk management;
- Animal Welfare;
- Research policies, including: Research IP Management, and Research Misconduct;
- Research Publication, Authorship and Peer Review;
- Research data management.
- Responsible conduct of research.

5 PERFORMANCE OBJECTIVES

This monitoring plan will address the performance objectives prescribed for Inshore Dolphins by the MEMP.

The following performance objectives will apply for the IDMP:

- Undertake all surveys at the identified period including undertaking the minimum number of secondary surveys within each primary period (weather conditions permitting); and
- All inshore dolphin monitoring to be conducted in a consistent manner, and meets the requirements of the appropriate environmental approvals; and
- Establish a temporal and spatial dataset to inform discussions with regulators and provide supporting information for ongoing performance; and
- Undertake Annual Program Review to identify trends or changes to dolphin populations and/or behaviour of listed dolphin species; and
- Timely delivery of annual and final reports and datasets/spatial layers, supplied by agreed milestone dates each year following data analysis; and
- Review and consideration of IDMP results by POTL and ITAC to identify any recommendations on likely causes/stressors to inshore dolphin populations and necessary management actions to be implemented as a result of the survey outcomes; and
- Report to the Department within 21 days of the identification of changes to dolphin populations and/or behaviour in these annual contractor reports and the ITAC considerations and advice on the results; and
- Where changes to dolphin populations and/or behaviour is reported in annual contractor reports, and those changes are not considered a residual adverse impact of the action, or that the impacts can be managed, POTL will report to the regulators why the ITAC and POTL does not consider those impact/s a residual significant impact; and
- Where it is assessed through the above review process that any residual adverse impact is a residual significant impact (i.e. the residual adverse impact cannot be managed), POTL will report this impact and why the impact is considered a residual significant impact to regulators in writing. This will include how this impact will be offset in accordance with the approved Offset Management Strategy;
- Annual review of the IDMP undertaken to review the effectiveness and relevance of the performance objectives and program; and
- Incorporation of any results from the IDMP into annual review processes for the CEMP; MEMP and DMP.

Unless otherwise prescribed by the agreed schedule of works, timely delivery is taken to be within a period of four weeks from the activity being completed.

The selection of highly experienced contractors for the implementation of the IDMP will provide some surety of meeting the objectives. The team is a highly qualified, multidisciplinary team that includes two of the three leading experts on these species of dolphin in Australia.

6 GOVERNANCE AND REVIEW

6.1 Development of Inshore Dolphin Monitoring Plan

The Inshore Dolphin Monitoring Plan has been developed in consultation with key stakeholders including:

- Representatives of the Traditional Owners, the Gurambilbarra Wulgurukaba people who are identified as the Native Title claimants of the land covering the Project area;
- POTL's Community Liaison Group (**CLG**), which comprises a number of community representatives;
- Environmental consultants;
- The CU Project Steering Committee, which comprises members of the POTL executive management team; and
- The Commonwealth Department of Agriculture, Water and the Environment (**DAWE**).

Traditional Owners were consulted in accordance with Condition 25 of EPBC Approval No. 2011/5979 during the development. This consultation involved the following:

- An initial presentation to Traditional Owners on the CU Project on 20 February 2018;
- The draft Monitoring Plan was subsequently presented to a meeting of the nominated Traditional Owners representatives on 30 May 2019. Comments raised were noted during the meeting with the Traditional Owners Working Group asked to provide any further comments on the IDMP within a nominated timeframe. All comments received from Traditional Owners were compiled, with no specific query or concern raised in relation to inshore dolphins. A copy of all comments made by the Traditional Owners Working Group was provided to the Minister with the IDMP;
- An update regarding the consultation with the Traditional Owners Working Group was then presented to the CU Project Steering Committee, which formally noted that the Traditional Owners Working Group had been consulted in relation to this Monitoring Plan.

6.2 Independent Peer Review of the Inshore Dolphin Monitoring Plan

In accordance with Condition 31 of EPBC Approval No. 2011/5979, the draft Inshore Dolphin Monitoring Plan, incorporating the IDMP, was independently reviewed by the CU project ITAC up to 20 June 2019, before submission to the Minister for approval. A copy of all advice and recommendations made by the independent peer reviewer was provided to the Minister with the draft Inshore Dolphin Monitoring Plan at time of submission.

6.3 Finalisation & Approval of Inshore Dolphin Monitoring Plan

The draft Inshore Dolphin Monitoring Plan was submitted on 07/08/2019 for the Commonwealth Minister for the Environment's approval to meet the submission timing requirements of EPBC Approval No. 2011/5979 Condition 24.

7 REPORTING AND RESPONSIBILITY

POTL is responsible for implementing this monitoring plan, with the assistance of suitably qualified contractors/consultants.

Under the IDMP, annual reporting will be prepared by the contractor incorporating the results of the monitoring undertaken during that year. This reporting will incorporate details of monitoring undertaken, results found and an interpretation of the results in relation to changes to dolphin populations and behaviour within the study area to identify any impacts from the project where practically able. This reporting will also identify any recommendations on likely causes/stressors to inshore dolphin populations as they may relate to observations, necessary management actions or requirement for any monitoring program modifications.

These annual monitoring reports will be considered by the CU Project team as part of the overall adaptive management of the project. The reports, including any project management responses, will also be presented to the POTL CU Project ITAC for review and consideration, particularly where there are monitoring results indicating areas of concern or population impacts. The ITAC will consider the results in the context of the project and evaluate the corrective actions proposed to be implemented. The ITAC advice will further contribute to any POTL revision of the relevant management controls and corrective actions to minimise impact on the inshore dolphin populations.

The identification of changes to dolphin populations and/or behaviour in these annual contractor reports and the ITAC considerations and advice on the results will be reported to the Department within 21 days. Where it is considered by the above review process that the impacts are caused by the action, POTL will report this residual significant impact to regulators in writing of that and how this residual impact will be offset in accordance with the approved Offset Management Strategy.

Where management controls are to be amended during the CU Project in response to these recommendations, the relevant Management Plans (CEMP, MEMP, DMP) will be updated to incorporate updated management arrangements into the on ground practices. The updating of the plans will occur immediately, or as part of the specified review schedule of the relevant plans depending on the significance of the management action modification. A record of changes made will be kept.

Outcomes from this monitoring program will be considered in annual reviews of the MEMP, CEMP and Dredge Management Plan (DMP) for the CU Project. Further to during project amendments, the outcomes of the inshore dolphin monitoring will inform the development of the CEMP, MEMP and DMP prior to commencement of the next stage of the action to manage and, as far as practicable, avoid adverse impacts to listed dolphin species.

In the event that the monitoring plan needs to be revised during implementation, then POTL will consult with the Department on the need for amendments and submit a revised plan for approval. Changes of a minor administrative nature will not require approval, in accordance with the EPBC Act approval conditions.

Copies of all report(s) will be kept on-site and will be available for regulatory inspection. If requested by the regulators, all survey data and information related to this Monitoring Plan will be submitted within 30 business days of the request, or within a timeframe agreed by the relevant regulator in writing.

In accordance with Condition 36 of the EPBC Act approval, POTL will notify the Department of publication of its annual compliance report. POTL will include in that report the findings and outcomes of implementing the Inshore Dolphin Monitoring Plan (including the implementation of the plan),the detection of changes to listed dolphin species behaviour and/or population and if residual significant impact from the action has occurred. If POTL, with advice from the ITAC, detects a residual significant impact from the action has occurred POTL will,

within 21 days of ITAC advice on the results, advise the Department in writing of the identification and how that residual impact will be offset in accordance with the approved OMS.

Any reviews of the IDMP will be conducted in accordance with the EPBC Act conditions of approval.

In support of improving understanding of the biology and demography of inshore dolphin species in the Townsville region, POTL will contribute the data collected as part of the IDMP to a centralised, accessible data repository with associated metadata at applicable times. This will contribute to Action 2.1 under the *CNRF*.

8 RECORDS

During construction activities in the marine environment, records relevant to this Inshore Dolphin Monitoring Plan will be maintained as objective evidence of compliance with environmental requirements. All records will be maintained according to POTL's Record Keeping Procedures and be kept for a minimum of five (5) years after the completion of the project or as required by the legislative conditions. All records will be retained electronically, including but not limited to:

- Induction and any specific environmental training records;
- IDMP establishment and implementation meeting agendas and minutes;
- ITAC meeting items relevant to Inshore Dolphin Monitoring and impact management;
- IDMP reviews and version control;
- Monitoring data, results and environmental reports.

Records will be made available to the regulators as requested.

9 CONTINUOUS IMPROVEMENT

This Monitoring plan is a "living document" which will undergo formal review annually during the construction phase. During delivery, review and amendment will occur as necessary via adaptive management actions to ensure the Program remains relevant and achieves the required program objectives, inclusive of identification and implementation of any new or changing environmental risks and mitigation actions (in accordance with Action 4.4 of the CNRF). Recommendations on improvements or amendments will be reported as part of the annual reporting process. This will align with the regular review of the performance of the IDMP as required under the EPBC Act approval conditions.

Changes to this Monitoring plan may be developed and implemented in consultation with relevant regulators and other stakeholders over time. All changes are to meet the requirements of the approval conditions and be approved by CU Project Management, before implementation.

Information from this Plan will be used to assist with improving the control measures in the MEMP and CEMP/ DMP where relevant and required.

As noted in section 7, an annual report on the IDMP will be produced that will identify the results found and an interpretation of the results in relation to changes to dolphin populations within the study area to identify any impacts from the project where practically able. This information will be reviewed and consider by POTL, in conjunction with the CU Project ITAC, to identify any recommendations on likely causes/stressors to inshore dolphin populations and necessary management actions to be implemented as a result of the survey outcomes.

Where the monitoring identifies the need for revised management actions (through trigger values or performance indicators), this IDMP and the associated management plans will be revised to incorporate the adaptive management arrangements. This may include the assessment of any monitoring program modifications.

As per Condition 38 of the EPBC Act Approval (EPBC 2011/5979), any changes to this Monitoring Plan, or any of the Management Plans as a result of the outcomes of the IDMP will be notified to the Department in accordance with the requirements of Condition 38.

Continuous improvement will also be achieved via the *Marine Environmental Management Plan,* to which this monitoring plan is a part of (Appendix F of MEMP). Consideration and review of improvements to the MEMP will be reflected within this Monitoring Plan.

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APPENDIX A

EPBC Act Approval Conditions pertaining to Inshore Dolphins

Ref	Cond. No.	Condition Requirement	Plan Reference	Demonstration of how the plan addresses the condition requirement
1	24	For the protection of listed dolphin species, the person taking the action must submit an Inshore Dolphin Monitoring Plan for the Minister's approval. The person taking the action must not commence the action unless the Minister has approved the Inshore Dolphin Monitoring Plan. The Inshore Dolphin Monitoring Plan must:	6.3	Section 6.3 covers "Finalisation & Approval of the IDMP" The action has not commenced given the final approval of the IDMP has not been provided.
2	24a	establish baseline information on the distribution, abundance and habitat use of listed dolphin species in areas of Cleveland Bay that may be directly or indirectly impacted by the action and adjacent non-impacted sites, before the commencement of the action;	4	Section 4 and Appendix B detail the Inshore Dolphin Monitoring Program including the completion of a baseline survey in 2019 to identify pre-construction information on inshore dolphins. The program includes impacted and adjacent non-impacted sites.
3	24b	establish a monitoring program to measure and detect changes to the population and behaviour of listed dolphin species throughout construction, pile driving operations and dredging activities for each stage of the action, and a sufficient period of time post construction (during operational activities) to identify any changes in population and behaviour of listed dolphin species as a result of the action. The monitoring program must be undertaken consistent with the Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins (Department of the Environment, 2015), or subsequent document;	4	Section 4 and Appendix B detail the Inshore Dolphin Monitoring Program and the specific parameters and information to be sourced from the monitoring program. This will include monitoring of dolphin population and behaviour, consistent with the Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins. The Program does however identify the limitations of the Monitoring Program to detect changes due to the small population effect.
4	24c	establish consistent and scientifically valid monitoring methodologies that allow for the monitoring of listed dolphin species in Cleveland Bay and appropriate nearby non-impacted control site(s), over sufficiently long-term timescales (throughout construction, pile driving operations and dredging activities for each stage of the action, and a sufficient period of time post construction (during operational activities)) to be	4	Section 4 and Appendix B detail the Inshore Dolphin Monitoring Program including the methodology for monitoring and estimating dolphin population statistics. The program includes impacted and adjacent non-impacted sites being Halifax Bay to the north and Bowling Green Bay to the south.

Ref	Cond. No.	Condition Requirement	Plan Reference	Demonstration of how the plan addresses the condition requirement
		able to determine trends, and to enable the identification of stressors with the potential to cause adverse impacts on listed dolphin species;		
5	24d	provide for the outcomes of monitoring to be incorporated into management plans required by this approval regularly, and at the completion of each stage of the action, to manage and, as far as practicable, avoid adverse impacts to listed dolphin species;	7	Section 7 establishes the annual reporting and review process for the outcomes of the monitoring, to ensure that all information relevant to the status of the dolphin populations and potential impacts are considered throughout the project.
6	24e	provide for the identification of residual adverse impacts to listed dolphin species in Cleveland Bay, in cases where impacts cannot be managed; and	4; 7	Section 4 and Appendix B detail the Inshore Dolphin Monitoring Program and the specific parameters and information to be sourced from the monitoring program to identify adverse impacts on the populations. The Program does however identify the limitations of the Monitoring Program to detect changes due to the small population effect, and the difficulty of identifying cause of any changes. Section 7 identifies the reporting of outcomes of the IDMP to Project staff, ITAC and the Department.
7	24f	include procedures for reporting to the Department the relevant findings and outcomes of monitoring, performance monitoring, and periodic reviews of the Inshore Dolphin Monitoring Plan, and the assessment of residual significant impacts on listed dolphin species.	7, 9	Section 7 identifies the reporting of outcomes of the IDMP to Project staff, ITAC and the Department.
8	25	The person taking the action must provide an opportunity for Indigenous people to comment on the management plans and strategies specified in this approval during their preparation. The person taking the action must provide to the Minister a copy of the outcomes of consultation with Indigenous people, and an explanation of how any comments have been addressed in the management plans and strategies.	6.1	Section 6.1 details the consultant phases undertaken with the local Traditional Owner Representatives. Outcomes of the consultation is to be provided to the Department.
9	31	Unless otherwise agreed in writing by the Minister, each plan or strategy specified in the conditions must be independently peer reviewed before submission to the Minister for approval.	6.2	Section 6.2 identifies the independent peer review undertaken, the review entity and the date the review was completed prior to submission of the plan to the Department.

Ref	Cond. No.	Condition Requirement	Plan Reference	Demonstration of how the plan addresses the condition requirement
10	32	The reviews undertaken for Condition 31 must include an analysis of the effectiveness of the avoidance and mitigation measures in meeting the outcomes, targets or management measures identified in the plan/s or strategies being reviewed.	6.2	Section 6.2 identifies the independent peer review undertaken, the review entity and the date the review was completed prior to submission of the plan to the Department.
11	33	Unless otherwise specified in these conditions or notified in writing by the Minister, the person taking the action must provide to the Minister a copy of all advice and recommendations made by the independent peer reviewer(s) with the plan or strategy, and an explanation of how the advice and recommendations will be implemented, or an explanation of why the person taking the action does not propose to implement certain recommendations.	6.2	Outcomes of the peer review is to be provided to the Department. This will include an explanation of how the advice and comments have been addressed, or the reasoning behind not actioning the comment.
12	35	The person taking the action must maintain accurate records substantiating all activities associated with, or relevant to, the conditions of approval, including measures taken to implement the management plans and strategy required by this approval, and make them available upon request to the Department. Such records may be subject to audit by the Department or an independent auditor in accordance with section 458 of the EPBC Act, or used to verify compliance with the conditions of approval. Note: Summaries of audits will be posted on the Department's website. The results of audits may also be publicised through the general media."	8	Section 8 identifies the records relevant to the IDMP that will be created and maintained, the Ports Record Management Procedure and confirming that records will be provided to the regulators on request.
13	36	Within three months of every 12 month anniversary of the commencement of the action, the person taking the action must publish a report on their website addressing compliance with each of the conditions of this approval, including implementation of any management plans as specified in the conditions. Documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of this approval must be provided to the Department at the same time as the compliance report is published.	7	Section 7 establishes the annual reporting and review process for the project and more specifically the IDMP.

Ref	Cond. No.	Condition Requirement	Plan Reference	Demonstration of how the plan addresses the condition requirement
14	38	The person taking the action may choose to revise a management plan approved by the Minister under Conditions 5, 10 and 12 without submitting it for approval under section 143A of the EPBC Act, if the taking of the action in accordance with the revised plan would not be likely to have a new or increased impact. If the person taking the action makes this choice they must:	9	Section 9 identifies the continuous improvement process associated with the project documentation including the IDMP. This includes identification of the need to notify the Department of any changes.
15	38a	notify the Department in writing that the approved plan has been revised and provide the Department with an electronic copy of the revised plan;	9	Section 9 identifies the need to notify the Department of any changes.
16	38b	implement the revised plan from the date that the plan or strategy is submitted to the Department; and	9	Section 9 identifies the continuous improvement process associated with the project documentation including the IDMP.
17	39	The person taking the action may revoke their choice under Condition 38 at any time by notice to the Department. If the person taking the action revokes the choice to implement a revised plan, without approval under section 143A of the Act, the plan approved by the Minister must be implemented.	9	Section 9 identifies the continuous improvement process associated with the project documentation including the IDMP.
18	40	Condition 38 does not apply if the revisions to the approved plan or strategy include changes to environmental offsets provided under the plan or strategy in relation to a matter protected by a controlling provision for the action, unless otherwise agreed in writing by the Minister. This does not otherwise limit the circumstances in which the taking of the action in accordance with a revised plan or strategy would, or would not, be likely to have new or increased impacts.	9	Section 9 identifies the continuous improvement process associated with the project documentation including the IDMP.
19	41	If the Minister gives a notice to the person taking the action that the Minister is satisfied that the taking of the action in accordance with the revised plan would be likely to have a new or increased impact, then: a. Condition 38 does not apply, or ceases to apply, in relation to the revised plan; and b. the person taking the action must implement the plan approved by the Minister.	9	Section 9 identifies the continuous improvement process associated with the project documentation including the IDMP. This includes identification of the need to notify the Department of any changes.

Ref	Cond. No.	Condition Requirement	Plan Reference	Demonstration of how the plan addresses the condition requirement
20	42	Conditions 38, 39, 40 and 41 are not intended to limit the operation of section 143A of the EPBC Act which allows the person taking the action to submit a revised plan to the Minister for approval.	9	Section 9 identifies the continuous improvement process associated with the project documentation including the IDMP. This includes identification of the need to notify the Department of any changes.
21	44	Unless otherwise agreed to in writing by the Minister, the person taking the action must publish all management plans, reports and strategies referred to in these conditions of approval on their website. Each management plan, report and strategy must be published on the website within 1 month of being approved by the Minister or being submitted under Condition 38a).	Document Approval (Pg 2)	The document approval section includes detailing of the date the IDMP was approved by the Department, and the date that it was published on the CU Project Website. The Plan has not been published given the final approval of the IDMP has not been provided.

APPENDIX B

Inshore Dolphin Monitoring Program – Detailed Methodology

Inshore Dolphin Monitoring Program for The Channel Capacity Upgrade Project of Port of Townsville

Report to the Port of Townsville Limited

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Introduction and Background

The Port of Townsville, located on Cleveland Bay, Townsville, North Queensland, is a vital component of Australia's transport network, supplying essential services to local communities and industry. Townsville Port is Northern Australia's largest container and automotive port and Australia's largest sugar, zinc, lead, copper and fertiliser port. Current trade through the Port is limited by the capacity of its access channel; which is not wide enough to accommodate ships larger than 238 metres in length and 32 metres wide. Only 5% of container ships servicing Australia today can fit into the Townsville Port. As larger vessels are used more frequently to achieve economies of scale in shipping, the Townsville port needs to be able to accommodate these vessels to be competitive in global markets. The Channel Capacity Upgrade Project (CCU Project) is Stage 1 of the Townsville Port Expansion project (PEP) and involves widening of the channels to cater for larger ships (Fig. 1 and Fig. 2). Construction works are estimated to take approximately 4.5 years. Based on the potential impact of construction activities on inshore dolphins listed as a Matter of National Environmental Significance under the EPBC Act, Port of Townsville Limited (POTL) has contracted Flinders University to develop and implement an Inshore Dolphin Monitoring Program (IDMP) to monitor the actual impacts of the CCU Project on the listed inshore dolphins, i.e. the Australian snubfin dolphin (*Orcaella heinsohni*) and Australian humpback dolphin (*Sousa sahulensis*).

The Australian snubfin dolphin (*Orcaella heinsohni*; hereafter snubfin dolphin) and the Australian humpback dolphin (*Sousa sahulensis;* hereafter humpback dolphin*)* are found throughout coastal waters of northern Australia [1,2]. They live in small populations of approximately 50-200 individuals, inhabit shallow inshore and estuarine waters, exhibit low genetic diversity, fine-scale genetic population structure and have relatively small home ranges [3-8]. These biological characteristics render these coastal dolphins vulnerable to anthropogenic threatening processes, including habitat degradation, fishery bycatch and vessel strike. As a result, both species are listed as 'Vulnerable' by the International Union for Conservation of Nature (IUCN) [9,10] as 'Near Threatened' in the Action Plan for Australian Mammals 2012 [11], and as Vulnerable in Queensland (Nature Conservation Act 1992). Furthermore, they are listed as a Matter of National Environmental Significance under the EPBC Act because of their status as migratory species and a cetacean.

Coastal waters off Townsville and adjacent waters, including Cleveland Bay and the Townsville Port Limits support important populations of the snubfin and humpback dolphin. Surveys by Dr. Parra in Cleveland Bay between 1999–2002 indicated less than 100 individuals of each dolphin species use the coastal waters of Cleveland Bay regularly from year to year [7]. These studies also showed that the areas most often used by snubfin and humpback dolphins were located close to river mouths (i.e. Bohle River and Ross River) and modified habitat such as dredged channels and breakwaters close to the Port of Townsville [12] (Fig. 3). The areas around the Ross River mouth and Port of Townsville are locally important for foraging snubfin and humpback dolphins, given the recurrent usage of the areas by feeding adults and calves of both species [12]. Recent surveys indicate that the populations are stable or slightly increasing in numbers, and that snubfin and humpback dolphins' main areas of use are still around the Townsville Port entrance and associated channel and near the river mouths and creeks further North West (Bohle and Black rivers and Bluewater Creek) [13].

The CCU Project land reclamation area is located within the dolphins' high use areas around the Ross River mouth and Port of Townsville. These areas were 16 km^2 in size for snubfin dolphins and 17 km^2 for humpback dolphins in 1999-2002 and encompass the proposed CCU Project land reclamation

site and widening area of the existing channel at harbour entrance (Fig. 3). The CCU Project at the Port of Townsville involves construction activities that can have potential effects on the distribution, habitat use, behaviour and population dynamics of Australian snubfin and humpback dolphins. Construction activities of concern include the capital dredging at the harbour entrance to widen the Platypus Channel, the construction of a ~62-hectare reclamation area adjacent to the port, and the pile driving operations associated with both of these construction activities.

Dredging, pile driving and land reclamation works can affect dolphin's communication systems, behaviour, habitat use and prey availability and can ultimately lead to displacement of animals from their natural habitat [14]. Noise emitted by dredges is predominantly below 1 kHz and is unlikely to mask the echolocation signals of delphinids or cause damage to their auditory systems, but it has the potential to affect their communication systems [15-17]. Underwater noise from pile-driving has the potential to mask echolocation sounds, cause behavioural disturbance, and can cause hearing damage or physiological injury at close ranges [18-22]. Land reclamation activities can reduce and fragment dolphin habitat and indirectly reduce the availability of dolphin prey through adverse effects on seawater quality and benthic and marine biota [8,23,24]. In addition, increased vessel traffic associated with dredging activities and construction works around ports have the potential to alter dolphin movement, behaviour and vocalisations [25-31]. Increases in suspended sediments, sedimentation, mobilisation of toxic compounds and alteration of substrate composition and dynamics associated with dredging activities can affect dolphins indirectly through changes to their prey [14,16].

Overall, effects from construction activities are likely to be species and location-specific, and vary depending on the intensity, equipment and mitigation measures taking place during construction activities. Thus, monitoring threatened dolphin species exposed to human disturbances is essential to determine 1) state of the species of concern prior to the disturbance, 2) population-level responses to disturbance, 3) recommendation of potential mitigation measures, and 4) raising public awareness about any potential issues.

To achieve the objectives of the IDMP requested in the scope of work we have assembled a multidisciplinary project team with proven expertise in inshore dolphins (especially humpback and snubfin dolphins) and extensive knowledge of the study area, capture-recapture methods, ecological modelling, and with proven track records of working together.

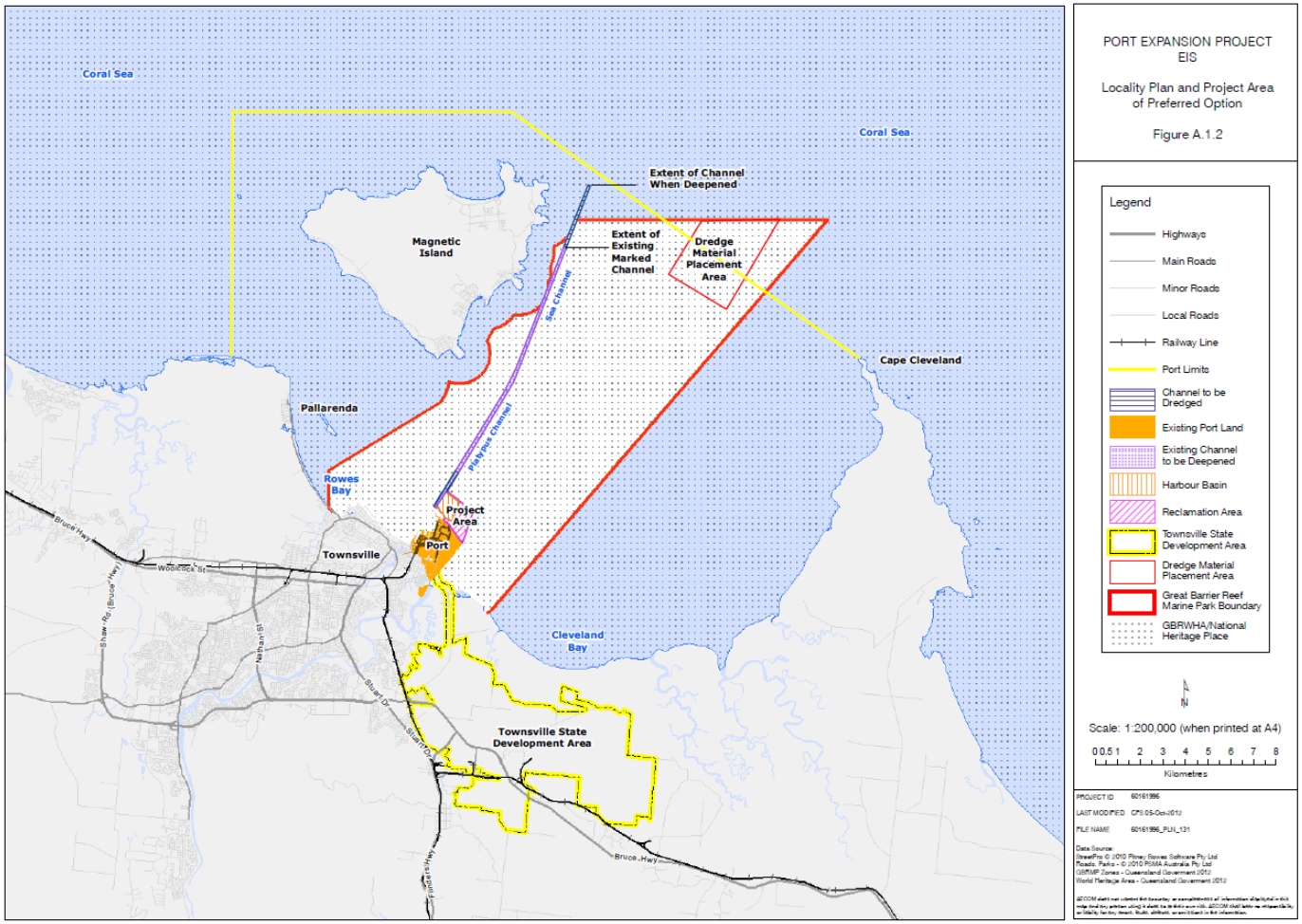


Figure 1. Map of Cleveland Bay indicating the Port Limits, CCU project land reclamation area and existing channel (Map from Port Expansion Project EIS, Part A Project Description).

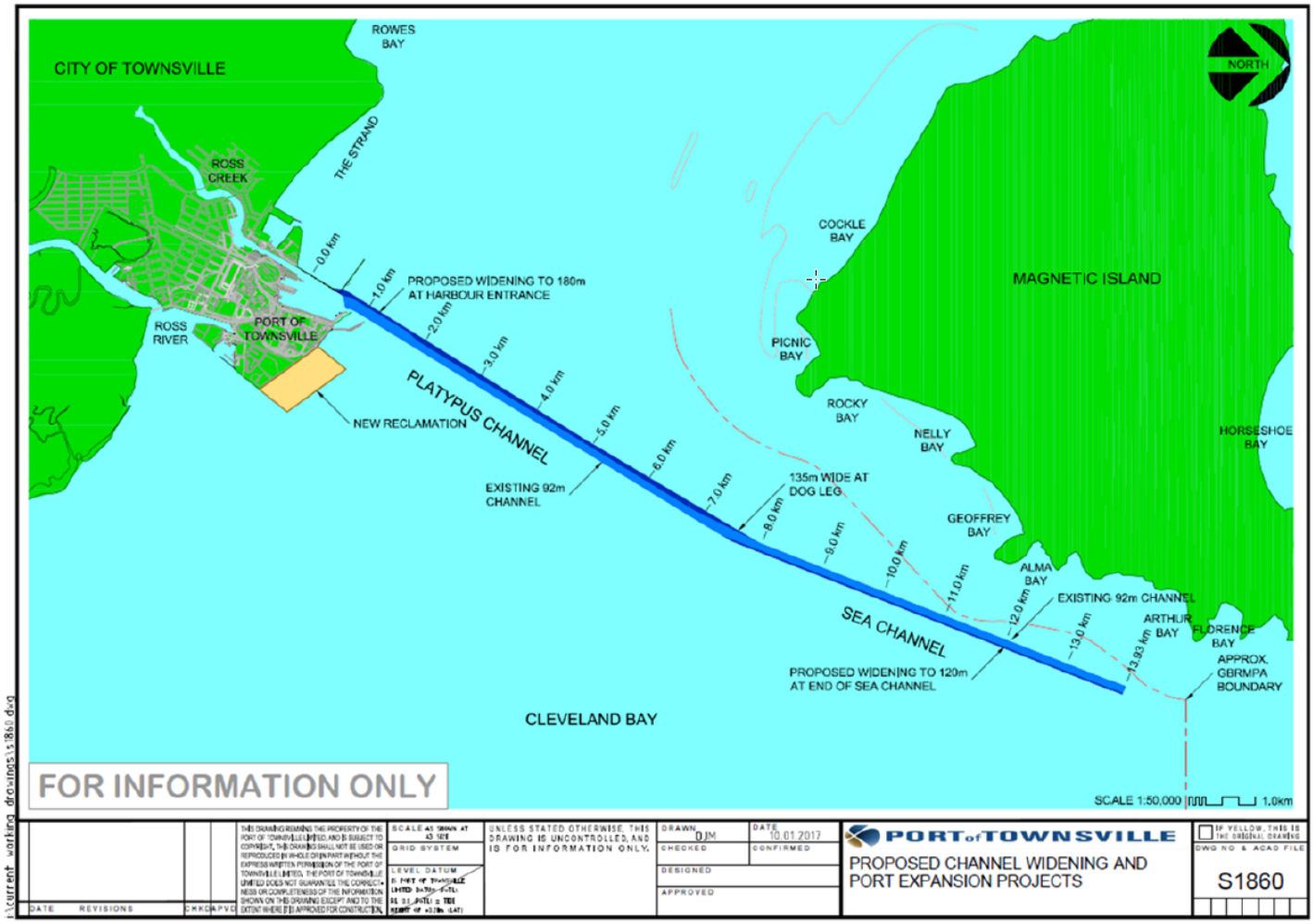


Figure 2. Site plan indicating the CCU project land reclamation area and proposed areas for widening of the existing channel (Map from Port Expansion Project EIS, Part A Project Description).

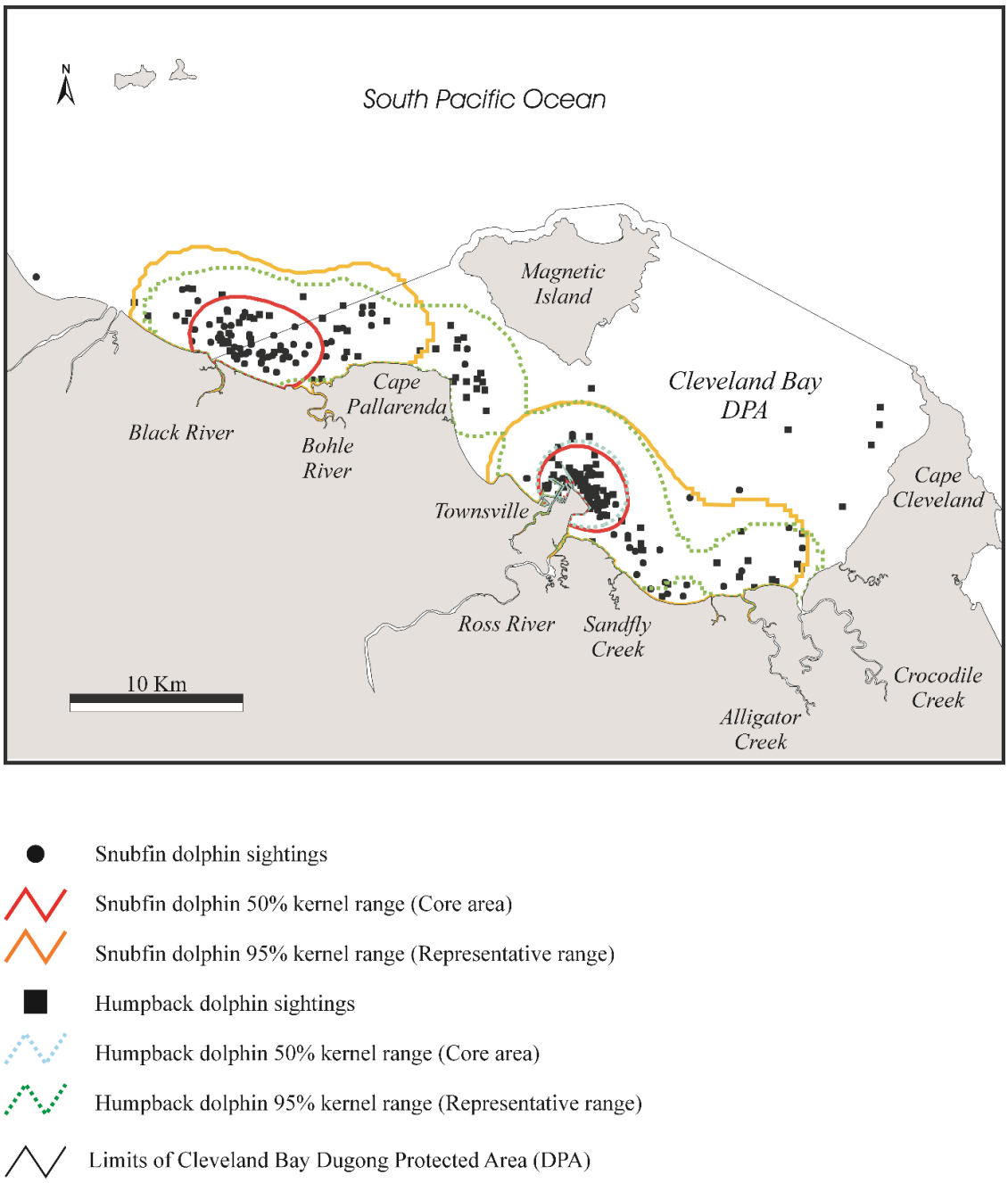


Figure 3. Core areas of use (50% kernel range) and representative ranges (95% kernel range) of Australian snubfin and humpback dolphins identified in Cleveland and Halifax Bays during surveys in 1999-2002 [12]. Core areas of both species within Cleveland Bay encompass the proposed CCU Project land reclamation site and proposed widening area of the existing channel at harbour entrance.

Suitability, Relevance, Track Record and Capacity of the Proponents

Dr. Guido J. Parra (Research Leader, Cetacean Ecology, Behaviour and Evolution Lab, CEBEL, Flinders University) has led ground-breaking research on a variety of aspects of dolphin ecology and behaviour. Since its establishment in 2010, CEBEL has grown into one of the leading and most productive groups of marine mammal research in Australia, with over 60 publications in peer-reviewed journals, and over US$1.5m in research funds. In recognition of his research leadership, Guido received the 2007 University of Queensland Early Career Research Award, the 2011 Flinders University Vice-Chancellor's Early Career Research Award, and in 2014, he was awarded the "100 Colombians" award by the Colombian Government, which recognises the entrepreneurship and success of Colombians, working overseas. His extensive research on the ecology of Australian snubfin and humpback dolphins has provided knowledge and tools to inform conservation and management priorities for these species. He led the initial development, and contributed to the final, coordinated national research framework and methods to inform the conservation and management of Australia's tropical inshore dolphins. He has been involved as a research partner in large collaborative efforts that has had close ties to industry including the development of dolphin monitoring programs for Gladstone Ports Corporation's Ecosystem Research and Monitoring Program, The Great Australian Bight (GAB) Research Program and the Spencer Gulf Ecosystem Development Initiative (SGEDI). He currently serves on the International Whaling Commission-Small Cetacean Scientific Committee and The IUCN Species Survival Commission-Cetacean Specialist Group.

Dr. Daniele Cagnazzi (Research fellow, Marine Ecology Research Centre, Southern Cross University) is recognized as one of the leading experts on Australian snubfin and humpback dolphins. Dr Cagnazzi has been working on Australian humpback and snubfin dolphin in Queensland since 2005. Most of his work has been focus in Central and North Queensland. Between 2014 and 2016, Dr. Cagnazzi led (in collaboration with Dr. Parra and Dr. Brooks) the dolphin monitoring program as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program. This project successfully assessed the conservation status of humpback and snubfin dolphin in the Ports of Gladstone (1400 km2) following a major development of existing port facilities. Completed and ongoing projects also include the use of biopsy samples for genetic, genomic and toxicological analysis. In all projects, Dr Cagnazzi applies protocols that are aligned with the best practice protocols developed by the national coastal dolphin network. Dr. Cagnazzi is a certify COXSWAIN grade 1, Medic First Aid an Oxygen provider. At present, Dr Cagnazzi leads a multiyear mark recapture project aimed at assessing the abundance and distribution of Australian humpback and snubfin dolphins in the Mackay, Whitsunday, and Bowen regions. This project was funded through the National Dolphin Conservation Plan of the Department of Environment and Energy and Great Barrier Reef Marine Park Authority.

Dr Robert Rankin is a population ecologist and Post-Doctoral Fellow at Georgetown University. He specializes in quantitative methods to study the life history and social structure of Australian dolphins, hierarchical Bayesian capture-recapture models, and network models. Prior to his academic career, he worked as data analyst for many government agencies and conservation organizations, such NOAA, where he developed large-scale sea-bird spatial species distribution models for risk-assessments, and Birds Studies Canada, where he ran the analyses of the Great Lakes Marsh Monitoring Programme.

Dr Lyndon Brooks (Adjunct Associate Professor, Southern Cross University) is an applied statistician with seventeen years' experience as methods advisor in the Division of Research at SCU. He has a special interest in marine mammal populations and is a member of the Marine Ecology Research Centre at SCU and the South Pacific Whale Research Consortium (SPWRC). He has published over 70 articles in refereed journals including marine mammal studies. Lyndon specialises in the design of research and statistical analysis and has presented five one-week workshops on capture-recapture models for wildlife populations with Professor Kenneth Pollock (NCSU). Lyndon developed the sampling and statistical methods guidelines for assessment of the conservation status of inshore dolphins in line with the Australian Inshore Dolphin Research Framework for the Australian Department of the Environment [32,33]. Lyndon was also a statistical advisor to the Darwin Dolphin Monitoring Program (2011-2015) initiated as part of the environmental approvals for the INPEX Ichthys Gas Field Development project. As part of this project, he developed the sampling design and conducted capture-recapture analysis of dolphin demographics and movements.

Dr Dave Paton (Managing Director, Blue Planet Marine) is an experienced Vessel Master, Project Manager, environmental trainer, HSE Manager, marine mammal, turtle and seabird biologist and ecologist with over 30-years' experience throughout Australia, the South Pacific, Southern Ocean (Antarctic waters), USA and Canada in marine and terrestrial protected area management, environmental planning and assessment, research and monitoring. He has expertise in managing large, multi-discipline projects. Complementing this experience, David also worked as the Occupational Health and Safety, and Health, Safety and Environment Officer for several organisations and is familiar with the relevant legislation, implementation and review of Health and Safety Issues in the work place. David recently was the HSE Manager for a large multi-discipline project with over 70 personnel in the field working on- and offshore. He leads Blue Plane Marine (BPM), a leading environmental science, research and consulting organisation providing expert services in the New Zealand, Australian, Asian, South Pacific and Antarctic marine environments. BPM help organisations understand and manage the impact of human activity on marine mammals and other marine megafauna. Dr Paton has number of charter/research vessels available to assist with marine monitoring programs. All vessels are in current Australian survey and are available as either a bare-boat charter or with an experienced and qualified crew.

Scope of Work and Specific Objectives

This contract is to undertake a monitoring program in association with the CCU stage of the overall Port Expansion Project. The objectives of this contract for the Inshore Dolphin Monitoring Program are to:

1. Objective One: Develop an Inshore Dolphin Monitoring Program consistent with the Coordinated National Research Framework to inform the Conservation and Management of Australia's Tropical Inshore Dolphins (Department of the Environment, 2015), or subsequent document; and that provides consistent and scientifically valid monitoring methodologies to be able to determine trends and identification of stressors with the potential to cause adverse impacts for these species. This program is to cover pre-, during and post-construction timescales as separate identified study stages and reporting deliverables.

2. Objective Two: Provide a baseline assessment on the distribution, abundance and habitat use of the Australian snubfin dolphin and Australian humpback dolphin species in areas of Cleveland Bay that may be directly or indirectly impacted by the CCU Project and adjacent non-impacted sites.

3. Objective Three: Monitor and report on changes, beyond natural spatial and temporal variation, to the population and behaviour of the Australian snubfin dolphin and Australian humpback dolphin species throughout construction, pile driving operations and dredging activities for the CCU Project, and a sufficient period of time post-construction to identify any changes in population and behaviour of the identified dolphin species as a result of the said activities.

4. Objective Four: Provide recommendations on key areas of adverse impact and potential mitigation measures, including the identification of residual adverse impacts in Cleveland Bay which cannot be managed.

5. Objective Five: Contribute to improving public awareness during the works on the inshore dolphin populations in Cleveland Bay.

The study design and analyses outlined below are fully aligned with the practice principles developed by the Coordinated National Research Framework to inform the Conservation and Management of Australia's Tropical Inshore Dolphins (Department of the Environment, 2015). Dr. Parra led the initial development of these practices and was closely involved together with Dr. Cagnazzi in the development of the final methodological recommendations led by Dr Lyndon Brooks.

Review of Component

An Inshore Dolphin Monitoring Program (IDMP) is required as part of the environmental approvals under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 for The Channel Capacity Upgrade Project (CCU Project) of Port of Townsville Limited (POTL) long-term Port Expansion Project (PEP) in Queensland. The aims of the IDMP are to establish baseline information and monitor and report on changes, beyond natural spatial and temporal variation, in the distribution, abundance, habitat use and behaviour of Australian snubfin dolphin (*Orcaella heinsohni*) and Australian humpback dolphin (*Sousa sahulensis*) in association with the CCU Project construction activities. The IDMP will be implemented over pre-, during and post-CCU Project construction activities.

Here we review the specific scope of this monitoring program including its rationale and requirements; methodology proposed; overall period and resources required for completion; potential problems that may arise and practical solutions; and provide recommendations for additional items we consider are required to fully meet the objectives and intent of the scope.

Rationale and requirements for an IDMP as part of the CCU Project of the Port of Townsville.

Coastal waters off Townsville and adjacent waters, including Cleveland Bay and the Townsville Port limits support populations of threatened Australian snubfin and humpback dolphins [7]. Previous studies by Dr. Parra's research group showed that, within Cleveland Bay, the areas most often used by snubfin and humpback dolphins are located close to Ross River mouth and modified habitat such as dredged channels and breakwaters close to the Port of Townsville [12]. These high use areas around the Ross River mouth and Port of Townsville encompass the proposed CCU Project development site and areas immediately surrounding it (see Fig. 3). The CCU Project at the Port of Townsville involves construction activities that can have potential effects on the distribution, habitat use, behaviour and population dynamics of Australian snubfin and humpback dolphins (see introduction section). Construction activities of concern include the capital dredging at the harbour entrance to widen the

Platypus Channel, the construction of a ~62-hectare reclamation area adjacent to the port, and the pile driving operations associated with both construction activities.

Overall, effects from construction activities are likely to be species and location-specific, and vary depending on the intensity, equipment and mitigation measures taking place during construction activities. Accordingly, the development of a snubfin and humpback dolphin-monitoring program is essential to determine: 1) state of the species of concern prior to the disturbance, 2) population-level responses to disturbance, 3) recommendation of potential mitigation measures, and 4) raising public awareness about any potential issues. We consider the objectives the IDMP as stated in the contract to be in line with Section 8 of the PEP Additional Environmental Impact Statement (AEIS) requirements. However, we note that monitoring and determining the impacts of human activities on marine mammals is challenging for a variety of reasons (see *Potential problems that may arise and practical solutions below*). Although we have considered these difficulties as much as possible in the proposed monitoring program, we note that separating "*changes, beyond natural spatial and temporal variation*" (Objective 3) requires robust ecological understanding of the population of interest and large datasets spanning over decades. The IDMP proposed here is likely only to detect catastrophic effects (e.g. large declines in population size), and it will be very difficult to separate construction impact effects (e.g. dredge related) from natural spatial and temporal changes in the environment (e.g. thermal stress). Thus, we suggest that this objective should be reworded to "Monitor and report on changes to the population and behaviour of the Australian snubfin and humpback dolphins in comparison to previous studies in the area and elsewhere, that could be linked to construction, pile driving operations and dredging activities for the CCU Project, including a sufficient period of time post-construction".

Summary of methodology proposed to address the scope of work objectives

The proposed Inshore Dolphin Monitoring Program methodology involves an integrated approach to address the scope of work objectives stated in the contract. This methodology includes:

1. A desktop assessment of existing data to establish baseline information on the distribution, abundance and habitat use of snubfin and humpback dolphins in Cleveland Bay.

The desktop assessment will synthesise existing published information (including "grey literature"), collate metadata from existing datasets and develop an annotated bibliography for the Townsville region including areas of Cleveland Bay that may be directly or indirectly impacted by the CCU Project and adjacent non-impacted sites. Information in this literature review will include a synthesis of existing information on the distribution, abundance, habitat use, behaviour, movement patterns and potential vulnerability of Australian snubfin and humpback dolphins to impacts from construction activities associated with the CCU Project.

2. A capture-recapture sampling design for long-term monitoring of dolphins' demographic parameters (i.e. abundance, survival, temporary emigration) and trends in Cleveland Bay and nearby non-impacted sites pre-, during and post-CCU Project construction activities,

Capture-recapture methods based on the capture histories of individuals identified by photographs of their dorsal fins from boat-based surveys are commonly used for estimating demographic parameters (i.e. abundance, survival, temporary emigration) of dolphin populations. Such methods have been used successfully to monitor populations of Australian snubfin and humpback of dolphins [5,7,8,32-34], and is the methodology recommended for long-term (multi-year) monitoring of inshore dolphins at key sites (impacted and non-impacted) by the Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins [35-37]. The major advantage of capture-recapture studies is that the resulting data can be used in the estimation, not only of abundance, but also of life history parameters (e.g., apparent survival, population

rate of change), home range, movement patterns, site fidelity, habitat use and social structure, which are all valuable information for species conservation assessments and tracking potential impacts from human activities. A statistically robust monitoring design has been developed which uses photo-identification, and multi-site Pollock's robust capture-recapture models to monitor abundance, survival, and movement patterns of snubfin and humpback dolphins in Cleveland Bay and in two adjacent sites of similar size (Halifax Bay and Bowling Green Bay). These sites are part of the home range of local snubfin and humpback dolphins, so monitoring of these three areas will allow us to monitor changes in abundance, survival and movement patterns of dolphins in relation construction activities and/or natural events.

We considered alternative monitoring methods such as manned and unmanned (e.g. drones) aerial surveys and passive acoustic monitoring devices but these were deemed inappropriate to achieve objectives of the IDMP for various reasons. Investigations into the feasibility of using passive acoustic monitoring for humpback and snubfin dolphins have shown that such techniques are limited to monitoring only the occurrence of vocally active animals and that discriminating correctly between species based on vocalizations alone is very challenging [38,39]. Aerial surveys provide mainly data on the density and/or abundance of populations using distance sampling, while boat-based surveys using capture-recapture methods estimate key population dynamics parameters in addition to abundance, including apparent survival, temporary emigration, population size rate of change, and movements between surveyed sites. Boat-based capture-recapture studies can also provide additional information on habitat use, behaviour, and movement patterns that are relevant for the IDMP. Manned aerial surveys also pose a substantial risk to marine mammal researchers over boat surveys, with at least 11 researchers dying due to aircraft accidents [40]. Furthermore, key requirements for aerial surveys of marine mammals involve flying at low altitude (500 feet usually) and at relatively slow airspeeds (90–100 knots) will be difficult to implement over coastal waters off Townsville. The Australia civil aviation authority regulations require that pilots fly no lower than 1000 feet over built-up areas along the coastline (i.e. most of the coastline of Cleveland Bay). In addition, most of the airspace around Townville is controlled airspace given it surrounds a civil and military aerodrome; to enter this airspace an aircraft must first gain clearance from air traffic controller and from the Civil Aviation Safety Authority. Use of a drone in and around the port and shipping channels will also require planning and approval of POTL and the regional Harbourmaster. These regulations will make it very difficult to use manned or unmanned aerial surveys to systematically survey most coastal waters of Cleveland Bay, in particular those around the Port of Townsville. Species identification from the air can also be problematic in the turbid waters snubfin and humpback dolphins occur.

3. Ecological modelling to assess trends in habitat use, changes in patterns of attendance to the area, and changes in dolphins' behavioural budgets.

We will use standard ecological modelling approaches to understand and assess trends in the distribution, habitat use and behaviour of dolphins over the duration of the CCU Project. In particular, we will use, kernel density methods and species distribution modelling techniques (SDMs) to estimate and compare snubfin and humpback dolphin distributions pre-, during and post-construction activities based on dolphins presence and correlations with environmental conditions at occurrence localities[41,42]. We will use land-based visual monitoring and multivariate regression techniques to assess the response of snubfin and humpback dolphins to dredging and pile driving activities by looking at their patterns of attendance to impact areas over consecutive years [14]. In addition, we will use Markov chain modelling for assessment of changes in behavioural budgets due to construction activities [43,44].

Overall period and resources required for implementation of the IDMP

The works including construction of the rock walls and capital dredging is estimated to take approximately 4.5 years. Thus, the IDMP is expected to be completed over a period of 5.5 years (including 12 months post-construction monitoring) to be able cover pre-, during and post-construction timescales and reporting deliverables.

The desktop baseline assessment on the distribution, abundance and habitat use of snubfin and humpback dolphin species in areas of Cleveland Bay that may be directly or indirectly impacted by the CCU Project and adjacent non-impacted sites should be completed within 1 month from being commissioned. Costs and resources needed are indicated in Tender's budget estimate and schedule.

Obtaining accurate and precise estimates of abundance and population trends of dolphins is usually difficult, expensive, and time consuming [45,46]. We ran simulations of capture-recapture monitoring using previous population data from Cleveland Bay and devised a sampling design that should facilitate the detection of changes in demographic parameters through the different stages of the CCU project. Based on these simulations and the need to consider adjacent non-impacted sites we propose a capture-recapture survey design involving surveys in similar sized areas in Cleveland Bay (i.e. the Townsville Port Limits area) and two adjacent sites in Halifax Bay and Bowling Green Bay (see Fig. 5). We consider that a sampling scheme with one primary sampling period per year composed of six secondary periods (a complete survey of each bay) at each of the three study sites represents the best trade-off between obtaining accurate yearly abundance estimates for each primary occasion, and survival and emigration probabilities between primary occasions, while minimising survey costs. To be able to estimate movements between sites under this sampling scheme, we need to align the sampling dates across the three bays (Cleveland, Halifax and Bowling Green Bays) as much as possible. Thus, the research plan is to use three boats to complete all six secondary periods as fast as possible at each bay before moving onto the next bay. We estimate these surveys will take us 40 days a year to complete (20 days of effort and 20 days to take into account down time for bad weather) in line with pre-, during and post-construction phases of the CCU project. This is assuming surveys will be conducted over our preferred timeframe, which is June-July (see survey timing section in page 20). If surveys are to be conducted at another time of the year, more down time (an extra 20 days) would need to be allocated to accommodate for bad weather and ensure that all secondary samples are completed and conducted under good sighting conditions.

The sampling design is in line with recommendations by the Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins (Department of the Environment, 2015). Supply and maintenance of all equipment and resources required for dolphin monitoring are provided in the Tender's budget schedule. All permits required for dolphin monitoring (i.e. Marine Park permits and Flinders University animal ethics) will be acquired prior to sampling.

Other than the resources stipulated in the budget we will need access to the following information and data from the POTL:

1) Timescales of the pre-, during and post-construction periods and construction activities conducted during these periods.
2) Spatial data regarding CCU Project development site and areas immediately surrounding it.

3) Sighing and associated data (location, time, species, group size, group composition, and behaviour) collected on inshore dolphins as part of the initial marine megafauna monitoring undertaken as part of the PEP Environmental Impact Statement (EIS) by GHD (GHD, 2012).
4) Water quality and habitat mapping that may be collected as part of the CCU Project.

Potential problems that may arise and practical solutions

Monitoring and determining the impacts of human activities on marine mammals is challenging for a variety of reasons. The biggest challenge is the lack of baseline data on the status of most populations before an impact takes place [35,47]. Moreover, given the restricted timelines of developers, weather dependency of surveying methods, the mobility of marine mammals, and their often-small populations make it difficult to design monitoring schemes to detect change with sufficiently high statistical power within practical timeframes [6,7]. Furthermore, given the complexity of ecological and environmental variability in marine ecosystems, separating the effects of human activities on coastal dolphins from natural ecological and environmental variability is difficult. In order to account for these difficulties as much as possible we have designed a best-in-class monitoring program involving practical solutions to these challenges, which are summarized in the following table:

Potential problem	**Practical solution**
Lack of baseline data	• Desktop assessment of existing data to establish baseline information on the distribution, abundance, habitat use and behaviour. • Obtain baseline information distribution, abundance, habitat use and behaviour of both species in impacted and non-impacted sites prior to construction activities to establishes pre-exposure measures and a point of reference to compare and evaluate changes over time
Restricted timelines of developers	• Appropriate and clear communication in advance by port authorities and survey team of the timescales of the pre-, during and post-construction periods.
Weather restrictions	• The timing of surveys will take into consideration researchers experience and historical weather data on rainfall and wind. The current preferred timeframe for the pre-, during and post-construction surveys is June-July, which is the best time of the year weatherwise for conducting dolphin surveys (low rain and low winds) and is also when the number of sightings of both species tends to peak in Cleveland Bay. • Weather will be monitored before and during survey periods to maximize on water survey time. • Contingency plans will be built into the survey design. • All flights and accommodation for survey will be booked based on flexible terms.
Mobility of marine mammals	• The study proposed is designed to distinguish movements between sites (Cleveland Bay and adjacent sites) and temporary emigration between primary samples from demographic changes in Cleveland Bay that otherwise might be attributed to other factors (i.e., decrease in survival).
Lack of power to detect trends	• The study design proposed offers the potential for assessing abundance estimates with a high level of precision (CV ~0.1). With such a precision detection of population changes shall be facilitated but is not guaranteed.
Complexity of ecological and	• The monitoring study has been designed to take into account known seasonal variability of dolphins in the area, and potential movements of

Potential problem	Practical solution
environmental variability	animals to adjacent sites. We aim to conduct the surveys at the same time of the year (June-July) throughout the CCU project to minimize the confounding effect of ecological and environmental variability. This will facilitate interpretation of the estimates and changes in relation to construction activities.
Delays in obtaining permits to conduct monitoring.	• Parra and Cagnazzi have extensive experience with permit applications procedures in Queensland minimising the risk associated with unsuccessful application or delays in permit assessment.

Project methodology

Objective One: Develop an Inshore Dolphin Monitoring Program consistent with the Coordinated National Research Framework to Inform the Conservation and Management of Australia's Tropical Inshore Dolphins (Department of the Environment, 2015).

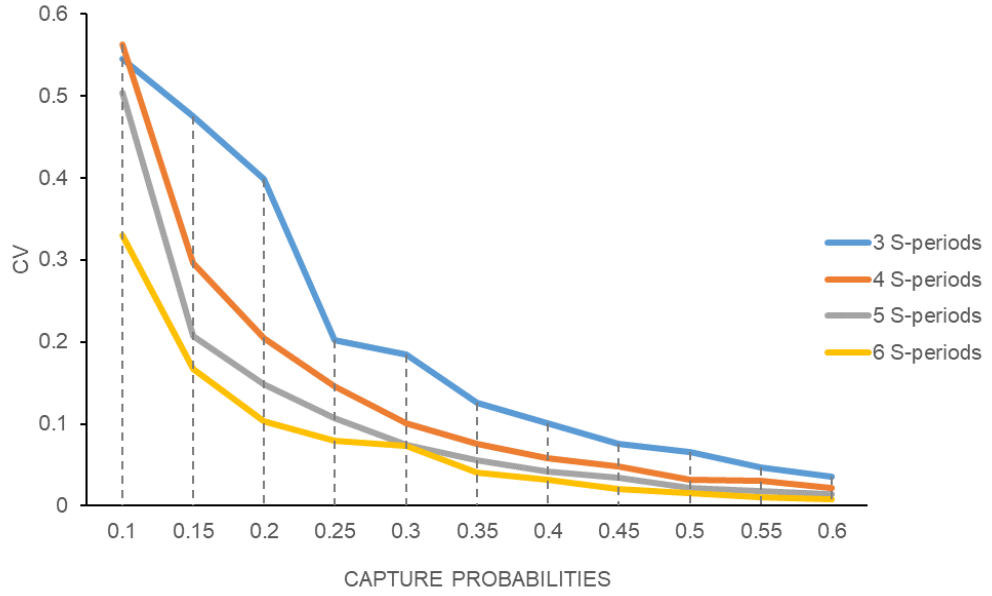
In order to monitor and assess the impact of construction activities associated with the CCU Project the proposed motoring program aims to employ: 1) a capture-recapture sampling design based on a multi-site closed robust design (MSCRD) to monitor dolphin demographic parameters (abundance, apparent survival, temporary emigration and movement) habitat use and behaviour across impacted (i.e. Cleveland Bay) and adjacent non-impacted sites (Halifax Bay and Bowling Green Bay) covering pre-, during and post-construction stages, and 2) visual land-based observations of dolphins around the Townsville Port area to record the presence and behaviour of dolphins in relation to the presence or absence of active dredging and or piling operations and vessel traffic.

Capture-recapture methods: considerations and survey effort

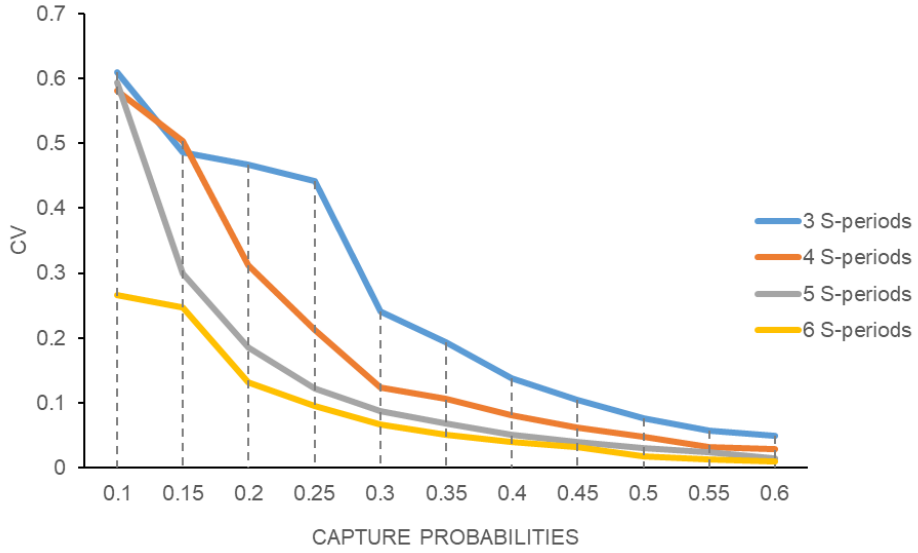
Accurate assessments of demographic parameters, such as population size, survival, recruitment and movement patterns, are integral components of the information needed to assess and manage human impacts on coastal dolphins. Studies of naturally-marked individual and capture-recapture models have been used successfully to estimate the population parameters of a wide number of dolphin taxa including snubfin and humpback dolphins [5-7,32-34]. Among the capture recapture sampling schemes and models available multi-site versions of Pollock's Closed Robust Design (CRD) [48-51] [52] presents several advantages over alternative models and has been recommended by the Coordinated National Research Framework for dolphin monitoring in sites where coastal development is expected [36,37]. Under the CRD, photographic 'captures' occur within a hierarchical sampling design, including: (1) primary periods (P-periods) between which the population is considered open to gains and losses, and (2) several secondary periods (i.e. a survey of the entire study site S-periods) per P-period, in which the population is assumed closed to demographic changes. Closed population models can be used to estimate capture probabilities and abundance within each P-period, while the open-population portion allows the accommodation of temporary emigration and apparent survival between P-periods [49,53]. The investigator team has successfully implemented CRD studies to monitor coastal dolphins including snubfin and humpback dolphins [5,33,54,55].

Obtaining accurate and precise estimates of abundance and population trends of dolphins is usually difficult, expensive, and time consuming [45,46]. The use of power analysis can help address questions regarding the ability of monitoring programs to detect trends and evaluating the performance of ongoing efforts [45,46]. In general, the probability of detecting upward or downward trends in abundance depends strongly on the number and precision of the samples [45]. For example, we have estimated that it will take 4 years to detect a 10% population change (with high statistical power), if annual abundance estimates of dolphins have a coefficient of variance (CV) of ~0.1, whereas with a CV of ~0.2 we would need about 8 years to detect the same trend [7]. Simulation studies have also shown that the overall capture probability of the sampled individuals (p), should be greater than 0.1 (10% of the population should be captured during any occasion) to obtain reliable abundance estimates [56]. Once a trend is detected, it is difficult to separate whether observed changes are attributable to the activities of a construction project or natural variation and/or animal movements given the mobility of dolphins and the complexity of ecological and environmental variability in marine ecosystems. Thus, the inclusion of adjacent non-impacted control sites (at least two) in monitoring programs are useful in helping to separate impacts from natural variation and movements [35,47]. The multistate version model of the CRD (MSCRD) can then be used to estimate abundance, apparent survival, and movements between sites and temporary emigration between primary samples [57].

Considering the above and data collected in previous studies in Cleveland Bay we ran a capture-recapture simulation in program MARK to estimate the amount of effort needed (number of secondary periods) under a Pollock's Closed Robust Design to obtain abundance estimates with a coefficient of variance (CV) of 0.1 under different capture probabilities. For these simulation we used the average abundance estimate of snubfin (N = 68) and humpback dolphins (N = 44) found in Cleveland Bay between 1999-2002 [7]. Based on these simulations we estimated that we would need to conduct sampling over 6 secondary sampling periods and have capture probabilities of ~0.2 (or higher) to obtain population estimates with a CV of 0.1-0.15 (Fig. 4). With capture probabilities greater than 0.3 the number of secondary sampling periods to obtain abundance estimates with a CV 0f 0.1 decreases. However, from analysis of mark recapture data in previous studies[5] and from nearby locations we know it is unlikely for capture-recapture studies to reach capture probabilities greater than 0.2 given the low population sizes of these species (Parra and Cagnazzi unpublished data). Thus, we consider, we need to conduct at least 6 secondary sampling periods per study site to reach abundance estimates with a CV of 0.1.



a) Snubfin dolphins



b) Humpback dolphins

Figure 4. Estimated coefficient of variance (CV) for a closed model abundance estimate with 3 to 6 secondary sampling periods (S) for Australian snubfin (N = 68) and humpback (N = 44) dolphins.

Therefore, based on these simulations and the need to consider adjacent non-impacted sites we propose a capture-recapture survey design based on the multisite extension of the CRD (MSCRD) to survey similar sized areas in Cleveland Bay (i.e. the Townsville Port Limits area) and two adjacent sites in Halifax Bay and Bowling Green Bay (Fig. 5). The survey area covers inshore and offshore areas across the three bays (including waters to the north of Magnetic Island), and past and recent areas identified as core areas within and Cleveland (Ross River mouth and Port of Townsville) and Halifax Bay (Mouths of the Bohle and Black rivers and Saunders Beach) [12,13]. The proposed survey design does not include all of Halifax and all of Bowling Green Bay. The northern area of Halifax Bay and southern area of Bowling Green Bay are large, more open and experience generally worse weather conditions than the sheltered Cleveland Bay. Further, due to logistic constraints relating to the locations of boat launch sites and accommodation for research team, in addition to extended survey time, we cannot cover these areas.

We consider that a sampling scheme with one primary sampling period per year composed of six secondary periods at each of the three study sites, represents the best trade-off between obtaining accurate yearly abundance estimates for each primary occasion, and apparent survival and emigration probabilities between primary occasions, while minimising survey costs. To be able to estimate movements between sites under a MSCRD model, which assumes that all sites were sampled simultaneously, we need to align the sampling dates across the three bays (Cleveland, Halifax and Bowling Green Bays) as much as possible. Thus, the research plan is to use three boats to complete all six secondary periods as fast as possible at each bay before moving onto the next bay (Table 1). Based on the vessel survey design described below we estimated it will take approximately 6.5 days to complete the six secondary periods needed per site for each primary period, totalling about 20 days to complete all secondary periods at all sites. To put this into perspective, using only a single boat it took us approximately 5 months (taking into account down time for bad weather) to complete four repeats of a much smaller area of Cleveland Bay and Halifax Bay [13].From the data collected in these surveys, we were not able to obtain abundance estimates with a CV of 0.1 for assessment of trends. Furthermore, we were not able to estimate movement between adjacent bays. With such data it would be impossible to discern if a decline in abundance at the impact site (Cleveland Bay) is a direct result of the CCU project activities or natural variation due to temporary movements away from core habitats.

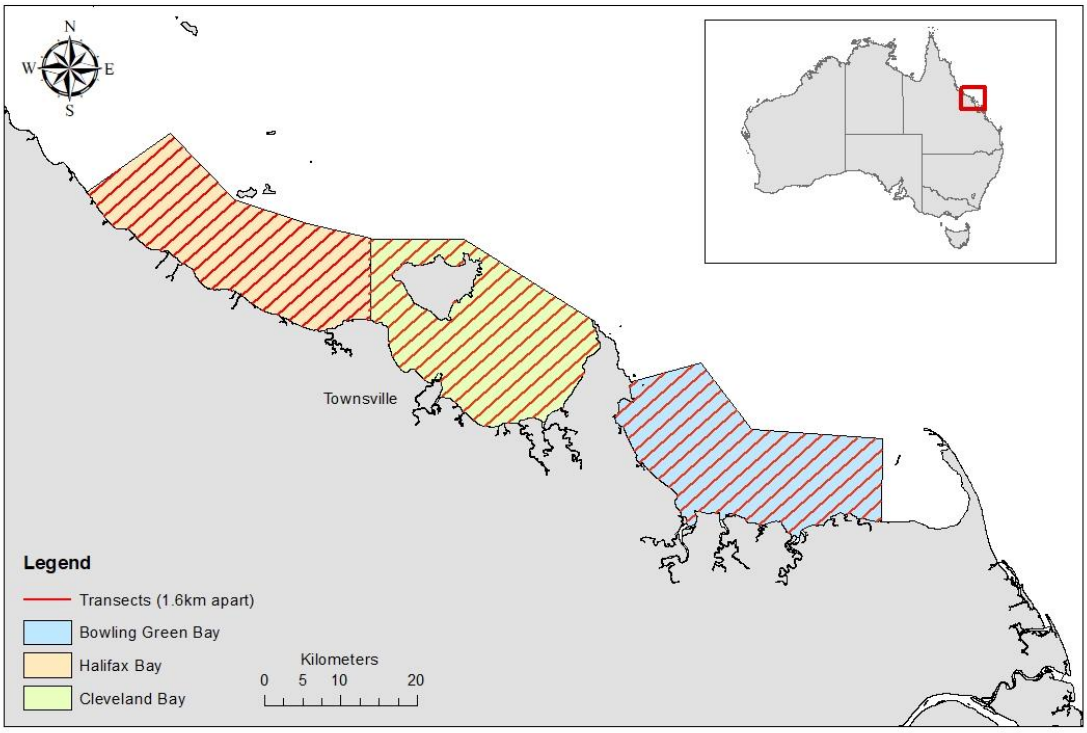


Figure 5. Map showing the proposed survey design to cover areas of similar size in Cleveland Bay (i.e. the Townsville Port Limits area) and two adjacent sites in Halifax Bay and Bowling Green Bay.

Table 1. Summary of survey areas, transect effort, coverage and estimates of time it will take to complete sampling per year.

Site	**No. Primary periods (year)**	**No. Secondary periods per primary period**	**Area (km^2)**	**Length of transect to be surveyed (km)**	**Percent Coverage %**	**Estimate No. of days to survey entire area once using three boats (7hrs/day at 12 km/hr)**	**Estimate No. of days to complete six secondary periods**
Cleveland Bay	1	6	422	275	49	1.1	6.5
Halifax Bay	1	6	422	275	49	1.1	6.5
Bowling Green Bay	1	6	422	275	49	1.1	6.5
TOTAL	3	18	1266	825	NA	3.8	19.5

Survey design and capture-recapture sampling methods

A 'good' capture-recapture survey design for marine mammals should guarantee a uniform and unbiased coverage of the study area. We used automated survey design algorithms [58] implemented in software program Distance [59] to design a systematic random line transect survey with regular line spacing (1.6 km apart and at 45º to the shore) within each of the three study areas (Figure 2). Systematic line spacing results in even spatial distribution of sampling effort, uniform coverage probability and better information on dolphin's spatial distribution and environmental variables than random designs [60,61]. Transect lines in offshore areas extend out to the Townsville Port limits. The total extent and the total transect length to be covered in each study area is shown in Table 1. At a boat speed of ~12 km/h, and, surveying for a maximum of 7 hours per boat per day (on effort time), we estimate it will take 1.1 days to cover each bay once, 6.5 days to complete all 6 secondary periods in each bay, and about 20 days to complete all secondary periods across all bays. Taking into account travel days and down days due to bad weather conditions, we estimate a maximum of 40 days needed to finish a primary period across all bays. We will use data collected during the first primary period to conduct further power analysis and refine sampling design if needed. Survey timing will be in line with construction phase activities to ensure sampling occurs across construction periods (pre-, during, and post-).

Sampling methods will follow standard procedures applied in capture-recapture studies of inshore dolphin studies [62,63]. Surveys across each study site will be conducted only in good sighting conditions (Beaufort Sea State ≤3 and no rain) between 07:00 and 18:00, depending on suitable conditions. A crew of three observers and a skipper will systematically search for dolphins forward of the vessel's beam with the naked eye and 7 x 50 binoculars. Once a group of dolphins is sighted, on-transect effort will be suspended and dolphins will be approached slowly (<5 knots) to within 5-10m to record GPS location, species identification, group size, group age composition (calf, juvenile, adult as defined by Parra, et al. [7]), predominant group behaviour [64] and to carry out photo-identification. Groups will be defined as dolphins with relatively close spatial cohesion (i.e. each member within 100 m of any other member) involved in similar (often the same) behavioural activities. Photographs of individual animals will be taken using digital SLR cameras fitted with telephoto zoom lenses. After all, or most individuals in the group are photographed or dolphins are lost, transect effort will resume at the location on the transect line where the dolphins were first sighted. Data on environmental variables (water depth, sea surface temperature, turbidity, salinity and chlorophyll *a* concentration) will be collected in situ at the location of every group of dolphins encountered, at set points along the transect line, and at the beginning and end of each transect leg.

Survey timing

Timing of the pre-construction survey will be in line with timeline of construction activities. The current preferred timeframe for the pre-, during and post-construction surveys is June-July, which is the best time of the year weatherwise for conducting dolphin surveys (low rain and low winds) and is also when the number of sightings of both species tends to peak in Cleveland Bay [65]. By conducting the surveys at the same time of the year (June-July) throughout the CCU project we will minimize the confounding effect of season and minimize the risks of not being able to complete the amount of sampling proposed due to bad weather. The latter would result in estimates of demographic parameters (abundance, apparent survival

emigration and movement), distribution patterns and behaviour with lower precision making the monitoring and detection of potential population changes more difficult throughout the CCU project.

If the construction activities are due to start earlier than June-July 2019, and there are no options for a later start, we will begin the pre-construction survey earlier in March/April 2019. This preconstruction baseline is critical for the monitoring program, but unfortunately imposes some challenges that require mitigation. By conducting the surveys in March/April we run into the risks of: 1) not being able to complete the amount of sampling proposed (six complete surveys of each bay: Cleveland, Halifax and Bowling Green) due to bad weather (i.e. March/April tend to be windier and rainier than June/July period) and 2) having a lower proportion of the small population available for sampling, as March and April are slightly before the peak of sightings of both species in June-July in Cleveland Bay. This will likely result in lower chances of us encountering the animals and estimates of demographic parameters (abundance, apparent survival emigration and movement), distribution patterns and behaviour with high uncertainty, thus hindering our ability to monitor and detect population changes throughout the CCU project. To lower the risks above, more down time (an extra 20 days) would need to be allocated to sampling in March/April to accommodate for bad weather and ensure that all secondary samples are completed and conducted under good sighting conditions. This also means that if we want to confidently estimate changes in population between pre-during, and post-construction, we will need to conduct the monitoring at the same time of the year (March/April) in during and post-construction stages to not confound comparisons due to potential effects of seasonal variability.

As conducting the surveys in March/April has the significant risks outlined above, the option of conducting a follow up survey in June-July during the first year (2019) would be very beneficial as it would give us:

- an assessment of the population at the onset of construction activities,
- another point of comparison with March-April baseline survey,
- a backup assessment of the population in 2019 in case sampling in March-April is compromised by bad weather,
- a point of comparison with follow-up surveys if, due to bad weather experienced during the first year, we decide to shift follow-up surveys to June-July period, and
- it would help us understand better the current seasonal variation in the dolphin populations (i.e., is there still a peak in animal sightings as observed in past surveys in 1999-2002?). The latter would help us make an informed decision about sampling in March-April or June-July in following years.

Once the two initial rounds of survey data are collected in the first year (March-April and June-July), we can do a preliminary analysis to determine whether there were major discrepancies between the two surveys (e.g., due to weather effects and seasonal population differences). At that time, we will determine the best time to conduct subsequent surveys for the during and post-construction phases and adapt the survey timing. We might find that there is little difference between March-April and June-July and combine the data into a 2019 sample and continue sampling in June-July in 2020-2023. If there is a strong difference that clearly indicates changes in dolphins' abundance and use of the study area, then we would need to

conduct the monitoring in March/April during following years to not confound comparisons due to potential effects of seasonal variability.

Model Assumptions

Robust Design capture-recapture models make several important assumptions. If these assumptions are violated the estimates can be biased downwards or upwards [52,66] . The assumptions, and how we intent to minimize their violation, are presented below:

1) Natural marks are distinct enough for individual identification without error:

To ensure correct identification of individual animals, we will used only excellent-good quality photographs of distinctive dorsal fins in our analysis [67].

2) Homogeneous capture probabilities between individuals within a sampling event i.e., no heterogeneity and no trap response:

Photo-identification is an instantaneous non-invasive technique where an individual is considered 'captured' in the first survey that is photo-identified and 'recaptured' whenever photo-identified in consecutive surveys. Therefore, the capture of an individual should not affect its subsequent recapture probability and we expect no trap response effect. Heterogeneity in capture probabilities can also be reduced by aiming to take photos of all the individuals present in a group regardless of the distinctiveness of their dorsal fins, and by following strict image selection and matching protocols [33,54]. Remaining heterogeneity can also be reduced by the inclusion of time-dependent covariates (e.g. year), and covariates associated with individual capture occasion (e.g. geographical location) in the modelling [52,66]

3) Survival probability is assumed to be the same for all animals in the population, regardless of availability for capture:

Dolphins' survival probabilities can vary by age class. We will reduce differences in survival among animals by using only adult animals in our analysis [5,54].

4) Sampling is instantaneous for secondary periods:
We aim to complete individual secondary samples over very short periods of time: 1-2-day period.
5) The population is assumed closed to additions and deletions (i.e. no births, deaths, permanent immigration or emigration) across all secondary sampling occasions within a primary sampling session:

We aim to complete a secondary occasion in the shortest possible time (i.e. on 1-2 days) and keep the duration of primary periods short (30-40 days) in relation to the life-span of dolphins (decades).

6) Captures are independent between individuals:

This assumption is always violated as dolphins occur mostly in social groups or localized populations. This assumption is always violated as dolphins occur mostly in social groups or localized populations. In practice, the grouping of captures and the violation of independence is best dealt with at the modelling stage, by examining goodness-of-fit statistics for clues about the severity of assumption-violations.

We will adjust for the potential resulting overdispersion by using the variance inflation factor [5].

7) In addition to the assumptions above, for the MSCRD there is also the assumptions that no transition between sites occurs within a primary period:

To minimize violation of this assumption we will run secondary periods at each site as close together as possible [5,68].

The monitoring study has been designed to take into account known seasonal variability of dolphins in the area, timing of planned construction activities, and potential movements of animals to adjacent sites. The occurrence of port development activities as well as any other major natural fluctuation (e.g. flooding) will be included into the demographic modelling process as covariates with values: for before, during, and post-construction. This will facilitate interpretation of any changes estimated in relation to construction activities. For example, the study design proposed should be able to distinguish movements between sites (Cleveland Bay and adjacent sites) and temporary emigration between primary samples from demographic changes in Cleveland Bay that otherwise might be attributed to other factors (i.e., decrease in survival).

Demographic analysis

Individual snubfin and humpback dolphins will be identified based on the unique natural marks on their dorsal fins [69,70]. All photographs taken during boat surveys will be examined and subject to a strict quality and distinctiveness grading protocol before matching and cataloguing to minimise misidentification [33]. Only high-quality photographs of distinctive individuals will be used in analyses. We will use DISCOVERY (version 1.2.) software to process, match, catalogue and manage all the photo-identification data [71].

Analysis of capture-recapture data under different multistate closed robust design models will be carried out in program MARK [72]. From these models we will estimate the following demographic parameters for both dolphin species at each site: 1) capture probability, abundance (number of animals in the study area), 2) apparent survival rate (probabilities of being alive and present in the sample site), 3) transition probability (the probability of moving from one site to another), and 4) temporary emigration (probability that an animal is absent from the total sampling area (all 3 sites) for the duration of a primary sample). Abundance estimates will be adjusted to take into account the proportion of individuals in the population that are unmarked. Model selection will be carried out using the Akaike Information Criterion [73]. For the capture-recapture modelling exercise, the primarily deliverable will be to detect whether a significant change has happened in abundance, apparent survival or movement. This will be determined through estimating the changes in survival and abundance and movement parameters and using Fisher p-values below 0.1 as a decision-rule to declare whether changes have been higher than statistical noise.

In addition, in the final years of the project when the most data has been collected, we will explore these capture-recapture models under a hierarchical Bayesian framework. This framework has proven to offer some advantages for handling some of the challenges with capture-recapture (random- effects, individual heterogeneity of detection probabilities, model uncertainty and multi-model inference) [55].

Species distribution modelling

Understanding species-environment relationships is at the core of identifying areas of biological importance and to prioritize areas for conservation, zoning design, impact assessment and resource

management decisions [74-76]. The spatial patterning of observed dolphins' groups will be studied with: 1) common spatial descriptive statistics (kernels density methods, clustering); and 2) if there are enough observations (>100 broadly distributed sightings) per primary period we will seek inference about the spatial drivers of dolphin occupancy and abundance using species distribution modelling approaches.

To estimate core areas of use (i.e. areas of intensive use) and representative ranges of snubfin and humpback dolphins, we will first convert all dolphin group sightings into an ArcMap spatial point coverage. Kernel density estimates will be then calculated using the 'kernel interpolation with barriers tool' available within the geostatistical analyst toolbox in ArcMap10.3.1 (ESRI). This analysis will enable us to estimate Kernel ranges of 50% (core area) and 95% (representative range) probability of occurrence for each primary period across the different study areas.

If we obtain enough observations (>100 broadly distributed sightings) per primary period; we aim to use species distribution models (SDM). SDMs provide a useful analytical framework to investigate the environmental and anthropogenic factors affecting species distribution and can help elucidate which areas constitute potential or priority habitat for a species and where potential conflicts with human activities may occur [77]. Since predictions of species distribution can vary greatly according to the employed modelling technique [78,79], we will model the presence-absence of snubfin and humpback dolphins in relation to explanatory variables using an ensemble modelling approach that combines a suite of species distribution models [80]. Ensemble modelling provides more robust estimates of species distributions because the combined model predictions yield higher accuracies and less bias than separate single models [79,80]. Ensemble modelling approaches have been used successfully by our research group in predicting inshore dolphin distribution (including humpback dolphins) in relation to a variety of environmental and anthropogenic variables [41,81,82].

The response variable used for species distribution modelling will be the presence−absence of dolphins (groups or single animals) which will be collected during the boat surveys. Explanatory variables that will be used to model dolphin distribution will consist of environmental (e.g. sea surface temperature, salinity, turbidity, water depth, distance to river mouth, benthic habitat type, chlorophyll *a* concentration) and anthropogenic variables (e.g. distance to port, distance to land, distance top dredge channel) known to affect the presence of dolphins and/or that of their prey. Explanatory variables will be derived from data collected in situ or from available spatial data-layers that have been mapped within the study area. A Geographic Information System (GIS) in ArcMap will be used to create spatial layers of all response and explanatory variables while taking into account survey effort. Before running models, correlations between continuous explanatory variables will be investigated using correlation coefficients and variance inflation factors [83].

Ensemble models of snubfin and humpback dolphin distribution will be constructed for the entire study area and for each of the CCU construction phases (pre-, during, and post-). Semi-parametric additive models, such as GAMs, and ensemble modelling techniques, such as Random Forest (RF) and gradient-based boosting (GBB), are known for high-accuracy predictive performance for SDMs. We will determine the most appropriate modelling technique for the SDMs based on the pattern of occupancy and abundance of dolphins. In our experience, the statistical distribution of occupancy and abundance will likely necessitate a particular type of "statistical error distribution" known as either a zero-inflated Poisson (ZIP) or a zero-

inflated density (e.g., Tweedie distribution), which will heavily influence our choice of modelling technique. Gradient-based boosting (R package mboost) will be most appropriate for data that conforms to a ZIP distribution, while a GAM-plus-model selection will be most suitable for Tweedie-distributed data. If the data appears non-zero-inflated, we can employ more modelling techniques (RF, GBB, GAMS) and build a robust ensemble [84,85]. To evaluate model's performance, prediction accuracy, and compare modelling methods, we will use the area under the curve values (AUC) of receiver operator characteristic (ROC) curves, and the AUC of the precision-recall curve (PRC).

To assess changes in species distribution and habitat use across the CCU construction phases (pre-, during, and post-) we will compare the predictive maps obtained for each period using the Structural Similarity (SSIM) index [86]. SSIM provides spatially explicit comparisons of the mean, variance, and spatial correlation between the spatial models obtained. This will allow us to detect if there are significant changes in space use between the different construction periods. For the SDM models, the primarily deliverable will be to detect whether a 'significant' change has happened in the spatial-patterning of occupancy and abundance. This will be determined through estimating SSIM indices between different P-periods and using Fisher p-values below 0.1 as a decision-rule to declare whether the changes have been higher than statistical noise.

Visual observations of presence and behaviour: sampling and data analysis

As part of the monitoring program we also propose to conduct visual land-based observations of dolphin presence/absence and behaviour around their high use areas around the Ross River mouth and Port of Townsville pre-, during and post-construction activities. This area coincides with the CCU project area for land reclamation and widening of the channel at the harbour entrance (see Figure 3). Visual observations at this site will help us to assess the response of dolphins to dredging and pile driving operations by looking at their patterns of attendance to the area over the CCU project duration [14]. Visual observations will be conducted from land (place to be determined with Port Authorities permission) by a team of three trained observers during good weather conditions (i.e. Beaufort sea state <3 and no rain). Each observer will carry one-three-hour shift per day (7:00-10:00, 10:00-13:00, 13:00-16:00) and conduct visual scan sampling of the area adjacent to the port every 10 minutes to record the presence of dolphins (including group size), number and type of boats traversing the area, and the presence or absence of CCCU construction activities. Once a group of dolphins is detected, two observers will conduct focal follows observations of the behavioural state of the dolphin group every 5 minutes using focal group scan sampling until animals are lost, out of sight or weather and/or daylight deteriorate. The behavioural state of each focal group will be determined using behavioural categories from previous studies [12] and determined by the activity of >50% of the group members [64]. These observations will be conducted over the same month periods the boat surveys will be running each year.

We will use Generalised Linear Models to model the day-level occurrence of the dolphins in coastal waters close to the port as a function of the proportion of scans during which dredging activity was recorded, the median, maximum and minimum number of non-dredging boats recorded per scan during each day, the median and maximum size of the dolphin groups, the median tide level and the mode tidal state (low, rising, high, and falling tide). Variance inflation factor will be used to detect multicollinearity in regression analysis. Model selection will be based on the Akaike Information Criteria.

In addition to the analysis above, we will use Markov chain models to assess the impact of construction activities on the behavioural state of snubfin and humpback dolphins. The assessment of changes in behaviour can provide information on the biological significance of an impact. Markov Chain Models present a powerful tool to analyse repeated discrete measurements over time (such as behaviour) and are often used when the focus is on establishing change and/or stability [44]. These models allow us to calculate transition probabilities from one behavioural state to another after a defined interval of time. We will use Markov Chain models to assess the difference in transition from one behavioural state to another, depending on the presence or absence of active dredging and pile driving operations during that sequence. We will construct contingency tables for both species representing the transition in behavioural sequences where no active dredging is recorded (i.e. control tables) and sequences where dredging is active (impact tables). These will then be compared to assess the effect of dredging activities on behavioural transitions for each species. As each transition is a proportion of the time that a succeeding behaviour was observed following a preceding behaviour, the effect of dredging activities on the behaviour-transition probability matrix can be statistically tested using a Z-test for proportions[87].

Objective Two: Provide a baseline assessment on the distribution, abundance and habitat use of the Australian snubfin dolphin and Australian humpback dolphin species in areas of Cleveland Bay that may be directly or indirectly impacted by the CCU Project and adjacent non-impacted sites.

To address this objective, we will: 1) conduct a desktop assessment to review all the available information collected previously on the distribution, abundance, habitat use and behaviour of snubfin and humpback dolphins in Cleveland Bay and adjacent areas and 2) conduct surveys prior to CCU construction activities, as part of the monitoring program developed above, to establish current baseline information on their distribution, abundance, habitat use and behaviour.

Review of current state of knowledge

The desktop assessment will synthesise existing published information (including "grey literature"), collate metadata from existing datasets including all available spatially referenced sighting data on snubfin and humpback dolphins from a variety of surveys conducted between 1985 and 2016 in Cleveland Bay and adjacent areas (Table 2), and develop an annotated bibliography for the Townsville region. Most of this data is already accessible and we are preparing a data sharing agreement for the data that are not (vessel surveys 2015-2016).

We will use the spatially referenced sighting data, population estimates, and behavioural data collected throughout these different sources to establish a baseline assessment of snubfin and humpback dolphin distribution, abundance, habitat use and behaviour in the region. Information in this literature review will outline the current state of knowledge about these species in the region, define important areas where aggregations of both species occur prior to this study; estimate the proportion of snubfin and humpback dolphin habitat potentially affected by the proposed CCU construction activities, and assess the level of concern in relation to different human pressures occurring in the area. Outputs will include an accessible and updatable bibliographic database of relevant literature on snubfin and humpback dolphin in

the Townsville region and beyond, and a spatial database of dolphin sightings and important dolphin areas in the region that can be used to identify data gaps, inform future sampling, and provide essential inputs to a spatial assessment of threatening activities.

Table 2. Summary of the aerial and vessel surveys conducted between 1985 and 2016 that covered the Townsville region and recorded Australian snubfin and humpback dolphins.

Year	Survey Platform	Study Area	Source
1985, 1986 ,1987, 1990, 1992, 1994, 1995	Aerial Surveys	Northern and Southern Great Barrier Reef	[87-90]
1996-1998	Aerial Surveys	Townsville-Cardwell region	[91]
1999-2002 2005-2007	Vessel Surveys	Cleveland Bay, Halifax Bay and Bowling Green Bay	[7] [92] (Parra unpublished data)
2010-2012	Aerial and Vessel Surveys	Cleveland Bay and Halifax Bay	[93]
2015-2016	Vessel Surveys	Cleveland Bay and Halifax Bay	[13]

Preconstruction assessment

As described above we will conduct the following surveys before CCU construction activities begin: 1) boat-based photo-identification surveys in Cleveland, Halifax and Bowling Green Bays and 2) land-based observations of dolphins around their high use areas around the Ross River mouth and Port of Townsville. We will analyse the data collected using methods described above. These assessments together with the desktop review of the current state of knowledge will establish a baseline on the current distribution, abundance, habitat use and behaviour of snubfin and humpback dolphins in the area prior to construction activities.

Objective Three: Monitor and report on changes, beyond natural spatial and temporal variation, to the population and behaviour of the Australian snubfin dolphin and Australian humpback dolphin species throughout construction, pile driving operations and dredging activities for the CCU Project, and a sufficient period of time post-construction to identify any changes in population and behaviour of the identified dolphin species as a result of the said activities.

The methods and analysis techniques described above will be used to monitor the distribution, abundance, habitat use and behaviour of snubfin and humpback dolphins pre-, during and post-CCU construction activities. By comparing demographic parameters and species distribution patterns across these three periods (pre-, during and post-construction) and across the three bays (Cleveland, Halifax, and Bowling green Bays) we will be able to report changes while taking into account natural spatial and temporal variation. Furthermore, by looking at the dolphin patterns of attendance and behaviour within the CCU project area for land reclamation and widening of the channel at the harbour entrance we will be able to assess the response of dolphins to CCU construction activities.

Objective Four: Provide recommendations on key areas of adverse impact and potential mitigation measures, including the identification of residual adverse impacts in Cleveland Bay which cannot be managed.

As part of the desktop assessment, we will examine the potential for adverse interactions between the proposed CCU construction activities and snubfin and humpback dolphins. Based on a literature review of the best available scientific data, gained in Australia and in other parts of the world, this desktop assessment will identify and describe: 1) the direct and indirect impacts to snubfin and humpback dolphins that may result from the construction and operational stages of the CCU project, 2) particular construction and operational elements of the CCU project that may affect snubfin and humpback dolphins,3) critical windows of environmental sensitivity for snubfin and humpback dolphins in the area that may be directly or indirectly impacted by the CCU project, 4) potential mitigation and management measures for the identified adverse impacts, and 5) residual adverse impacts.

Objective Five: Contribute to improving public awareness during the works on the inshore dolphin populations in Cleveland Bay.

Outreach and education are key parts of improving public awareness about inshore dolphin populations and their conservation challenges [94]. We will create and implement an appropriate communications strategy about the inshore dolphin populations in Cleveland Bay by working closely with stakeholders to maximise communication opportunities, including relevant government agencies (Port Authorities, Great Barrier Reef Marine Park Authority, Marine Parks) and ensure consistent delivery of messages. We will work closely with the Port Authority to develop an agreed media plan, especially in the event of the dolphins showing a flight response related to construction activities. Public forums will be

conducted in Townsville before the beginning of each field season to inform people about the dolphins and the monitoring activities. To alert the research community of our findings we will present our results at national and international conferences (e.g. Australian Marine Sciences Association, Society for Marine Mammalogy), and aim to publish our results in peer-reviewed scientific journals (e.g. Marine Mammal Science). To generate awareness and impact across a wider audience (e.g. school students, the general public, tourist industry) we will work closely with the Flinders Office of Communication and Engagement team to optimise media opportunities (e.g. press releases, articles in local newspapers), and develop promotional and educational materials (brochures, multimedia content, video and graphical abstracts, infographics) that could be disseminated through established social media platforms (e.g. Port authorities website and University website, Facebook).

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