Townsville Port Expansion
Channel Upgrade Project

Mechanical Backhoe
Dredge Management Plan

November 2023

Document Control Sheet

Revision history

Revision No.	Date	Changed by	Nature of amendment
0	17/09/2021	T Smith	Submitted version
1	11/05/2023	T Smith	Revised to align with current organisation structure and DIAT process review changes
2	29/11/2023	T Smith	Revised to incorporate Eastern Entrance Widening, and remove Diagonal Breakwater works from the plan and other minor amendments

Document approval

Approval of the DMP (R1) via condition 38 notification to DCCEEW occurred on 09 June 2023.

This version of the DMP (R1) was published on the CU Project's website on 09 June 2023.

This document has been prepared to meet the Commonwealth Government's EPBC Approval No. 2011/5979 Conditions, and the Queensland's Coordinator General's Evaluation Report Conditions (and subsequent state approvals) 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) David McLoughlin

Organisation (please print) **PORT OF TOWNSVILLE LIMITED**

Date 29 /11 / 2023

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ACRONYMS

ADCP	Acoustic Doppler Current Profiler
ADT	Articulated Dump Truck
AEIS	PEP Additional Information to the Environmental Impact Statement
AMSA	Australian Maritime Safety Authority
ANOVA	Analysis of Variance
AIMS	Australian Institute of Marine Science
ASS	Acid Sulphate Soil
ASSCMP	Acid Sulphate Soil and Contamination Management Plan
BHD	Backhoe Dredge
BOM	Bureau of Meteorology
BPAR	Benthic PAR
CCTV	Close Circuit Television
CU Project	Channel Upgrade Project
CDIT	Capital Dredging Implementation Team
CEMP	Construction Environmental Management Plan
CEO	Chief Executive Officer
CG	Queensland Coordinator-General
CGER	Coordinator-General's Evaluation Report on the PEP EIS
CHMP	Cultural Heritage Management Plan
CIO	Chief Infrastructure Officer
CMP	Coral Monitoring Program
CROC	Compliance Regulatory Oversight Committee
CSEP	Community and Stakeholder Engagement Plan
CSSPPP	Construction Ship-Sourced Pollution Prevention Plan
CTD	Conductivity Temperature Depth
CU	Channel Upgrade
CUSP	CU Seagrass Program
CVTMP	Construction Vessel Traffic Management Plan
DAF	Department of Agriculture and Fisheries
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water (formerly the Commonwealth Department of Agriculture, Water and Environment) or any other agency administering the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) from time to time

DES	Queensland Department of Environment and Science, or any other state agency regulating coastal developments and dredging from time to time
DFT	Dugong Feeding Trail
DIAT	Dredging Inference Assessment Team
DLI	Daily Light Integral
DMP	Dredge Management Plan
DVSP	Data Visualisation and Storage Platform
EA	Environmental Authority
EIS	PEP Environmental Impact Statement
EMS	Environmental Management System
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FHA	Fish Habitat Area
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
GPS	Global Positioning System
GUI	General User Interface
HSE	Health, Safety and Environment
IDW	Inverse Distance Weighted
IMO	International Maritime Organisation
IMP	Invasive Marine Pest
ITAC	Independent Technical Advisory Committee
JCU	James Cook University
LAT	Lowest Astronomical Tide
LMDMP	Long-term Maintenance Dredging Management Plan
LTSMP	Long-term Seagrass Monitoring Program
MEMP	Marine Environmental Management Plan
MNES	Matters of National Environmental Significance
MSDS	Material Safety Data Sheet
MSES	Matters of State Environmental Significance
MWMP	Marine Water Monitoring Program
NAGD	National Assessment Guidelines for Dredging
NATA	The National Association of Testing Authorities

NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NIMPIS	National Introduced Marine Pest Information System
NTU	Nephelometric Turbidity Unit
OEMP	Operations Environmental Management Plan
OMS	Offset Management Strategy
PAR	Photosynthetically Active Radiation
PASS	Potential Acid Sulphate Soils
PEP	Port Expansion Project
PIT	Point Intercept Transects
POLREP	Marine Pollution Report
The Port	The Port of Townsville (location)
QA/QC	Quality Assurance/Quality Control
REMP	Receiving Environment Monitoring Program
RHM	Regional Harbour Master
RTK-GPS	Real Time Kinematics GPS
SAP	Sediment Sampling and Analysis Plan
SARA	State Assessment and Referral Agency
SE	Standard Error
SOPEP	Shipboard Oil Pollution Emergency Plan
SPAM	Sediment Plume Associated Monitoring
TSHD	Trailer Suction Hopper Dredge
TSS	Total Suspended Solids
VHF	Very High Frequency Radio
VMP	Validation Monitoring Program
VTS	Vessel Traffic Service

1 Introduction

Port of Townsville Limited 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 (Figure 1). Townsville is a long-established township with a history of urbanisation and industrial activities in the Ross River and Ross Creek drainage system. Townsville Port 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 within the Great Barrier Reef World Heritage Area, and outside of the Great Barrier Reef Marine Park.

The Townsville Port Expansion Channel Upgrade Project (CU project) is Stage 1 of Port of Townsville's long-term Port Expansion Project (PEP). The PEP 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.

The Port has engaged Halls Contracting to undertake the CU project dredging using a mechanical dredge. See further Section 2.

Figure 1. Locality Plan of the Port of Townsville and Channel Upgrade Project

1.1 Conditions of Approval

Environmental assessment for the proposed PEP was undertaken in accordance with the Queensland *State Development and Public Works Organisation Act 1971* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), as it was considered the project may impact upon both Matters of State and National Environmental Significance (MSES and MNES), including:

- World Heritage properties
- National Heritage places
- Wetlands of international importance
- Listed threatened species and communities
- Listed migratory species
- Commonwealth marine areas
- Great Barrier Reef Marine Park

Following the environmental impact statement (EIS) process PEP was deemed an approved action under the EPBC Act (Federal) and a Coordinator General's Evaluation Report (CGER) issued (Queensland). A number of subsequent state approvals are required for each stage.

Table 1 provides the Permits and Approvals have been (or will be) obtained for PEP, and the CU Project before dredging commences.

Tables 2 and 3 provide a list of the Commonwealth EPBC Permit and Queensland CGER conditions relevant to this Dredge Management Plan (DMP).

Table 1. Port of Townsville PEP and CU Approvals

Regulator	Approval Type	Approval Number	Date Issued
PEP Approvals			
Commonwealth Department of Climate Change, Energy, the Environment and Water (formerly the Commonwealth Department of Agriculture, Water and Environment) (DCCEEW)	EPBC Controlled Activity Approval	2011/2979	5th February 2018
Queensland Government Coordinator-General (CG)	Coordinator General's Evaluation Report (on the Environmental Impact Statement for the Townsville Port Expansion Project)	N/A	September 2017
CU Approvals			
Port of Townsville and Queensland Government State Assessment and Referral Agency (SARA)	Operational Works – Tidal Works within a Coastal Management District (Project Rock Wall and Reclamation Works)	DA0190 1905-11091 SRA	25th June 2019;
Queensland Government (SARA) and Port of Townsville	Development Approval – MCU for ERA 16 and Operational Works – Tidal Works within a Coastal Management District (for the purpose of capital dredging) and Marine plant disturbance	2103-21775 SDA	25 June 2021
Queensland Government Department of Environment and Science (DES)	Environmental Authority (EA) capital dredging and placement activities	SDA EA0002890	11June 2021 Amended 7 November 2023
Queensland Government DES	Allocation of Quarry Material, for the purpose of placing capital dredge material within the reclamation area	APP0073541	16 July 2021 Amended 7 November 2023
Queensland Government SARA	Development Approval – Operational Works – Tidal Works for Diagonal Breakwater	2103-21834 SDA	25 June 2021
Queensland Government SARA	Development Approval – Operational Works – Tidal Works for Temporary Unloading Facility	03-21840 SRA 0197 POTL / CU	19 May 2021

Queensland Government SARA	Development Approval – Operational Works – Tidal Works for Partial Demolition of Eastern Breakwater	2306-35238 SRA 0208 POTL / CU	9 August 2023
Queensland Government SARA	Development Approval – Operational Works – Tidal Works for dredging of Eastern widening	2308-36219 SDA AM10	19 October 2023

The following tables are the conditions currently set by the Commonwealth and State Governments that are relevant to this DMP.

Table 2: EPBC 2011/5979 – Approval Conditions Relevant to the DMP

Cond. No.	Condition Requirement		DMP Section reference
5	The person taking the action must submit a Dredge Management Plan (DMP) for the Minister's approval to mitigate impacts to MNES from capital dredging before the commencement of dredging for each stage of the action (stages 1-3). The person taking the action must not commence dredging for that stage unless the Minister has approved the DMP for that stage of the action. The DMP must be prepared in accordance with the Department's Environmental Management Plan Guidelines and include at least the following:		
	5 a)	Clearly defined objectives and performance criteria to mitigate and manage potential impacts to MNES, including to: i. avoid or minimise disturbance to seagrasses and corals; ii. avoid or minimise impacts to marine fauna from dredge vessels; iii. avoid or minimise the uncontrolled release of dredged material into the marine environment; iv. avoid the release of potentially contaminated sediments into the marine environment; v. manage risks associated with extreme weather events; and vi. avoid vessel accidents and oil spills;	Section 4 for the DMP Section 11 for individual objectives and performance outcomes of each element
	5 b)	A schedule of dredging works associated with the relevant stage of the action	Section 3.2
	5 c)	Methodologies and results of the analyses undertaken of sediments to be dredged in accordance with Condition 2, including measures to manage potentially contaminated sediments, if identified, to prevent impacts to MNES	Section 12.1.5 Mitigation measures Section 11.1
	5 d)	Methodologies and results of the surveys and assessments undertaken in accordance with Conditions 3 and 4	Section 12.1.4 Seagrass footprint offsets survey Section 12.1.1 Marine Water, 12.1.2 Coral and 12.1.3 Seagrass baseline Methods and Results
	5 e)	Specific and auditable mitigation and management measures to avoid and minimise impacts to MNES taking account of the outcomes of surveys and assessments in Conditions 3 and 4, including: dredging techniques, dredging controls, performance indicators, real-time monitoring, early-warning	Section 11 – Risk elements & mitigation measures Section 12.2 Receiving Environment Monitoring Program (REMP) including

Cond. No.		Condition Requirement	DMP Section reference
		trigger levels, risk management, adaptive management strategies, corrective actions, and emergency response measures	Trigger Levels and response procedures. Appendix 2 – Summary table
	5 f)	Measures to avoid or minimise potential impacts to corals during coral spawning periods (usually between October to March);	Section 11.3 Risk element (see mitigation section)
	5 g)	Measures to minimise impacts to MNES from dredging activities, including from vessel strike, dredge entrapment, underwater noise, wastes generated from dredging operations, fuel and oil spill mitigation and response measures, invasive marine species, and artificial lighting;	Section 11 – for each individual Risk Element
	5 h)	A program to monitor water quality before, during and after dredging to validate risk assumptions, modelling results and predicted effects from TSHD and mechanical dredging activities. The validation monitoring must comprise: i. establishment of the pre-dredging baseline condition of the environment before the commencement of dredging; ii. surface and sub-surface monitoring of dredge plumes; iii. measures to monitor turbidity and suspended sediment concentrations at sensitive habitat sites, including seagrass and coral habitat; iv. measures to monitor the amount of fine sediment returned to the marine environment that was available for resuspension before commencement and the amount of fine sediment returned to the marine environment that was not available for resuspension before commencement; v. measures to monitor potential contaminants based on the results of sediment analyses undertaken in accordance with Condition 2; vi. quality assurance/quality control measures for validation monitoring; and vii. mechanisms for reviewing the outcomes of the validation monitoring against the objectives of the DMP, and modifying mitigation and management measures, if necessary, to avoid or minimise impacts to MNES;	Section 12.1.1 Marine Water Monitoring Program Section 12.2 Receiving Environment Monitoring program (REMP) Section 12.3 Validation monitoring Section 12.3.2 Fine sediment validation Section 12.1.5 – SAP Methods and Results

Cond. No.	Condition Requirement		DMP Section reference
	5 i)	An adaptive management program to monitor and manage impacts from dredge plumes associated with TSHD and mechanical dredging activities. The adaptive management program must comprise: i. scientifically peer-reviewed water quality trigger limits providing early-warning trigger levels, and trigger levels for modifying or ceasing dredging. The trigger levels must be ecologically relevant, and determined based on the assessment of the condition of seagrass and coral communities in areas likely to be affected by dredging as required by Condition 4, and suitable for preventing sub-lethal and lethal impacts to seagrasses and corals from dredging; ii. real-time monitoring measures including photosynthetic active radiation, turbidity and total suspended solids; iii. adaptive management measures, including measures to modify dredging activities or cease dredging to avoid or mitigate impacts to corals and seagrasses; iv. quality assurance/quality control measures; and v. procedures for reporting to the Department, in instances where trigger levels were exceeded and the adaptive management measures or corrective actions taken;	Section 12.2 Receiving Environment Monitoring program (REMP) (including Trigger levels for active management of the dredge and response procedures) Section 12.1.1 – Marine Water monitoring program methodology Appendix 2 – Summary table
	5 j)	A program to monitor the condition of seagrass and coral communities in areas likely to be affected by dredging. The monitoring program must be designed to: i. continue for a sufficient period of time after dredging ceases, to detect lethal or sub-lethal impacts on seagrasses or corals as a result of the action; and ii. delineate impacts as a result of the action from impacts due to maintenance dredging and/or extreme weather events, in a scientifically valid manner;	Section 12.1.2 Coral Monitoring Program Section 12.1.3 Seagrass monitoring program Section 12.3 Validation monitoring
	5 k)	Despite condition 31, the method for defining, delineating and quantifying the fine sediment returned to the marine environment as required by condition 26(b), must be reviewed by a suitably qualified independent expert. The suitably qualified independent expert must not have been involved in the development of the method mentioned in this condition (5(k));	Section 12.3 Validation monitoring section includes Fine sediment validation monitoring. (Methods detailed in Offset Management Strategy.
	5 l)	Contingency plans should undesirable or unforeseen impacts occur, including as a result of extreme weather events or any additional pressures that may impact MNES;	Section 13 – Contingency Plans

Cond. No.	Condition Requirement		DMP Section reference
			Section 11 – Risk Elements provide Risk level, mitigation measures, and corrective actions. Also Tables 11 and 12 provide an overview of the key activities and risks; and uncertainties around the DMP Success Appendix 2 – Summary Table
	5 m)	An outline of the involvement of scientific and technical experts in the development and review of the DMP, and procedures for the involvement of scientific and technical experts in the development of associated monitoring programs;	Section 5 (Tables 6, 7, 8 and 9) Roles and Responsibilities
	5 n)	Mechanisms for the regular review of the performance of the DMP in achieving its objectives and to support continuous improvement, taking into account the outcomes of monitoring programs required by Conditions 5(h), 5(i) and 5(j);	Section 14 DMP Audit and review
	5 o)	Procedures for reporting to the Department on outcomes of the monitoring programs required by Conditions 5(h), 5(i), 5(j), and 26(b), performance monitoring and periodic reviews of the DMP;	Section 11 – Reporting included in each Risk Element Section 12.2 REMP Section 14 – annual reports
	5 p)	Procedures for reporting actual lethal or sub-lethal impacts on sensitive habitat sites, including seagrasses and corals, to the Department;	Section 12.3 Validation Monitoring
	5 q)	Mechanisms for stakeholder consultation on the implementation of the DMP;	Section 14.4
	5 r)	An outline of the governance structure, including roles and responsibilities for implementing the DMP.	Section 5
6	The person taking the action must review the DMP at the conclusion of each stage of the action, and before the commencement of the next stage of the action. The person taking the action must seek the Minister's approval of the DMP in accordance with Condition 5.		Section 14.2

Cond. No.	Condition Requirement	DMP Section reference
Other Relevant Conditions		
2	The person taking the action must ensure that an analysis of the sediment to be dredged within the dredging footprint at Appendix A is undertaken to meet at least the standards in the NAGD, before the commencement of dredging associated with each stage of the action (stages 1-3).	
3	The person taking the action must ensure that field surveys of the dredge footprint in Appendix A and surrounding areas are likely to be affected by dredging, are undertaken before each stage of the action (stages 1-3) to determine the presence and density of seagrass within the footprint to be dredged and surrounding areas for the relevant stage.	
4	The person taking the action must undertake a baseline assessment of the condition of seagrass and coral communities in areas likely to be affected by dredging, before commencement of dredging for each stage of the action.	
7	The approved DMP for each stage of the action, or subsequent version of the DMP as provided for under Condition 38, must be implemented.	
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.	
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.	
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.	
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.	
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.	

Cond. No.	Condition Requirement	DMP Section reference
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: a) Notify the Department in writing that the approved plan has been revised and provide the Department with an electronic copy of the revised plan; b) implement the revised plan from the date that the plan or strategy is submitted to the Department; and c) For the life of this approval, maintain a record of the reasons the approval holder considers that taking the action in accordance with the revised plan would not likely to have a new or increased impact	
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.	
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.	
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.	
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.	
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 38 a).	

Table 3: CGER Conditions Relevant to the DMP

Cond. No.	Condition Requirement	DMP Section reference
G6	An appropriately qualified person(s) must monitor, record and interpret all indicators that are required to be monitored by this environmental authority and in the manner specified by this environmental authority and the Dredge Management Plan.	Section 5 – roles and responsibilities
G9	The dredging and dredged material placement activity must be undertaken in accordance with written procedures that: a) identify potential risks to the environment from the activity during routine operations, closure and an emergency; b) establish and maintain control measures that minimise the potential for environmental harm; c) ensure plant, equipment and measures are maintained in a proper and effective condition; d) ensure plant, equipment and measures are operated in a proper and effective manner e) ensure that staff are trained and aware of their obligations under the *Environmental Protection Act 1994*; f) ensure that reviews of environmental performance are undertaken at least annually.	Section 5 – Roles and Responsibilities Section 7 – Training Section 11 – Risk elements Section 14 – DMP Audit and review
G15	Where the zone of influence of a sediment plume generated by the activity encroaches upon a sensitive receptor, slightly disturbed or high ecological value waters, sediment plume-associated monitoring (SPAM) is to be undertaken. The SPAM requirement is continuous logging at concern sites and control sites during dredging, with a baseline collection phase (baseline-based assessment with control site-based checking)	Section 10.3 Dredge plume dispersion modelling Section 12.2 REMP (including SPAM and compliance sites for Trigger levels)
G16	Prior to the commencement of the new dredging activity, a Dredge Management Plan for the activity must be developed and implemented in consultation with the Technical Advisory Committee and the Dredge Management Plan must contain the following:	
	1. Clearly stated aims and objectives	Section 4
	2. Description of all dredging operations including: a) type of equipment to be used in dredging; b) volume of material to be removed, and duration and timing of the dredging campaign; c) methods to be utilised for transporting dredged material; d) dredged material disposal methods; e) dredged material disposal location;	Section 9 – Dredge Operation and Equipment Section 11 – Risk Elements

Cond. No.		Condition Requirement	DMP Section reference
		f) standard operating procedures including impact-reduction procedures; management of noise generated by the dredging.	
	3.	Maps or plans showing: a) legend, north arrow and scale; b) boundaries of dredging operation; c) estimated or modelled risk-based zones of influence and zones of impact of sediment plumes; d) location of the designated disposal site; e) location of sensitive receptors; all monitoring locations	Section 10.3 Dredge plume dispersion modelling (zone of influence & location of sensitive receptors Figure 24) Figure 4 – CU capital dredge footprint Figure 5 – reclamation / placement area Section 12.1 (monitoring programs and locations)
	4.	A detailed description of the sediment plume-associated monitoring program for both dredge types including: a) sampling regime and methods; b) sediment plume model validation; c) monitoring sites; d) the assessment methodology for the monitoring data; the assessment methodology used to develop trigger values that will define alert levels.	Section 12.2 REMP (inclusive of the SPAM)
	5.	Data handling and evaluation procedures that demonstrate how monitoring data will be tested against alert levels.	Section 12.2
	6.	A detailed description of the receiving environmental monitoring program (REMP) for water quality and sensitive receptor indicators including: a) the location of concern sites and control sites for monitoring purposes; b) sampling regime and methods; c) data handling and analytical procedures; d) the assessment methodology for the monitoring data that will include evaluation of: i. background water quality and sensitive receptor indicators at control sites and concern sites;	Section 12.2 REMP Section 12.3 Validation Monitoring

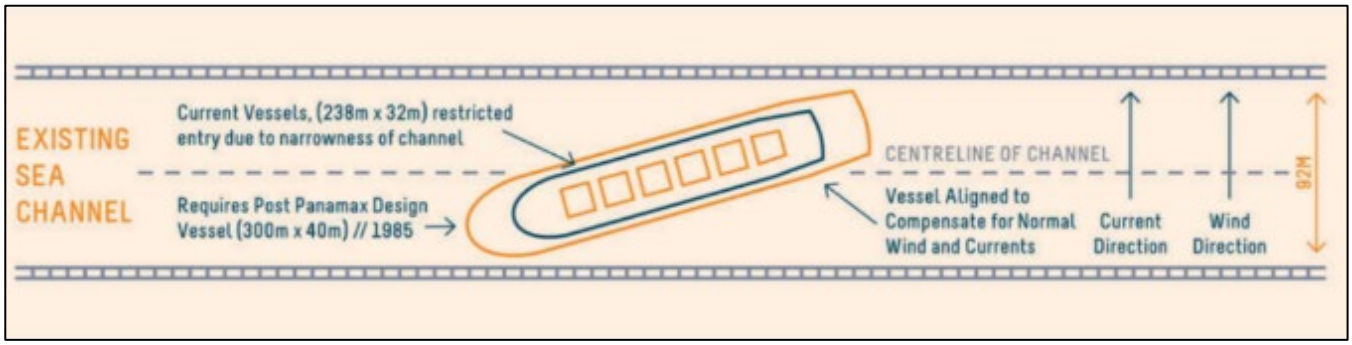
Cond. No.	Condition Requirement		DMP Section reference
		ii. the results of monitoring at concern sites compared against limits and background indicators; iii. the suitability of limits and triggers in this authority and the Dredge Management Plan to protect environmental values Water quality monitoring for the tailwater receiving environment based on risk identified in Condition WT3	
	7.	Management actions to be initiated if alert levels are exceeded.	Section 12.2 – Figures 57, 58, 59, 60
	8.	Details of the Technical Advisory Committee members and their respective roles.	Section 5 – roles & responsibilities (and on Port Website)
G19	A copy of the Dredge Management Plan must be submitted to the administering authority at least 40 business days prior to the commencement of the activity and, if necessary, amended in accordance with any comments made by the administering authority within 10 business days of the comments being received.		
G20	The Dredge Management Plan must not be implemented or amended in a way that contravenes or is inconsistent with any condition of this authority		
L1	The suitability of dredging material for land reclamation must be determined no more than five years before dredging is undertaken under a sediment sampling and analysis plan in accordance with the methodologies provided in the latest editions of the: a) National Assessment Guidelines for Dredging; b) Queensland Acid Sulfate Soil Technical Manual; c) National Environment Protection (Assessment of site Contamination) Measure.		Section 12.1.5
G22	A report validating the hydrodynamic modelling of the dredge plume detailed in the report Townsville Port Expansion Project Additional Information to the Environmental Impact assessment, Appendix A2 Townsville Port Expansion AEIS Hydrodynamic and Advection – Dispersion Modelling Technical Report, prepared by AECOM and BMT WBM, dated 30/03/2016, reference R.B21057.003.03.AEIS-Modelling.docx revision 3, must be submitted to the Technical Advisory Committee and the administering authority: a) within three (3) months of the commencement of mechanical dredging; b) within three (3) months of the commencement of TSHD dredging in the Platypus and Sea channels		Section 12.3 Validation Monitoring

2 Scope

The Port of Townsville has a single lane shipping channel, (comprised of the Platypus and Sea Channels), which is considered narrow by prescribed international standards. The width of a shipping channel needs to be significantly wider than the ship's width to ensure there is capacity on either side of the vessel to prevent it grounding on the channel edges (Figure 2). When a ship transits the channel, the steering of the ship is affected by several factors including: the channel configuration, vessel size, vessel speed, wind speed, tidal variations, and sea currents. Over the past 40 years, ship sizes have grown significantly and are continuing to increase as trade demand changes.

Townsville's shipping channels are not capable of meeting this growth, with the current width of access channel approximately half of that of other major ports within Australia. By widening a channel, longer and wider ships are able to safely transit in normal operating conditions. The Townsville channel upgrade design has been designed to accommodate this increase in ships sizes to enable an increase in length from the current 238 metres to up to 300 metres.

Figure 2. Channel width restriction for vessel size comparison



This DMP outlines the environmental management requirements relating to capital dredging and placement activities being undertaken as part of the CU project, by the Mechanical Backhoe Dredge (BHD) *Woomera* and other support vessels, some minor dredge activity may be undertaken with a smaller backhoe dredge.

This DMP is only one of a number of management plans which are implemented for the whole CU project for environmental management. These management plans (which are available on the Port's website) include: -

- *Construction Environmental Management Plan* (CEMP) which covers the construction and reclamation activities and associated environmental management requirements, controls and contingency plans for extreme weather events.
- *Marine Environmental Management Plan* (MEMP) which covers the environmental management requirements and controls for Matters of National Environmental Significance in relation to construction activities; and
- *Offset Management Strategy* (OMS) which covers the offset management strategy for the construction of the rock wall, dredge footprint, and fine sediment release during dredging.

Note: the Construction Vessel Traffic Management Plan (CVTMP) a project plan, however this is not a port plan as it is the responsibility of the dredging contractor who has established a CVTMP in consultation with the Port and the Regional Harbour Master. The contractor's CVTMP addresses the navigational safety and environmental requirements for dredging and related vessels during the dredging program.

Table 4 provides the list of all the management and monitoring plans associated with the three different phases of the CU Project. Figure 3 provide an overview of how the management plans align to CU Project Activities. As shown in this figure, the various plans work together to cover different elements of the CU Project. Importantly, the scope of the DMP ends at unloading of material, with reclamation and tailwater management activities managed under the CEMP.

This DMP has been developed in line with the Commonwealth's *Environmental Management Plan Guidelines*, the requirements stated within *EPBC Approval No. 2011/5979* permit Conditions; as well as the requirements stated within the Queensland CGER Conditions (as listed in Table 2 and 3 above).

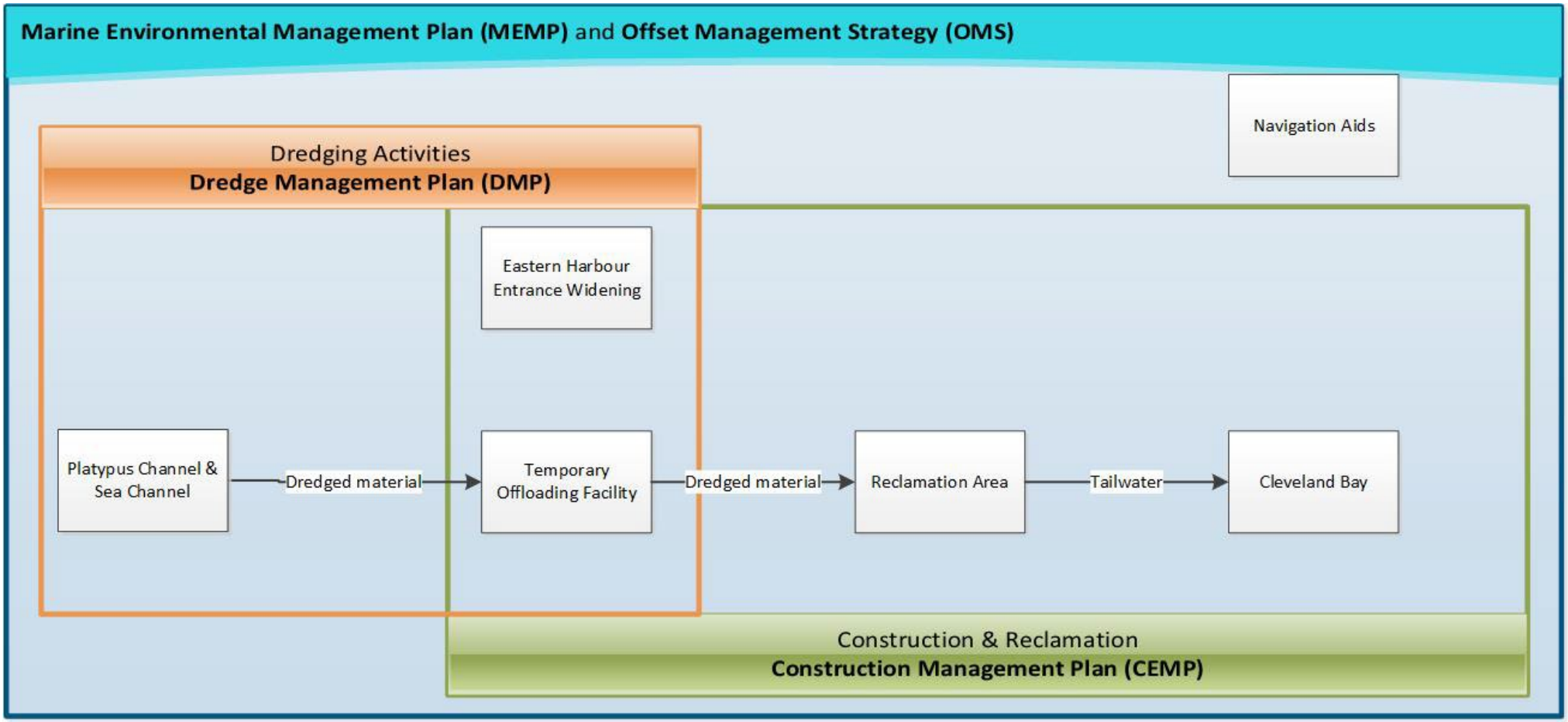
This DMP only applies to capital dredging for the CU project, it does not apply to Port maintenance dredging and placement related activities. Maintenance activities are addressed through the Port's *Long-Term Maintenance Dredge Management Plan* (LTMDMP) and as part of the Port's existing operational approvals and management controls.

Table 4. Phases of the CU Project and associated Management Plans

Phase	Management Plan	Description of Content
Rockwall	Offset Management Strategy (APPROVED)	Outlines the offset management strategy for the construction of the rockwall
	Construction Environmental Management Plan (**CEMP**) (APPROVED)	Outlines the overview of the construction activities for the rockwall construction and associated environmental management requirements and contingency plans for extreme weather events
	Marine Environmental Management Plan (**MEMP**) (APPROVED)	Outlines the environmental management requirements for MNES from activities in the marine environment
	Construction Vessel Traffic Management Plan (**CVTMP**), incorporating the Construction Ship-Sourced Pollution Prevention Plan (**CSSPPP**) (APPROVED)	Outlines the navigational safety and environmental requirements for all vessels during the construction activities Outlines the environmental requirements to prevent pollution from vessels during the construction activities
	Inshore Dolphin Monitoring Plan (APPROVED)	Outlines the monitoring program for the inshore dolphins
Capital Dredging and Reclamation	Updated Offset Management Strategy (APPROVED)	Outlines the offset management strategy for the capital dredging
	Updated Construction Environmental Management Plan (**CEMP**) (APPROVED)	Outlines the overview of construction and reclamation activities for the rockwall, Diagonal Breakwater and temporary unloading facility construction and associated environmental management requirements and contingency plans for extreme weather events
	Dredge Management Plan (**DMP**)	Outlines the overview of the capital dredging activities and associated environmental management requirements and contingency plans for extreme weather events

Phase	Management Plan	Description of Content
	Updated Marine Environmental Management Plan (**MEMP**) (APPROVED)	Outlines the environmental management requirements for MNES in relation to the capital dredging activities
	Inshore Dolphin Monitoring Plan (APPROVED)	Outlines the monitoring program for the inshore dolphins
Operations	Operations Environmental Management Plan (**OEMP**)	Outlines the environmental requirements for operational activities associated with the expanded future outer harbour operations (to be completed)

Figure 3. Management Plan structure in relation to each CU Activity.



3 Project description

The CU project involves (Figure 4): -

- Rockwall construction forming a 62ha reclamation area for the beneficial re-use of all capital dredge material generated from the channel widening works;
- Installation and operation of a temporary unloading facility to allow transfer of dredged material from the dredge barges to the reclamation area;
- Capital dredging to widen the Platypus Channel on its western side from 92 metres wide to 180 metres for the main section of the channel and 248 metres at the outer harbour, tapering down to 135 metres at the seaward end;
- Capital dredging to widen the Sea Channel on its eastern side from 92 metres wide to 120 metres along its entire length;
- Realignment of the Inner Harbour Entrance, including realignment of an existing breakwater, to cater for the Platypus Channel widening at the Inner Harbour entrance; and
- Realigning the channel navigation beacons with the new configuration widths of the Platypus and Sea Channels.

The capital dredging, construction activities and infrastructure developed for the CU project will be wholly within the existing port limits, with the designated water areas in which navigation sits under the control of the Regional Harbour Master (RHM). The land-based construction activities will occur in/on the new reclamation area: Lot 794 on SP308904, which will become the northern extent of the East Port Area (Lot 791 on EP2348) (Figure 5).

The full capital dredge campaign to widen the two channels, removing approximately 3.9 million cubic meters of material by mechanical backhoe dredge is expected to take approximately 2 – 2.5 years. All dredging will be kept within the approved depths and batters as detailed in the AEIS, and approved by both Queensland State and Commonwealth Approvals (-13.6 LAT and 1:4 Batters). Target navigational design depths for this stage of works is -12.5 LAT and 1:2 batters (all works need to be undertaken as per state approvals). Figures 6 to 9 provide the typical cross section the dredge footprint of the channels. Dredging is intended to be undertaken by mechanical BHD only.

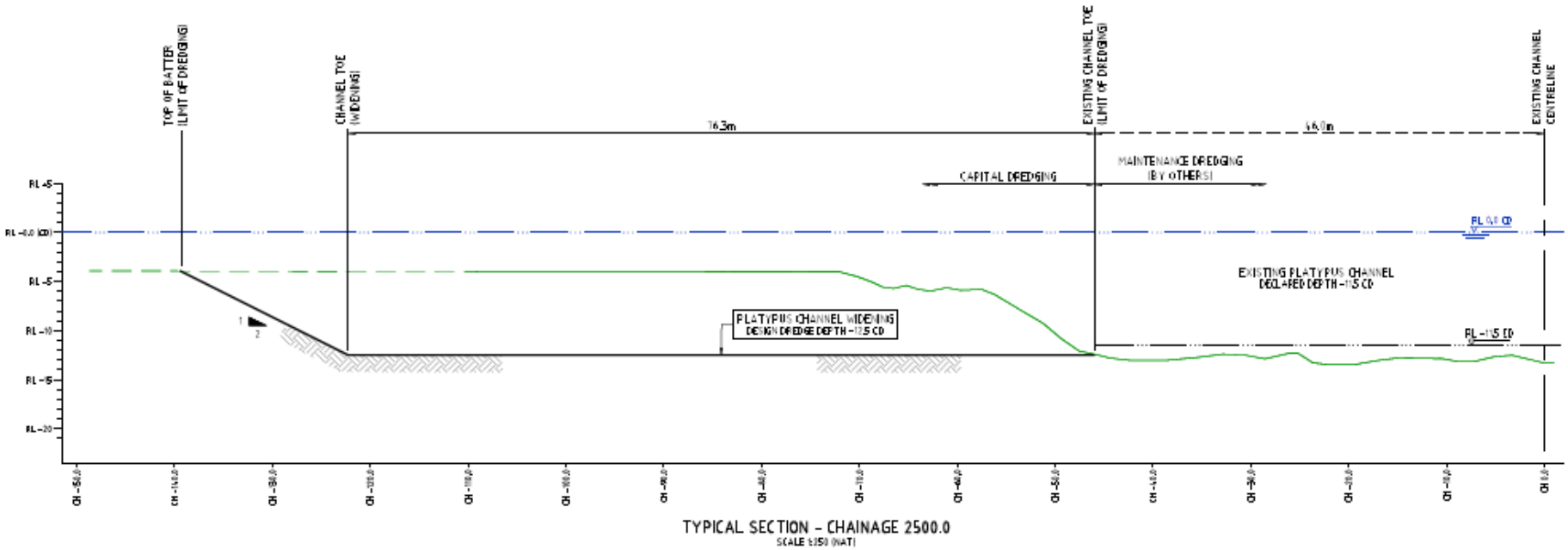
All dredge material from the capital dredging works will be placed in the new reclamation area (Lot 794 on SP308904). Dewatering and ground improvement of placed sediments within this area will be undertaken as works progress. A Temporary Unloading Facility (TUF) is required to facilitate the transfer of dredge material from the dredge barges and into the placement area; Figure 10 provides the constructed TUF structures and dredge area.

To fully maximise the capital dredge area at the entrance to the Inner Harbour and to cater for longer ships, the harbour entrance will be widened on the eastern side of Platypus Channel with the Eastern Breakwater shortened to open the entrance up wider Figure 11 provides the design for the Eastern Breakwater construction and dredge footprint.

Figure 4. Site Plan for CU Project Capital Dredging Activities – Platypus & Sea Channels

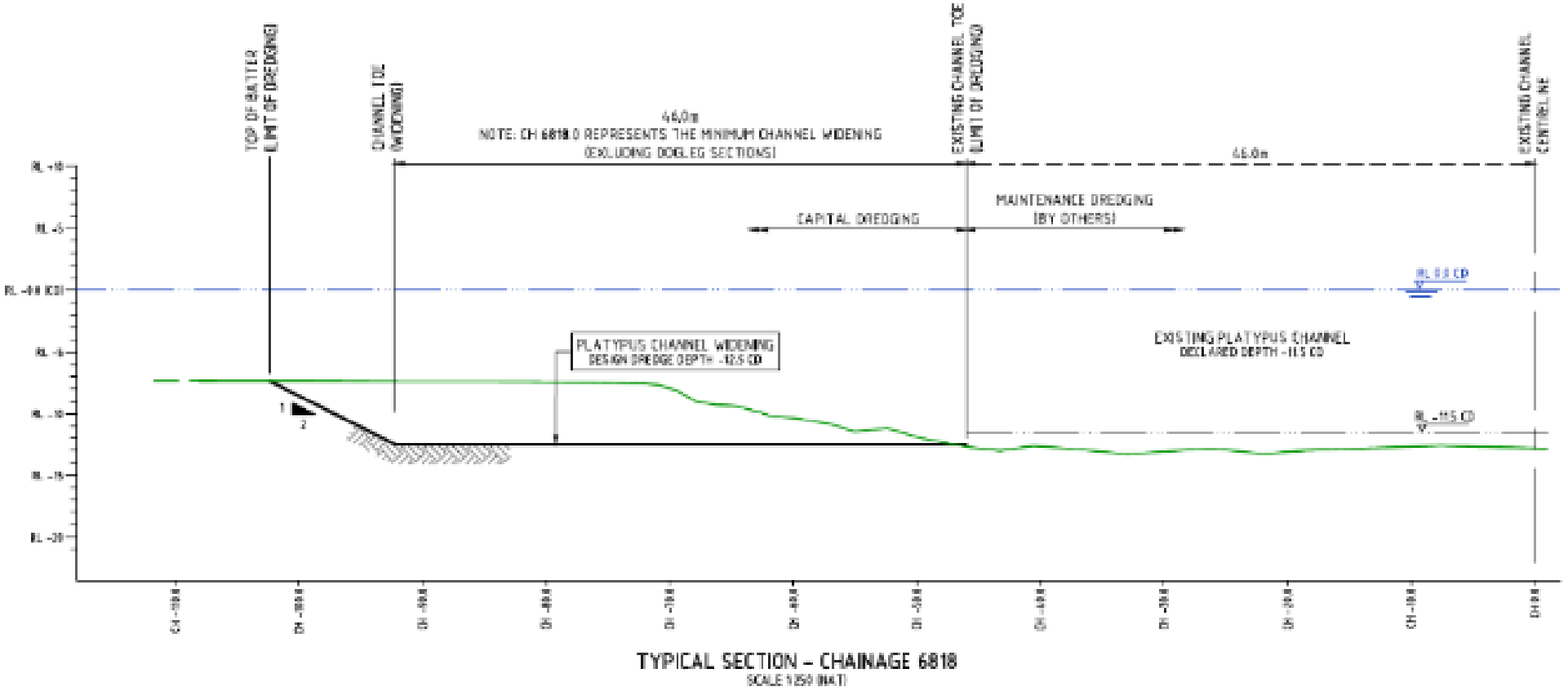
Figure 5. Reclamation Area Layout (and dredge material placement area)

Figure 6. Platypus Channel at Western Breakwater (CH 2500) typical cross section*



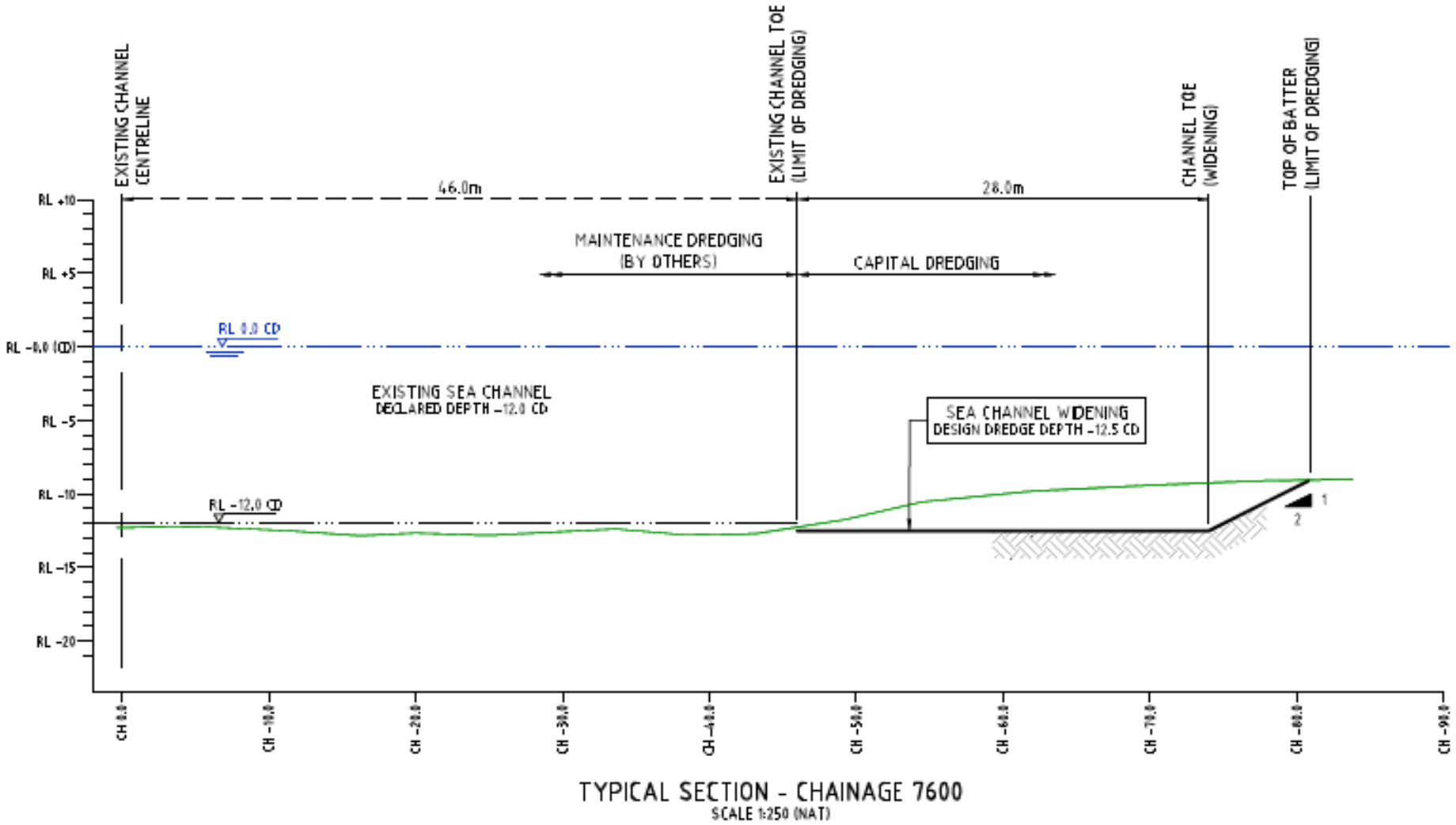
*TARGETED DESIGN, INDICATIVE CROSS SECTIONS ONLY – ALL DREDGING WILL REMAIN WITHIN 1:4 BATTERS AND -13.6M LAT AS PER AEIS, PEP EPBC AND CGER APPROVALS.

Figure 7. Platypus Channel (CH 6818) typical cross section (dog leg)



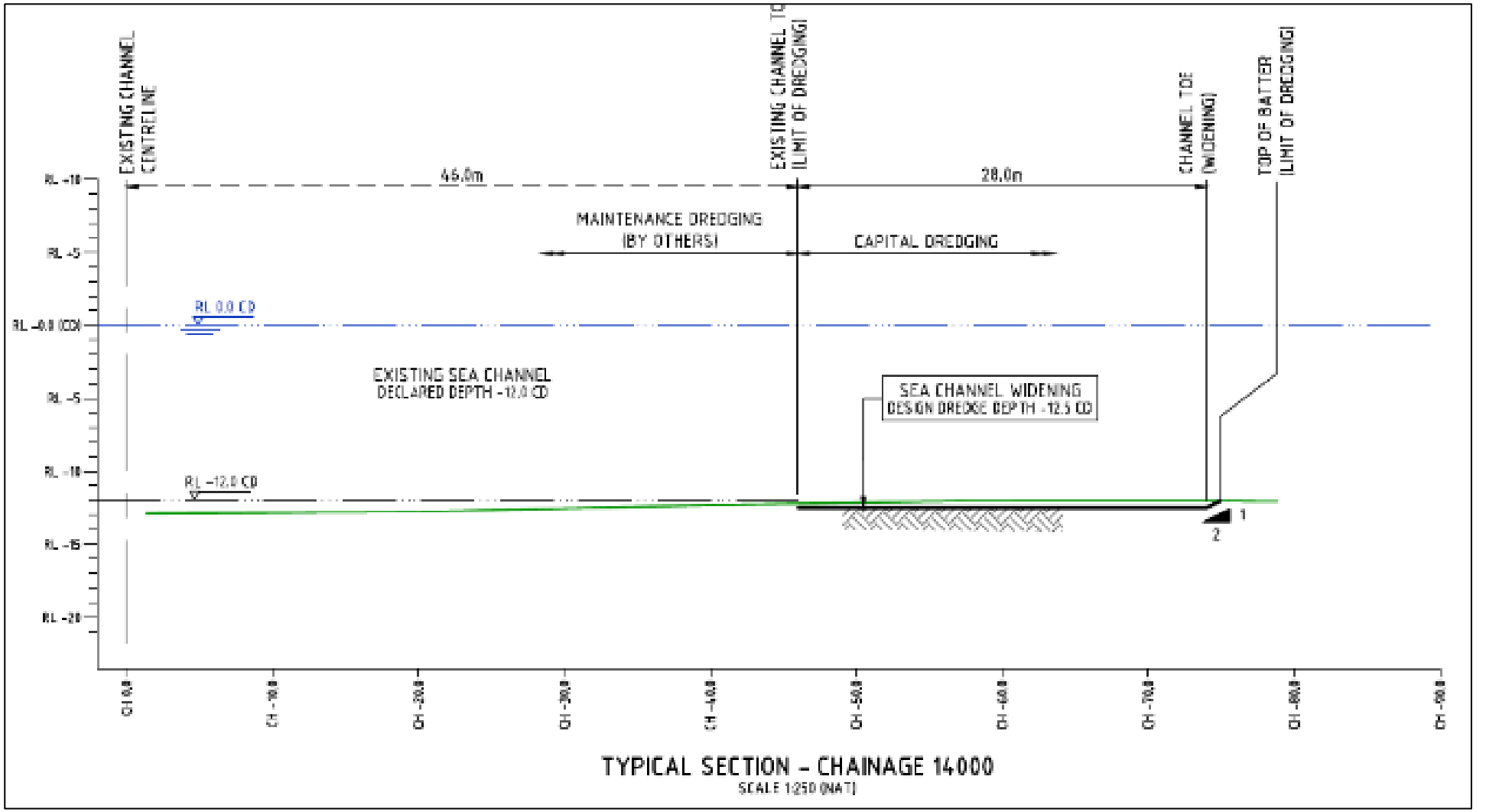
*TARGETED DESIGN, INDICATIVE CROSS SECTIONS ONLY – ALL DREDGING WILL REMAIN WITHIN 1:4 BATTERS AND -13.6M LAT AS PER AEIS, PEP EPBC AND CGER APPROVALS.

Figure 8. Sea Channel (CH 7600) typical cross section (dog leg)



*TARGETED DESIGN, INDICATIVE CROSS SECTIONS ONLY – ALL DREDGING WILL REMAIN WITHIN 1:4 BATTERS AND -13.6M LAT AS PER AEIS, PEP EPBC AND CGER APPROVALS

Figure 9. Sea Channel (CH 14000) Typical Cross section*



*TARGETED DESIGN, INDICATIVE CROSS SECTIONS ONLY – ALL DREDGING WILL REMAIN WITHIN 1:4 BATTERS AND -13.6M LAT AS PER AEIS, PEP EPBC AND CGER APPROVALS.

Figure 10. Temporary Unloading Facility (material transfer location)

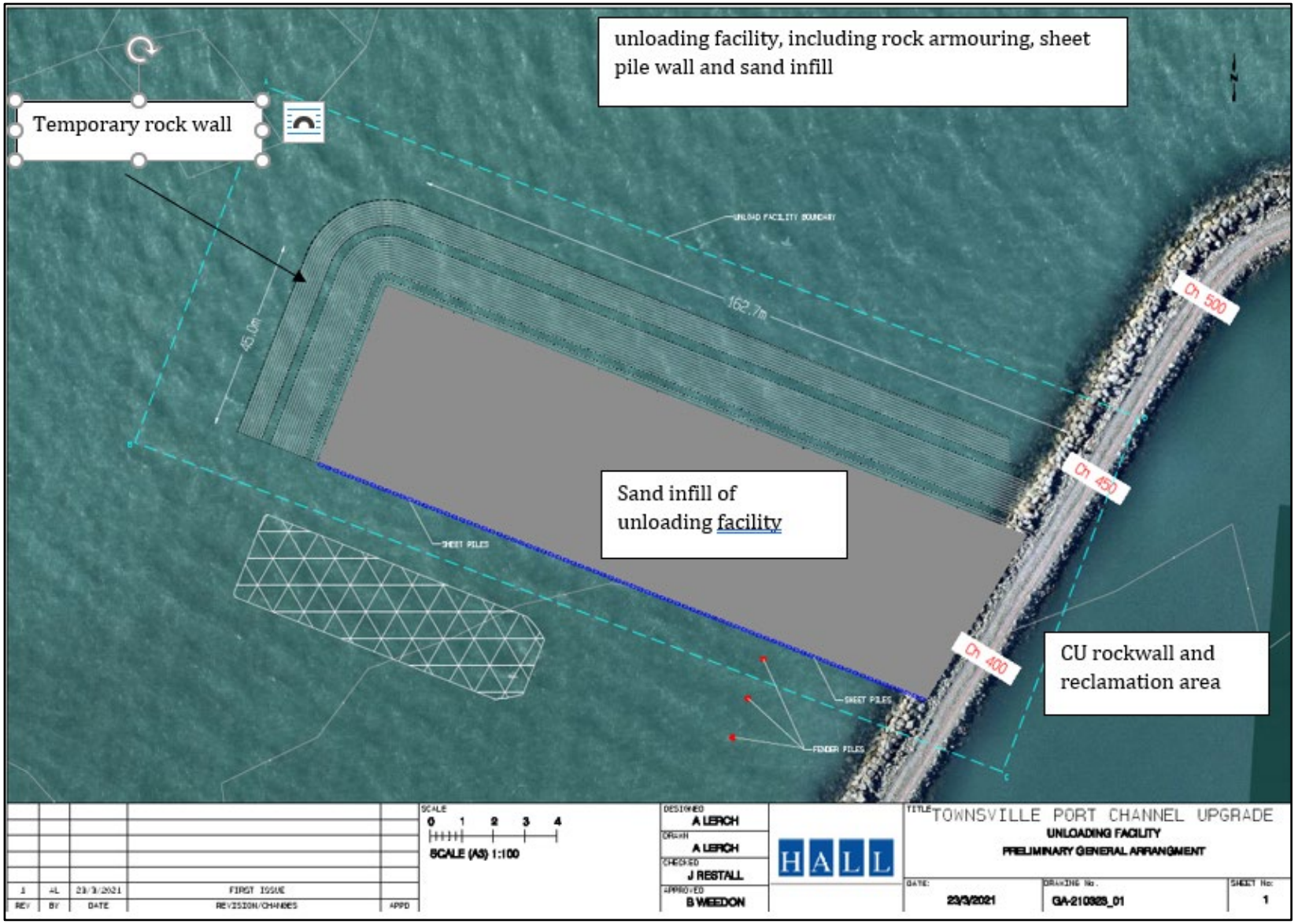
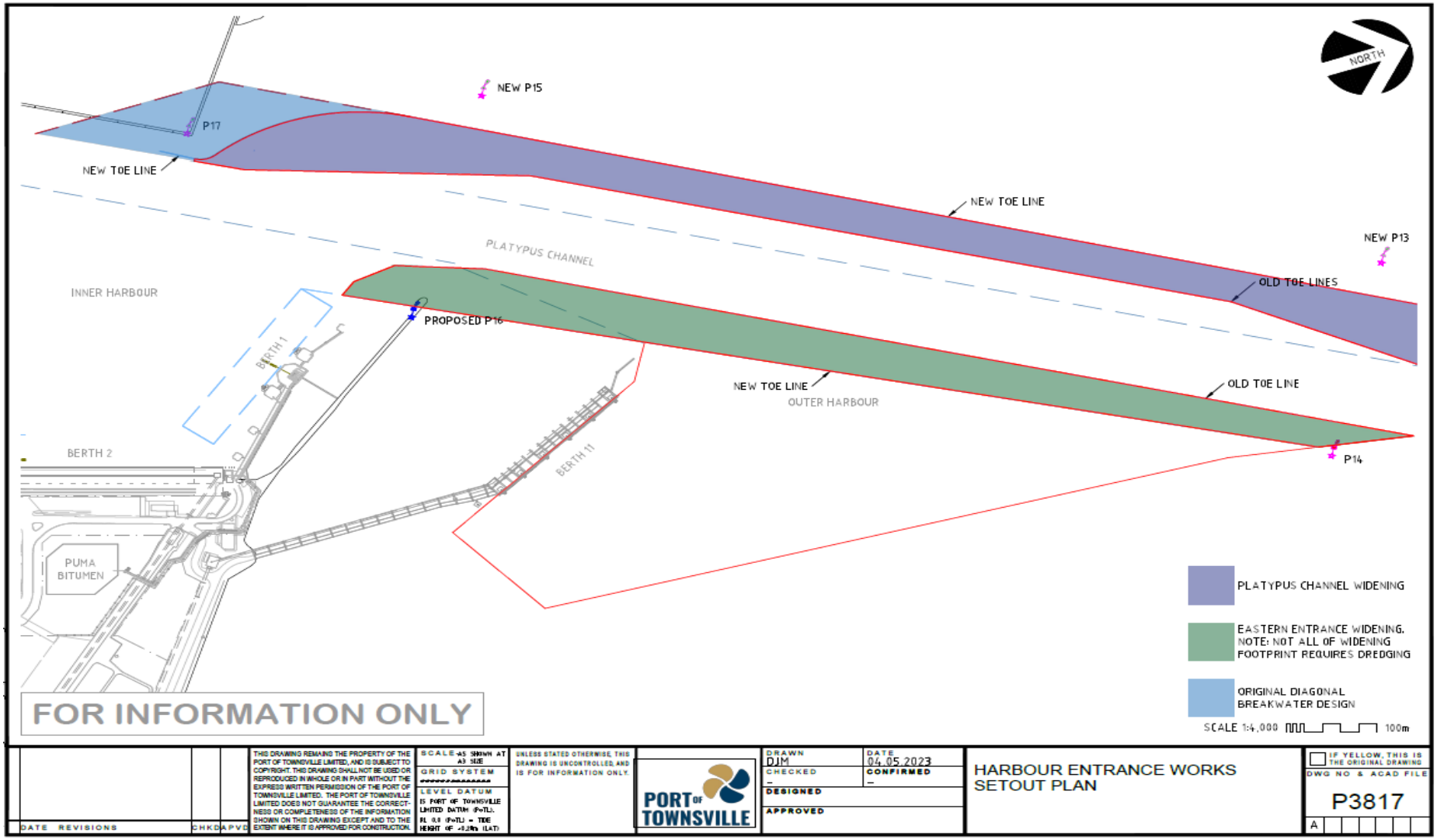


Figure 11. Eastern Harbour Entrance widening



NOTES

1. REFER TO PRINCIPAL FOR CHANNEL WIDENING DESIGN DRAWINGS.
2. OUTLINE OF EXISTING STRUCTURE HAS BEEN INTERPRETED BASED ON SITE SURVEY AND ORIGINAL DESIGN DRAWINGS. CONTRACT TO VERIFY EXTENT OF EXISTING STRUCTURE ON SITE.
3. CONTRACTOR TO ALLOWED TO MODIFY EXCAVATIONS LOCALLY TO ENSURE THE PORT'S EXISTING NAVIGATIONAL MARKER REMAINS IN PLACE AND IS FUNCTIONAL FOR DURATION OF WORKS.
4. INSTALL THE PORT'S NAVIGATIONAL MARKER ON EASTERN BREAKWATER ROUNDHEAD IN ACCORDANCE WITH HARBOUR MASTER REQUIREMENTS AT COMPLETION OF WORKS, OR SOONER AS PER HARBOUR MASTER REQUIREMENTS.

PLAN

SCALE 1:1000

LEGEND:

CADASTRAL BOUNDARY

ISSUED FOR CONSTRUCTION

REV	DATE	AMENDMENT / REVISION DESCRIPTION	APPROVAL	TITLE	NAME
A	19.07.2023	ISSUE FOR CONSTRUCTION	AF	DRAFTER	D. LEE
				DRAFTING CHECK	P. BROWN
				DESIGNER	A. FOLAN
				DESIGN CHECK	P. TURNEY
				APPROVED NAME	

SMEC
Member of the Surbana Jurong Group
LEVEL 6, 480 ST PAULS TERRACE
FORTITUDE VALLEY QLD 4006

CLIENT: PORT of TOWNSVILLE

PROJECT TITLE: CHANNEL CAPACITY UPGRADE PROJECT

EASTERN BREAKWATER MODIFICATION
GENERAL ARRANGEMENT

SCALE	PHASE	PROJECT / DRAWING No.	REVISION
AS NOTED	FOR CONSTRUCTION	30032296-GE-EBW-01-010	A

3.1 Existing Environmental Values

The Port of Townsville has a standalone Environmental and Social Values document which provides a detailed assessment of the values of Cleveland Bay (POT 1898). The following is a snapshot of the existing environmental values of Cleveland Bay.

Cleveland Bay supports numerous rich and diverse coastal habitats with varying ecological sensitivities, typically abundant in north-east Australia's coastal wet-dry tropics including:

- Soft bottom (unvegetated) communities, occupying over 85% of the bay;
- Intertidal and subtidal seagrass meadows, are present in about 10% of the bay and provide food for the threatened dugong and turtles and are also a nursery for prawns and fish;
- Mangrove and saltmarsh communities, containing twelve species of mangrove and 15 species of saltmarsh, all of which:
    - provide a nursery and shelter for fish, mud crabs and prawns;
    - trap tide-borne sediments and help control coastal erosion; and
    - provide vital protection from strong winds, tidal surges and heavy rainfall associated with cyclones, which occasionally affect this part of Queensland's coastline;
- Forested, brackish and freshwater swamps; and
- Corals which occupy only around 1% of the bay.

Cleveland Bay is also recognised as a habitat for key marine megafauna, including:

- Loggerhead Turtle (*Caretta caretta*);
- Leatherback Turtle (*Dermochelys coriacea*);
- Olive Ridley Turtle (*Lepidochelys olivacea*);
- Green Turtle (*Chelonia mydas*);
- Hawksbill Turtle (*Eretmochelys imbricate*);
- Flatback Turtle (*Natator depressus*);
- Dugong (*Dugong dugong*);
- Australian Snubfin Dolphin (*Orcaella heinsohni*);
- Australian Humpback Dolphin (*sousa sahulensis*); and
- Humpback whale (*Megaptera novaeangliae).*

Cleveland bay is also home to over 450 different species of birds (Wildlife Online 2018), including migratory species.

Cleveland Bay hosts the following protected areas:

- The Great Barrier Reef World Heritage Area (GBRWHA), a world and national heritage place;
- The Great Barrier Reef Marine Park (GBRMP) and the State Great Barrier Reef (GBR) Coast Marine Park (including a number of different zones of protection) noting the area depicted with a red boundary is the port exclusion zone;
- Declared Dugong Protected Areas, in Cleveland Bay and around Magnetic Island;
- A declared Fish Habitat Area (FHA) in the east of Cleveland Bay; and
- The neighbouring Bowling Green Bay, a Ramsar listed wetland and major wetland area of significance to migratory and wading birds.

3.2 Dredging and Reclamation Works Schedule

Following a competitive tender process, the Dredging works was awarded to Hall Contracting. Table 5 provides the proposed works schedule for dredging, placement and reclamation works; expected infield water quality monitoring of dredge operations to validate the numerical modelling and associated reporting delivery; as well as the dredging post completion report due once all works have been completed. Capital dredging is currently proposed to be completed over approximately a 2 – 2.5 year period.

Table 5: Channel Upgrade proposed works schedule relevant to this DMP

Project Stage	Planned Start	Planned Finish
Capital Dredging	Early 2022	Early 2024
Dredge material placement and reclamation works	Early 2022	Mid to Late 2024
Model validation – infield water quality monitoring	Timed with dredging	Within 3 months of start of channel dredging
Model validation – infield monitoring and close out report	Delivered within 6 months of start of dredging (fine sediment validation to be completed during final cut dredging)	
Post completion works report	Expected delivery by mid 2025*	

* contingent upon dredging and post -dredging monitoring completion

Note: The CU capital dredging, transport, placement, and reclamation activities operate 24hrs a day, 7 days a week.

4 Objectives

The purpose of this DMP is to manage the environmental risks and reduce the potential for negative impacts on the environment associated with the mechanical capital dredging and transfer of material to the placement area. This will be achieved by identifying and detailing the appropriate and preferred environmental management controls.

Note: As outlined previously, three other documents support the management of environmental risks associated with placement and reclamation activities. These are:

- CEMP which covers the construction and reclamation activities and associated environmental management requirements, controls and contingency plans for extreme weather events;
- MEMP which covers the environmental management requirements and controls for Matters of National Environmental Significance in relation to construction activities;
- ; and
- OMS which covers the offset management strategy for the construction of the rock wall, dredge footprint, and fine sediment release during dredging.

The key environmental values likely to be affected by the capital dredging and placement related activities associated with the CU Project were identified in the PEP EIS; and re-assessed in the PEP Additional Information to the Environmental Impact Statement (AEIS). For each key value (Element) identified, environmental management controls to address potential risks and impacts have been provided in Section 11 of this document.

This DMP provides a greater level of detail to that of the PEP EIS / AEIS and is focused only on capital dredging required for the Channel Upgrade (CU) project (as opposed to the PEP as a whole). The DMP sets out the framework for avoiding, mitigating, managing, and monitoring the relevant impacts affiliated with capital dredging (mechanical) and unloading activities for the CU Project.

The principal objectives of this DMP are to:

- Provide an overview and description of the dredging works, equipment, methodology and timing.
- Describe the project's commitments regarding environmental performance, reduction of adverse impacts, and appropriate mitigation measures to avoid or minimise potential impacts from dredging on sensitive receptors of Cleveland Bay.
- Establish and maintain control measures that minimise the potential for environmental harm.
- Avoid or minimise disturbance to seagrass and corals.
- Avoid or minimise impacts to marine fauna from dredge vessels.
- Avoid or minimise the uncontrolled release of dredge material into the marine environment.
- Avoid the release of potentially contaminated sediments into the marine environment.
- Manage risks associated with extreme weather events.
- Avoid vessel accidents and oil spills.

5 Environmental Management Roles and Responsibilities

5.1 Port and Contractor Roles and Responsibilities

The roles and responsibilities of personnel in charge of the environmental management for CU capital dredging and placement activities for the Port of Townsville, are provided below. Figure 12 and Table 6 provide the Port Project team and responsibilities, while Figure 13 and Table 7 provide the Hall Contracting team and responsibilities:

Figure 12. Port of Townsville CU organisational chart

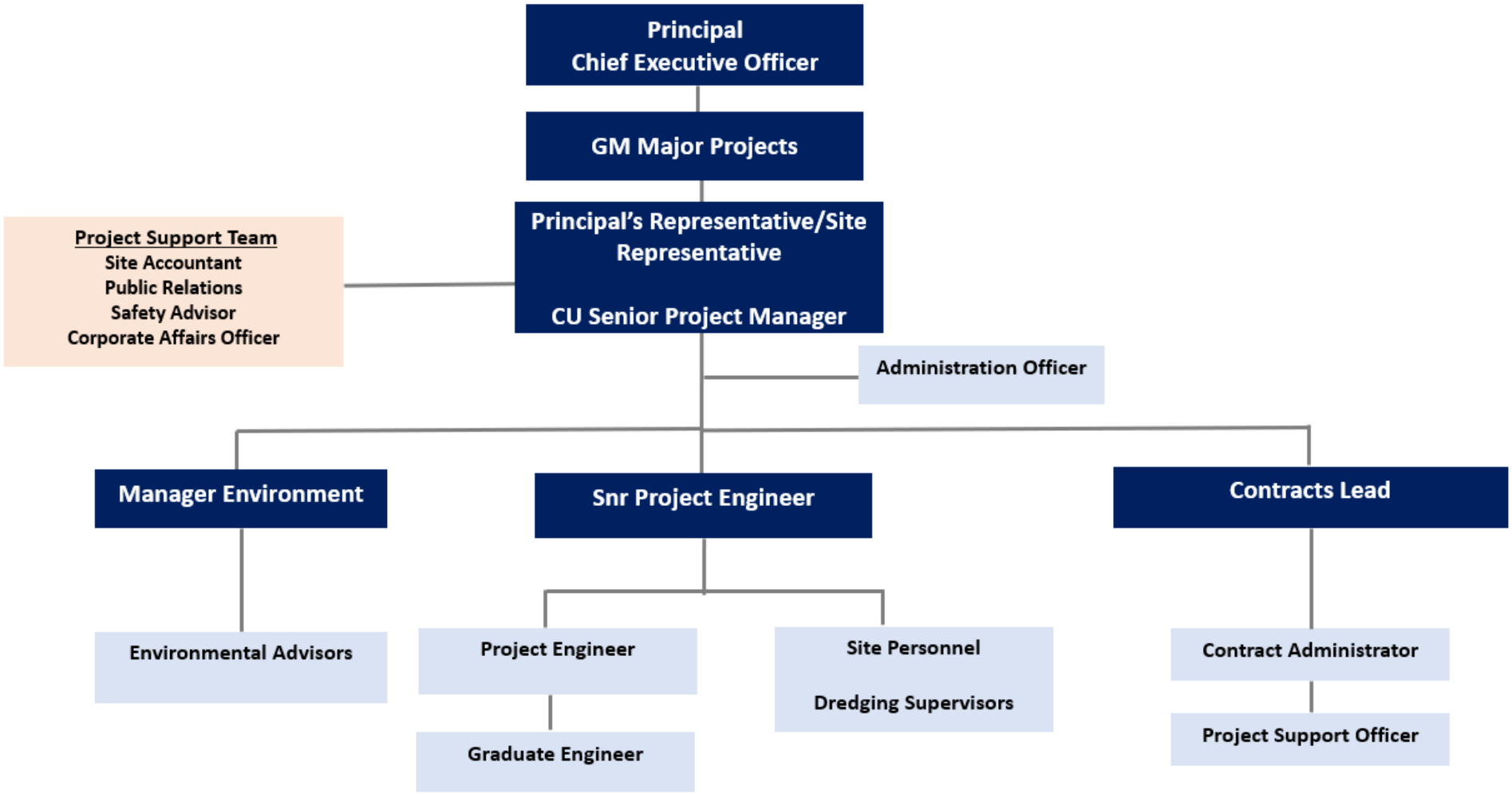


Table 6: - Port of Townsville Roles and Responsibilities

Position	Responsibility	Reports to
Principal's Representative	• Responsible for the overall management of the CU project; • Represents the Port's interests in the CU Project; • Oversees the CU Project and its execution; • Provide final approval of all Project documentation;	GMMP
Principal's site representative for Dredging and Reclamation Works	• Manages the CU Project dredging and reclamation contract; • Ensure that project responsibilities and authorities are defined and communicated; • Provide authorisation for project documentation; • Reports to Port senior management on project performance and non-conformance. • Oversee the day-to-day construction, dredging and reclamation activities; • Ensure that all project personnel operate in accordance with the Project Management Plans; Australian Standards, and any relevant Code of Practice and/or Industry Standard; • Ensure all Project personnel are appropriately qualified and trained; • Facilitate the regular environmental observations by the Environmental Advisors – CU and on site monitoring as required under all CU management plans. •	GMMP
Manager Environment – CU	• Point of contact for State and Commonwealth environmental Regulators; • Point of contact for the Independent Technical Advisor Committee (ITAC) and Compliance Regulatory Oversite Committee (CROC); • Ensures all licences / permits / approvals are in place prior to any works being undertaken; • Monitor and review technical, environmental and quality performance of the project, including the implementation of this DMP (and other management plans), refining procedures as necessary to ensure relevant management measures are implemented effectively and adaptive management/ corrective actions is taken in a timely manner; • Take action to resolve environmental non-conformances and incidents; • Reports to Principal's Site Representative on the performance of the project, and technical environmental and quality non-compliances; and • Liaise with regulators including reporting environmental incidents and complaints to the relevant regulators.	Principal's Site Representative
Environmental Advisors – CU	• Responsible for undertaking monitoring of DMP implementation; • Support the CU Project team in day-to-day management of environmental performance; • Review compliance with all environmental legislation, approvals, permits, and management plans and liaise with relevant regulators as required;	Manager Environment – CU

	• Ensure all project personnel has undertaken the set environmental training/inductions and are aware of their environmental responsibilities; • Monitor, investigate and report on environmental performance, incidents, complaints and non-conformances. Ensure corrective actions are implemented effectively; • Conduct environmental inspections and audits for the duration of the project and report to the Manager Environment – CU on the environmental performance and improvement opportunities; • Review contractor environmental management plans; • Verify any environmental non-conformance, incidents and complaints are recorded, and written reports provided. Liaise with the Principal's Site Representative for Dredging and Reclamation Works and Manager Environment – CU to confirm the nature and adequacy of any corrective actions required; and • Ensure environmental records are filed appropriately and maintained.	
Works Engineer	• Undertake regular inspections, audits and Quality Control for reclamation works, including any associated works with backing land; • Report all environmental non-conformances, incidents and complaints to the Manager Environment CU and/or Environmental Advisor – CU and facilitate any investigations needed; • Co-ordinate the response to environmental non-conformances, incidents and complaints through implementation of corrective actions, where necessary; • Lead for the Eastern Breakwater demolition works.	Principal's Site Representative
Safety Representative	• Review management plans to ensure they conform to statutory/contractual obligations and the company policies and procedures; • Monitor and assist in the risk management processes as required during every stage of the project.	Principal's Site Representative
Dredging Supervisors	• Provide daily oversight and guidance to the dredging and reclamation works activity for the Channel Upgrade and Diagonal Breakwater programs; • Ensure the works are completed in accordance with the Contract and all environment and health and safety requirements.	Principal's Site Representative
Corporate Affairs and Capital Works PR Officer	• Point of contact for Complaints handling; • Maintain Complaints Register; • Media, PR and Corporate Affairs point of contact.	Principal's Site Representative
All other Port Personnel	All port personnel have an environmental duty to report events that may result in environmental harm. Any environmental observation noted is to be reported to the Manager Environment CU for awareness and action; inclusive of support staff.	Respective line managers

Figure 13. Contractor - Hall Contracting - Organisational Chart

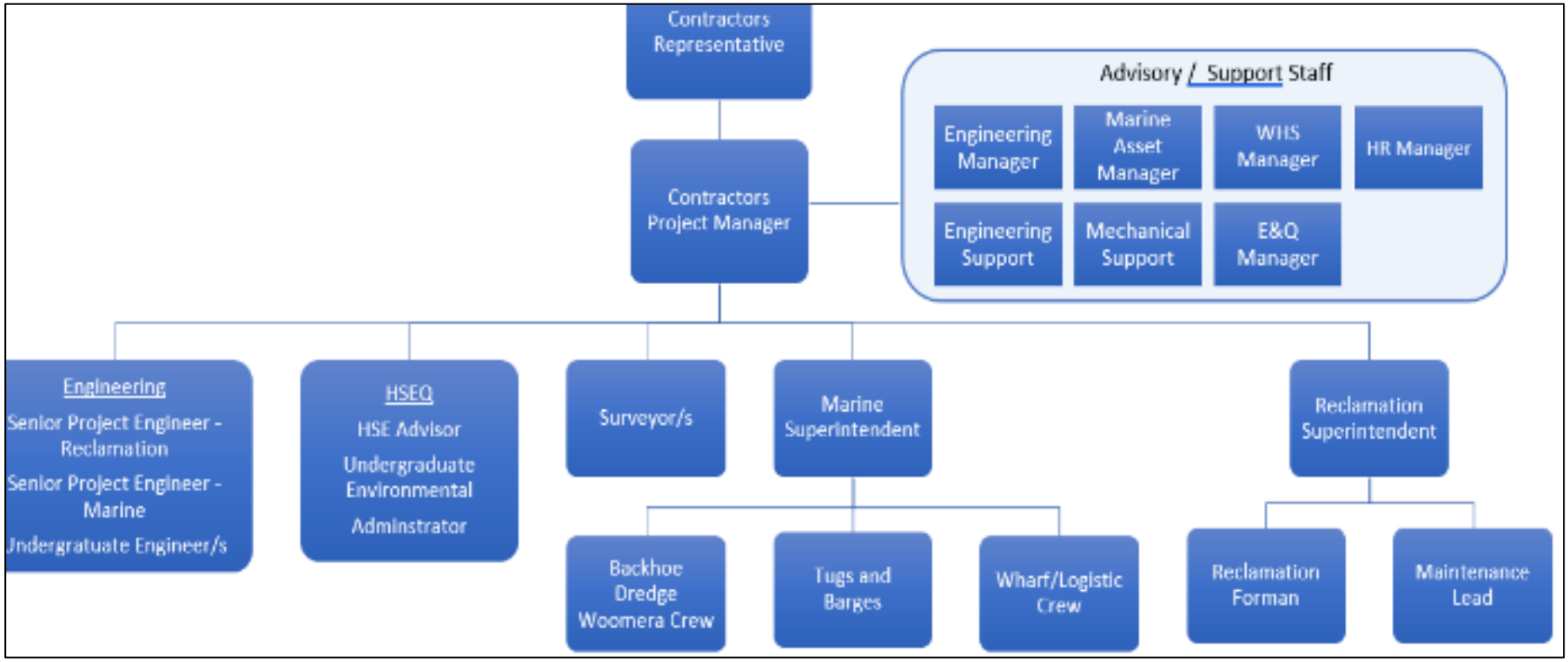


Table 7: - Hall Dredging and Reclamation Roles and Responsibilities

Position	Responsibility	Reports to
Contractor's Representative	The Contractors Representative is part of Hall Contracting's Executive Team and is responsible to ensure the project is being effectively managed to meet all contractual and statutory obligations whilst meeting client requirements.	Hall CEO
Project Manager	The Project Manager is the Senior Manager for the project and reports to the Contractors Representative. The Project Manager has responsibility for the project in meeting all the obligations and has the following roles and responsibilities: • Reports to the Principal's Site Representative for Dredging and Reclamation Works on all aspects of the project including Work Health Safety, Environment and Quality compliance and non-compliance issues. • Understand the needs and expectations of relevant interested parties and establish the project's objectives and targets. • Ensure all contractual/statutory obligation are met • Ensures all environmental licences / permits / approvals are in place prior to any works being undertaken. • Ensure sufficient, trained and competent persons are appointed to complete the project • Understand and implement the Client requirements (project contract and specification) • The approval of the contractors Management Plans • Ensure all persons with responsibility under the plans are themselves aware of their obligations • Direct responsibility for all Work Health Safety, Environmental and Quality aspects for the project. • Monitor, review and manage all environmental aspects of the project related to the implementation of the DMP, CEMP, MEMP and all related subplans. • Liaise with Principal's site Representative for Dredging and Reclamation Works and Government Regulators in relation to environmental non-conformances and/or site inspections or investigations. • Ensuring all works are executed in accordance with the management plans and policies. • Employ effective risk management processes during every stage of the project including on-going assessment and review. • Manage all investigations of complaints, incidents, near miss events and hazards. • Implementation and management of change on a project level.	Contractor's Representative
Senior Project Engineer	The Senior Project Engineer reports to the Project Manager and has the following roles and responsibilities: • Preparation of management plans relating to their delegated area of responsibility • Understand the needs and expectations or relevant interested parties.	Project Manager

	• Undertake project reporting for their delegated area of responsibility. Ensure all reporting is clear, accurate and meets the requirements of any Interested Parties. • Work closely with the Superintendent to ensure works are planned, controlled and compliant to all relevant management plans • Work closely with the Superintendent to ensure controls identified from risk assessments and management plans are implemented and maintained for their delegated area of responsibility. • Assist in the risk management processes as required during every stage of the project • Assist in the implementation and management of change on a project level • Understands and assists, when required, all environmental obligations, actions, monitoring and reporting requirements for the project. • Work closely with the Superintendent to ensure all personnel (direct employees, casual labour and subcontractors) associated with the project are aware and understand the relevant policies, procedures and other project specific documents. • Strive to achieve the project's objectives and targets. • Have a complete understanding, ability to utilise and an ability to explain to others the forms associated with the Health & Safety, Environmental and Quality management on the project. • Employ effective risk management processes during every stage of the project including on-going assessment and review. • Understand and complete compliance inspection in accordance with the Project Risk Assessment and Vessel Safety Management System relevant to their delegated area of responsibility. • Assists in the preparation, implementation and review of Quality control documents and procedures.	
Superintendent	The Superintendent reports to the Project Manager and has the following roles and responsibilities: • Understand the needs and expectations or relevant interested parties. Assists the Senior Project Engineer to ensure all project reporting is completed in a timely and accurate manner • Control personnel and plant in their specific area of work and ensure that safe work practices are undertaken in accordance with the relevant management plans and Work Method Statements (WMS). • Ensuring all personnel and equipment used are suitable for the required function and operated in a safe manner. • Work closely with the Senior Project Engineer to ensure all personnel (direct employees, casual labour and subcontractors) associated with the project are aware and understand the relevant policies, procedures and other project specific documents. • Understands and assists all site personnel in adhering to the project's environmental obligations and requirements under the contract. • Assists in Environmental incident response actions in a timely manner to reduce environmental impacts on the surrounding environment, that may arise as a result of dredging and/or construction activities.	Project Manager

	• Ensure all site personnel (direct employees, subcontract labour and subcontractors) associated with the project meet the Health & Safety, Environmental and Quality requirements through enforcing the established site rules. • Ensure workers are qualified to undertake the role assigned to them. • Monitor and mentor new or inexperienced workers to ensure work in accordance with the work standards. • Ensure that equipment used on site is in suitable operating condition. • Assist in the investigation of incidents, near miss events and hazards. • Assist in the risk management processes as required during every stage of the project • Assist in the implementation and management of change on a project level • Understand and complete compliance inspection in accordance with the Project Risk Assessment and Management System relevant to their delegated area of responsibility. • Ensure the site is kept in a neat and tidy condition at all times.	
Health, Safety and Environmental Advisor	The Health Safety and Environmental Advisor reports to the Project Manager and works closely with other members of the project team to assist in the management of the project. The Health Safety and Environmental Advisor has the following roles and responsibilities: • Review management plans to ensure they conform to statutory/contractual obligations and the company policies and procedures. • Understands and assists the Project Manager, Senior Project Engineer, and Superintendent, ensuring all Licences / permits and approval conditions are being met throughout the duration of the project. • Responsible for ensuring all day to day environmental monitoring requirements are being undertaken for all dredging, reclamation and construction activities relevant to approval conditions and applicable management plans. • Provide technical advice in relation to environmental aspects of the project. • Assist in training and induction requirements of site personnel to ensure a clear understanding of environmental obligations are being undertaken. • Assist and provide guidance to the Project Manager, Senior Project Engineer, Superintendent and site personnel in emergency response procedures for the project, particularly in relation to Work Health Safety and Environmental aspects. • Monitor, review and maintain environmental data and records and assist in adaptive strategies for continual improvement. • Liaise with Principal's Site Representative for Dredging and Reclamation Works and Manager Environment when required, in relation to Work Health Safety and Environmental matters. • Monitor and assist in the risk management processes as required during every stage of the project	Project Manager

	• Understand and complete compliance inspection in accordance with the Project Risk Assessment and Management System relevant to their delegated area of responsibility. • Conduct Health Safety, Environmental and Quality audits in accordance with the Project Risk Assessment and Vessel Safety Management System. • Lead the investigation of incidents, near misses and hazards and report the finding of the investigation • Assist in complaints handling, investigations and reporting. • Convey all companywide procedural changes to the management staff and assist in the implementation of any necessary changes required to the project management plan/s. • Facilitate the consultation and communication with workers and/or their representatives regarding the management of risk • Promote continual improvement in-line with the needs and expectations of interested parties. • Advise and assist in the implementation and management of change on a project level to ensure the integrity of the Management System is maintained.	
Person in Charge	The Person in Charge is a worker whom is competent to identify, assess and manage risk in the undertaking of works and to effectively communicate and instruct workers in the execution of such works. The Person in Charge will either be the Superintendent or will be appointed by the Superintendent to a task. This person will be identified at the daily pre-start meeting. The Person in Charge has the following roles and responsibilities; • To approval the commencement of high-risk work activities • To control and manage any emergency procedures and notifications that may be required for the associated task or specific area of work • Cease works if found a breach site rules • Understand and complete compliance inspection in accordance with the Project Risk Assessment and Management System relevant to their delegated area of responsibility	Superintendent or Project Manager
All workers (including subcontractors)	All workers will share the responsibility to; • Plan all work activities, understand and undertake work in a safe and healthy manner without causing environmental harm by assessing all work prior to carrying it out. • Attend and actively participate in inductions, toolbox meetings, safety observations, environmental inspections, competency assessments and any other training required to ensure they undertake their work in a safe manner. • Read, understand and apply the requirements established in the Work Method Statement/s related to the work being undertaken. • Take responsibility for their safety and that of their fellow workers through proactive work process and positive attitudes. • Take responsibility for the quality of work in accordance with the needs and expectations of interested parties. • Take responsibility for the environment in which they work, ensuring their works will not cause environmental harm	Variable, dependent on role

	• Monitor and mentor new or inexperienced workers to ensure they remain safe and work in accordance with safe and accepted work standards. • Comply with any reasonable instruction given by the Person in Charge or other Manager • Report, and/or, if safe to do so, rectify unsafe conditions or incidents that come to their attention as soon as possible.	
Advisory/Support Staff	Several advisory/support staff whom specialise in various disciplines have been delegated to assist the site-based project team in the successful delivery of the project. The Advisory/Support Team are personnel whom work as required on the project, either remotely or through via regular visits, to provide support and advice where requested by the Project Manager. The Advisory Support Team report to the Project Manager and Contractors Representative on all matters of the project where they provide support.	Contractor's Representative and Project Manager
Engineering Manager	• Understand the needs and expectations of relevant interested parties. • Provides technical Engineering support to the Project Manager, Senior Project Engineer, and Superintendent.	Contractor's Representative and Project Manager
Marine Asset Manager	• The Marine Asset Manager has the responsibility of all maintenance and planning for the large vessels (dredges, workboats, boosters and pontoons). • Execute, manage and support others to effectively identify the equipment works component, pre-plan these work components with time, cost, quality, safety and environmental considerations.	Contractor's Representative and Project Manager
Work Health and Safety Manager	• The Health & Safety Manager is responsible for managing the company's health and safety in accordance with the Integrated Management System, whilst providing expert assistance, guidance and direction to staff and engaging key decision makers. • The Health & Safety Manager will ensure that effective policies, procedures, systems and services are in place to provide and maintain the highest level of safety awareness, accident prevention and rehabilitation across all of Hall Contracting's operations, and continuously strive for improvement. • Provide support, recommendations and review in project specific management plans and ensuring the implementation of such plans. • Provide direct assistance to the Work Health Safety and Environment Representative for all site related matters where required. • Periodically assist in conducting Health Safety Environment and Quality Audits and/or site inspections. • Assist in incident investigations and corrective actions for site related incidents and near miss events.	Contractor's Representative and Project Manager
Environment and Quality Assurance Manager	• To represent the Company on all Quality Assurance related issues and policies. • Reviewing and revising all Company standard quality system procedures and the Company's Quality Management System.	Contractor's Representative and Project Manager

	• Provide guidance and support to project teams in relation to quality and environmental aspects throughout the project. • To ensure conformance with environmental licenses, permits and regulations. Provide support, recommendations and review in project specific management plans and ensuring the implementation of such plans. • Provide direct assistance to the Work Health Safety and Environment Representative for all site related matters where required. • Periodically assist in conducting Health Safety Environment Quality audits and/or site inspections. • Assist in incident investigations and corrective actions for site related incidents and near miss events.	
Human Resources Manager	• The Human Resource Manager is required to provide quality services by planning and coordinating the efficient and effective delivery of Human Resources in accordance with the Hall Group key strategic directions, legal guidelines and in accordance with the Integrated Management System. • The Human Resources Manager will provide guidance, advice and practical support to managers, supervisors and employees in a precise and timely manner in relation to all Human Resource matters.	Contractor's Representative and Project Manager
Environmental Advisor	• Reports to the Project Manager • Assists in the writing and implementation of management plans to ensure they conform to statutory/contractual obligations and the company policies and procedures. • Understands and assists the Project Manager, Senior Project Engineer, and Superintendent, ensuring all Licences / permits and approval conditions are being met throughout the duration of the project. • Provide technical advice in relation to environmental aspects of the project. • Provide direct assistance to the Work Health Safety and Environment Representative for all site related matters where required. • Will periodically assist in conducting Health Safety Environment and Quality Audits and/or site inspections. • Assist in incident investigations and corrective actions for site related incidents, near miss events and hazards.	Contractor's Representative and Project Manager
Engineering Support and Mechanical Support	• These positions will provide ongoing support to the Project Manager, Senior Project Engineer, Superintendent and all other staff when required, in relation to engineering and mechanical aspects of the project. • When required, they may assist on site or remotely, to ensure the project needs and requirements are being met.	

5.2 Oversight Committees

Under the CGER conditions, the Port is required to establish a series of committees to support preparation for and oversight of dredging works. These consist of the:

- Independent Technical Advisory Committee (ITAC)
- Compliance Regulatory Oversight Committee (CROC)
- Capital Dredging Implementation Committee (CDIC).

Additionally, as part of the Receiving Environment Monitoring Program (REMP) and adaptive management regime established within this DMP, the Port has established a Dredging Inference Assessment Team (DIAT) to support the Port and ITAC in responding to monitored changes in water quality that could be attributable to the dredging. Details on these committees in the context of this DMP are set out below. The membership and relationship between these committees is shown in Figure 14.

Note that the CGER conditions reference these various committees in the context of TSHD dredging only. The following therefore adapts the role of these committees as necessary to BHD dredging.

5.2.1 Independent Technical Advisory Committee (ITAC) and Dredging Inference Assessment Team (DIAT)

The ITAC's role is to provide:

- independent, expert-based input into the scientific basis underlying the REMP and the contingency measures in the DMP;
- to provide advice regarding the scopes of work for the ecological surveys and the development of water quality and ecological trigger levels with consideration of the current condition and tolerances of coral and seagrasses;
- to review and endorse the REMP (and any proposed changes), particularly the control and impact monitoring locations, the monitoring design and trigger levels for corrective actions;
- review, comment on and support if appropriate the contingency measures in the DMP (where the issue is within ITAC scope and expertise);
- to provide independent oversight of the implementation of the REMP; to review the environmental performance of the CU Project's capital dredge campaign against trigger levels;
- to evaluate corrective actions implemented; and
- to review and endorse sediment plume associated monitoring program and resultant report validating the hydrodynamic modelling of the dredge plume.

The ITAC is made up of the following team members:

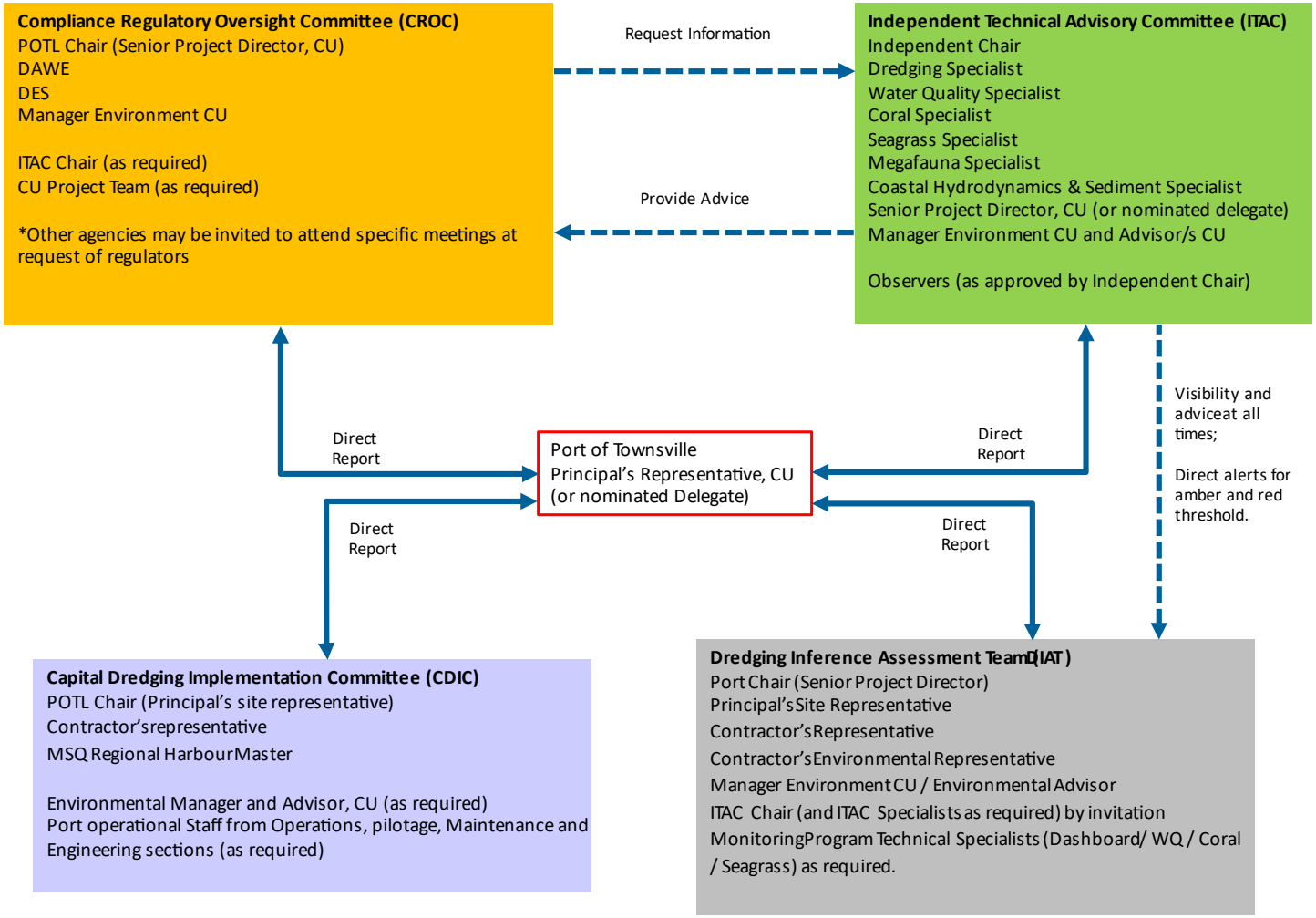
- ITAC Chair
- Seagrass Specialist
- Coral and Marine Water Quality Specialist
- Marine Megafauna Specialist
- Dredging Specialist
- Hydrodynamic Specialist

The roles of these members are summarised in Table 8, with more detail set out in separate terms of reference for the ITAC.

Table 8: Membership and Responsibilities of the ITAC

Position	Responsibility
ITAC Chair	• Facilitate ITAC meetings • Review incoming correspondence • Provide correspondence on behalf of the ITAC • Present at community forums as required • On advice from the ITAC or in the event of a serious complaint, advising the Dredging Inference Assessment Team on mitigation actions, including whether dredging should cease.
Seagrass Specialist	• Provide expert technical input on Seagrass and expert input into ITAC feedback in accordance with the objectives of the ITAC • Involvement in DIAT meetings as required.
Coral Specialist	• Provide expert technical input on Corals and expert input into ITAC feedback in accordance with the objectives of the ITAC • Involvement in DIAT meetings as required.
Marine Water Quality Specialist	• Provide technical input on marine water quality and expert input into ITAC feedback in accordance with the objectives of the ITAC • Involvement in DIAT meetings as required.
Marine Megafauna Specialist	• Provide technical input on marine megafauna and expert input into ITAC feedback in accordance with the objectives of the ITAC • Involvement in DIAT meetings as required.
Dredging Specialist	• Provide input on water quality contingency measures and appropriate responses in case of trigger levels being reached and provide expert input into ITAC feedback in accordance with the objectives of the ITAC • Involvement in DIAT meetings as required.
Hydrodynamic specialist	• Provide technical input into hydrodynamic modelling and expert input into ITAC feedback in accordance with the objectives of the ITAC • Involvement in DIAT meetings as required.

Figure 14: Membership and relationship of Governance Committees for capital dredging



The ITAC's role in the DMP will be supported by the DIAT. The DIAT will be chaired by the Port's Principal's Representative, and made up of the following team members:

- Principal's Site Representative for Dredging and Reclamation;
- Contractor's Representative and/or Project Manager;
- Contractor's Environmental Representative;
- Manager Environment CU / Environmental Advisor;
- ITAC Chair (and ITAC Technical Specialists as relevant) by invitation;
- Port's consultant monitoring program technical specialist (Marine Water Monitoring Program Technical Specialist and other technical Port Contractor specialists) as required.

The role of the ITAC and DIAT in the DMP's implementation relates primarily to providing advice on dredge management in response to changes in the receiving environment, as indicated by the REMP (section 12.2). The DIAT will be engaged where water quality exceeds Level 2/Amber trigger levels and for review of sentinel site water quality data where required while both the DIAT and ITAC will be engaged for exceedances of Level 3/Red trigger level.

In both instances, the role of the committee(s) will be to advise on potential of dredge-related impact and to advise on changes in dredging activity to maintain water quality or bring water quality back into compliance. Both committees will also provide oversight of the REMP and monitoring results.

Further information around the roles and operations of the DIAT and ITAC regarding the REMP is provided in Section 12.2.The Port and ITAC will also regularly liaise regarding the implementation of the DMP and other aspects of the CU Project, as per the existing ITAC terms of reference.

5.2.2 Compliance Regulatory Oversight Committee

As per Table 9, the CROC is to oversee the compliance with the environmental approval conditions and implementation of the monitoring program for water quality, including liaison with the ITAC during the capital dredging campaign. Note that the member Agencies of the CROC have direct compliance jurisdiction over the CU Project through statutory approvals, this statutory role is not intended to be replaced by the CROC. The frequency of meetings of the CROC during dredging works will be subject to agency availability. The Port sought nominees from DCCEEW and DES to establish the CROC in early 2021 but the agencies have not indicated a specific need for the CROC at the current time and on that basis the body has not been established. However, a Terms of Reference has been developed and shared with the agencies should they wish to pursue forming this committee in the future.

Table 9: Membership and Responsibilities of the CROC

Department	Role	Responsibility
Port of Townsville	Chair	• Overseeing compliance of environmental conditions related to PEP dredging, specifically as they relate to water quality and other environmental monitoring requirements

DCCEEW (Commonwealth)	Member	• Reviewing (and commenting if required) on the development of the water quality monitoring programs associated with the capital dredging;[1] • Liaising with and/or referring matters to the ITAC for technical advice
DES (Queensland)	Member	[1] The Water Quality Monitoring Programs refer to the Receiving Environmental Monitoring Program (REMP), Sediment Plume Associated Monitoring (SPAM) and tailwater release monitoring as described under the Stated Conditions for an Environmental Authority under the CGER and the program to monitor water quality described under the EPBC Controlled Action Approval conditions 5(h) and conditions 10(e) and 10(f).
The Chair may invite a representative from the Queensland Office of the Coordinator General's office to attend meeting as an observer in recognition of the on-going role of the Office in the implementation of its Evaluation Report		

5.2.3 Capital Dredging Implementation Committee (CDIC)

This CDIC will meet periodically, as required to oversee the operational and logistical issues of the capital dredge campaign and any associated issues arising related to maritime safety and vessel operations (as opposed to environmental issues). Committee members will be:

- Principal's site representative for Dredging and Reclamation Works
- Contractor's representative
- MSQ Regional Harbour Master.

6 Reporting

As required in legislative conditions, an annual compliance report will be produced within three months of the annual anniversary date of the commencement of the Action (4 March 2020). The report will provide detail of the Compliance with the conditions of the EPBC Approval 2011/5979 including an overview of environmental incidents, complaints or impacts related to MNES, and corrective actions as needed, noting exception reporting occurs throughout the year.

Copies of this annual report(s) will be kept on-site, will be published on the CU Project website in accordance with Condition 36 of EPBC Approval No. 2011/5979 and will be available for regulatory inspection.

The Port will report to DCCEEW (or successor agency) any exceedance of performance criteria, along with the implemented risk management, adaptive management strategies, corrective actions or emergency response measures, within 21 days of an exceedance or action/response. Refer to Section 11 for each Risk Elements relevant to this DMP and their individual reporting requirements.

6.1 Complaints Handling

A Community and Stakeholder Engagement Plan (CSEP) has been developed which details the engagement methods which will be used during the CU Project. This document is published on the Port's website (https://www.townsville-port.com.au/projects-development/channel-upgrade/management-monitoring-plans/). Relevant information on the implementation of the DMP will be communicated through the mechanisms established in the CSEP.

Complaints represent an opportunity for improvement and enhancement of environmental performance. All complaints relating to the CU Project, including those from members of the public, stakeholder groups and regulators, will be investigated and responded to in accordance with the complaints process detailed in the CU Project's CSEP.

Complaints received directly by the Corporate Affairs and Capital Works PR Officer CU must be recorded, including investigations undertaken, conclusions formed and actions taken. Complaints can be made verbally, via email or via the Complaint Lodgement page https://www.townsville-port.com.au/community/lodge-a-complaint/ on the Port's website. The Corporate Affairs and Capital Works PR Officer CU will notify the CU Project Team Line Managers who will assign a lead (pending on nature of complaint), to investigate and implement corrective measures where required.

The Corporate Affairs and Capital Works PR Officer CU is responsible for maintaining the Register of Complaints. Notification about the complaint and any associated response will be provided to Port Management in a timely fashion and all outcomes of complaint(s) will be communicated to Port Management for further review. The outcome of the investigation and corrective actions, where required, will be communicated to the complainant to close out the issues raised.

Complaints received directly by Hall Contracting, must be referred to the Hall Project Manager or Health, Safety and Environment (HSE) Advisor in their absence. When the complaint is received, the following information is to be recorded: - The time, date, name and contact details of the complainant and reason for complaint.

This information will then be forwarded as soon as possible onto the Port of Townsville along with information on any investigation undertaken, conclusions formed, any actions taken, for follow up and close out, by both Hall to the satisfaction of the Port. Note that actions to respond to complaints should not be taken without first consulting the Port CU Team to confirm the most appropriate response.

6.2 Records

During construction activities, DMP records will be maintained as objective evidence of compliance with environmental requirements. All records will be maintained according to the Port's Record Keeping Procedures or as required by the legislative conditions. All DMP records will be retained electronically, including but not limited to:

- Induction and any specific environmental training records;
- DMP reviews and version control;

- Monitoring data sheets, calibration records, results and internal and external environmental reports;
- Environmental incidents, complaints, exceedances of performance criteria and/or early warning triggers, and non-conformance and corrective action reports; and
- 'Issued for Construction' and 'As Constructed' drawings and specifications signed off by a suitably qualified person (RPEQ where applicable).

Records will allow auditing and encourage the use of preventative action, as well as corrective action following any non-conformances or early warning triggers. Records will be made available to the regulators as requested.

7 Environmental Training

All personnel engage with the CU Project will have appropriate qualifications and experience to undertake their works. Additionally, all personnel involved with the dredging aspects of the project will receive relevant environmental training to ensure they understand their responsibilities when implementing the DMP. All personnel involved with the project will complete both the Port of Townsville Induction, and the Hall Induction before commencing works; and a record of all inductions will be kept on site (note: all personal means Port staff, Hall staff, additional contractors, and subcontractors).

The compulsory induction will cover general environmental management requirements, site-specific and work-specific risks, site-wide controls and mitigation measures. The environmental component of the induction will include, but not be limited to:

- Relevant legislation and approvals, General Environmental Duty and Duty to Notify and General Biosecurity Duty;
- Cultural Heritage Duty of Care responsibilities and the implications of failing to fulfil these duties;
- Key sensitive areas in and around the works area (including GBRWHA and MNES);
- Environmental values, management requirements and responsibilities under the DMP;
- Implementation of mitigation measures and corrective actions and reporting of environmental
- Incidents and complaints procedures;
- Environmental emergency response procedures (i.e. spill kit locations) and training in the use of this equipment;
- Code of conduct and behaviour expected on site; and
- Marine fauna observer training (also as outlined in the MEMP)

An induction register will be maintained to record induction attendance for all staff, contractors and visitors. All project personnel attending the induction will be instructed that all external communication pertaining to the Project is to be conducted by the Contractor's Representative or the Principal's Site Representative for Dredging and Reclamation Works, communication by others is only on consultation with and authorisation by the Port of Townsville Chief Infrastructure Officer.

To assist with managing environmental risks associated with the works, understanding the required mitigation measures and corrective actions, certain roles require specific training. Training records will be maintained and kept on site for the duration of the CU project, up to and including the post works completion report.

All CU Project personnel attend regular toolbox talks which include raising environmental awareness and educating personnel on environmental issues related to all aspects of dredging.

8 Incidents and Non-Conformances

8.1 Environmental Emergencies

Environmental incidents and emergencies will be managed by the key project contacts are listed in Table 10.

Environmental emergencies will be reported to the relevant line manager in the first instance for initial response and activation of the Manager Environment CU and Contractor HSE Advisor. Additionally, the Principal's Site Representative for Dredging and Reclamation Works will be notified, and the Contractor and CU Environmental Advisors will be engaged to provide further technical advice, input and response for the environmental emergency. As per any incident that may occur at the Port of Townsville, the Port Control Tower Duty Officer will be made aware of all emergency situation.

The Manager Environment CU will be responsible for notifying all relevant authorities within the deemed timeframes. The Principal's Representative will be responsible for notifying the Port Executive.

The *Woomera* maintains a *Shipboard Oil Pollution Emergency Plan*, which outlines the roles, responsibilities and actions to be followed should an uncontrolled release of oils/fuels occurs. Each vessel owner/operator are responsible for ensuring all crew are trained and accredited in accordance with the Australian Maritime Safety Authority (AMSA) requirements for Australian Coastal Voyages.

Each vessel associated with dredging (dredge, tugs, small craft, etc) has a number of lines of communication available at all times in case of emergencies, including VHF and UHF radio, mobile and satellite phones.

Table 10. Environmental Emergency Contact details

Reporting organisation	**Initial contact details**
Principal's Representative	cugeneral@townsville-port.com.au
Principal's Site Representative for Dredging and Reclamation Works	cugeneral@townsville-port.com.au
Contractors site representative	town-ops@hallcontracting.com.au
Contractor Project Manager	town-ops@hallcontracting.com.au
Works Engineer CU	cugeneral@townsville-port.com.au
Manager Environment CU	cugeneral@townsville-port.com.au
Safety Representative CU	cugeneral@townsville-port.com.au
Port Control Tower	dutyofficer@townsville-port.com.au
Townsville Regional Harbour Master (RHM)	Townsville.maritime@msq.qld.gov.au
Australian Maritime Safety Authority (AMSA)	1800 627 484
Maritime Safety Queensland (MSQ)	Townsville.maritime@msq.qld.gov.au

Note: For privacy, specific contact details have been left out of this public document. Specific contact details will be provided to the Dredge Vessel Master, Tug Master, and Reclamation Superintendent.

8.2 Environmental Incidents

All project personnel and contractors will report all environmental incidents and near misses i.e. events that occur that have or could have negatively affected the environment) to the Contractor's Project Manager and CU Environment Team (Environment Manager CU, Environmental Advisors CU).

Examples of environmental incidents include:

- Minor fuel/chemical spills to water;
- Contained fuel/chemical spills;
- Fire and/or explosions;
- Unearthing of unknown historical or cultural heritage items;
- Minor sediment and erosion control failure;
- Uncontrolled release of dredged sediments from the barges; and
- An action or near miss with potential or actual environmental impacts (e.g. marine fauna strike/entrainment/entrapment).

Near misses will be reported to the Port as these are pre-cursors to incidents and provide an avenue to proactively mitigate potential incidents before environmental harm is caused.

The contractor is required to report all environmental incidents to the Port of Townsville as soon as practicable and no later than 12 hours after occurrence.

Upon an incident, an environmental incident investigation is to be undertaken by the contractor and provided to the Principal's Site Representative for Dredging and Reclamation Works and Manager Environment CU; where any impacts will be assessed, and corrective actions will be implemented during the investigation. Investigation reports will be submitted to the Port within 5 business days if a serious incident occurs.

The Manager Environment CU will provide an environmental incident notice to the appropriate regulator within legislative timeframes; and will manage any communication with environmental regulatory authorities, noting detail investigation may be pending. Note the master of a vessel must by law report a discharge or probable discharge of any pollutant, as such the Master will submit a Marine Pollution Report (POLREP) if required and POTL and Hall management shall receive a copy of this notification.

Both the CU Environmental Advisor and Hall Environmental Advisor are responsible for maintaining a Register of Incidents; investigating incidents and near misses; maintaining records of incident and near miss investigations, including corrective actions undertaken.

Note that issue-specific corrective actions are detailed in Section 11 in relation to environmental management measures for the dredging works. In the event of any conflict in timing between actions in Section 11 and the incident reporting noted above, the requirements of Section 11 will prevail.

The Manager Environment CU will inform the ITAC of all environment incidents as part of regular ITAC reporting activities. Note this is distinct to water quality exceedances detected through the REMP, which will be managed as described in Section 12.2.

8.3 Environmental Non-conformances

Project work inspections will be carried out by the Contractors, supported less frequently by Port, on a regular basis (timing dependent upon type of work inspected). These inspections will be documented, and any deficiencies/non-conformances recorded for rectification and follow up. Inspections may be carried out by the Contractor, CU personnel, or both.

Non-conformances include:

- An incident or near miss with potential environmental impact;
- An incident with actual environmental impact;
- Reasonable and justifiable complaints regarding the dredging, material transfer, placement or reclamation activities (note all complaints will be further investigated but complaints found to be vexatious or erroneous will not be recorded as a non-conformance);
- Not meeting an objective or performance criteria in the DMP; and
- Environmental inspections not undertaken within the nominated timeframe.

The Contractor's Project Manager is responsible for identifying and implementing any preventative and/or corrective actions in response to any non-conformances. This will be completed in collaboration with Port, overseen and endorsed by the Principal's Site Representative and/or the Manager Environment CU. New preventative and corrective actions will be incorporated into the DMP by the Manager Environment CU where appropriate.

9 Dredge Operation and Equipment

9.1 Dredging Operation Description

The focus of this DMP is for the operation of a mechanical BHD within the Platypus Channel, Sea Channel, Eastern Harbour Entrance Widening and Temporary Unloading Facility (area and approach).

The section of the Platypus Channel that is approved for capital dredging is 7km long, starting at inner harbour entrance. The widening of the Platypus Channel will be to a max width of 248m; and will mostly occur on the western side of the channel (apart from at the Inner Harbour entrance where it will also be widened on the Eastern side).

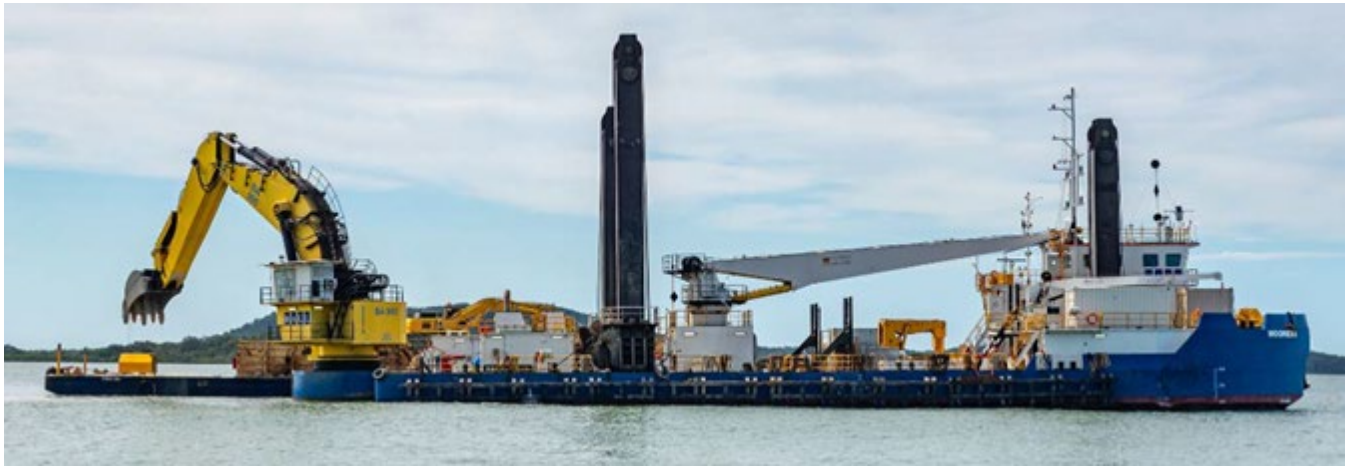
The section of Sea Channel that is approved for capital dredging is 7km long, starting at the intersection with the Platypus Channel (the dogleg), and continuing out to the seaward end of the channel. The widening of the Sea Channel will be to a max width of 120m; and will occur on the eastern side of the channel.

All dredge areas are GPS marked to ensure dredging does not occur outside the approved footprint and will remain within the approved dredge depth and batters.

9.2 Dredge Equipment, Material Transport and Placement Methods

The BHD *Woomera* is a platform mounted excavator on a fabricated pedestal located on one end of a spud-rigged pontoon (Figure 15). The spud locations on the pontoon are necessary to provide a positive reaction to the hydraulic digging action of the excavator arm. A single digging bucket is located at the end of the excavator arm and can dig approximately 14.7m^3 of material in one lift. The excavator arm, between the bucket and the body of the machine, has three points of rotation, all in the same plane to allow for extended reach. High-pressure hydraulic cylinders control the movement of each section relative to the other.

Figure 15. Mechanical backhoe dredge *Woomera* (side view)



The *Woomera* utilises an RTK-GPS positioning system. This system provides centimetre accuracy in horizontal and vertical plane. A monitoring system shows in real time the position and configuration of the boom, stick and bucket relative to the chosen reference datum and coordinate system used.

This monitoring system is connected to the RTK-GPS system. It provides the dredge operator accurate real time dredge information; the position of the bucket relative to the design to be dredged; and shows the actual survey data and the dredge design. The display as seen/used by the dredge operator in the cabin are shown in the Figure 16.

Figure 16. Monitoring system within the *Woomera*

When starting the dredging works, the BHD will be positioned at an appropriate location inside the dredging area. The dredging area will be divided into cuts of a certain width, depending on the depth and the relative reach of the dredger. The backhoe dredger will complete small steps, dredging a cut in circular segments, before being relocated to the next cut.

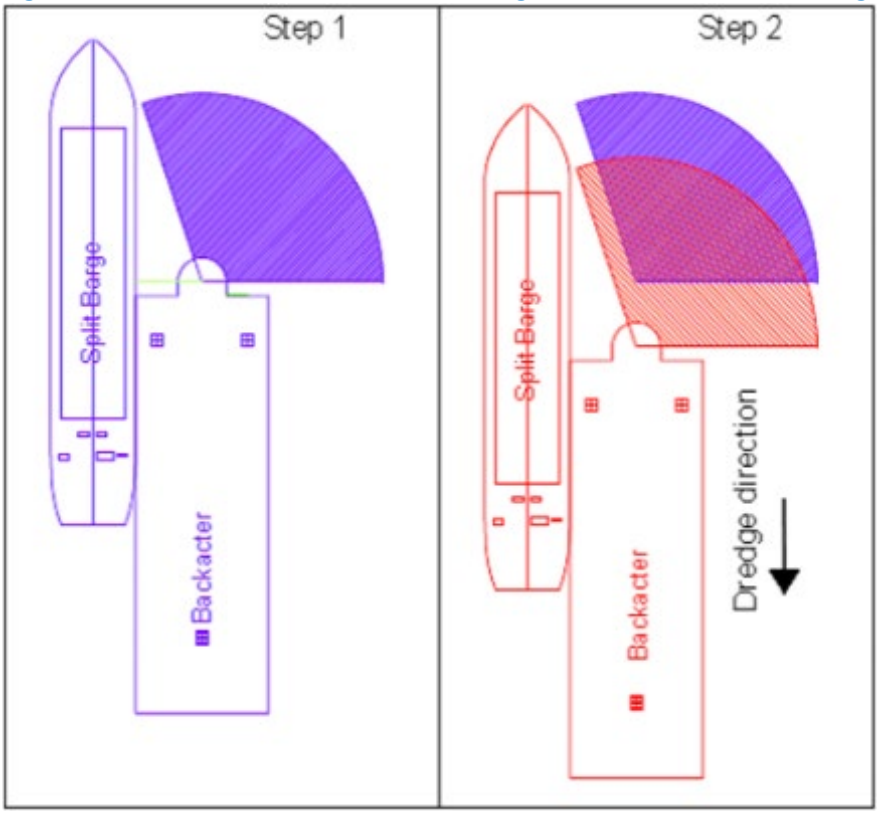
Once the dredger is in the correct position the spuds will be lowered, the bucket will then be lowered to the required level, and dredging can commence.

To control the dredging operation, monitors on board the dredger will display the geometry of the dredging area, latest bathymetric survey and an outline of the vessel, including the dredging arm in cross view. Inputs for this system are generated by data from angle and displacement measurement devices, RTK-GPS receiver positioning information [including vertical reference], and the gyrocompass.

The BHD's computer has a minimum of two screens. Each screen is a graphical representation of the excavator while in operation. One screen provides a top view of the entire excavator and dredged area. The second screen provides a cross section of the entire excavator including the cut width. The entire dredge monitoring system will be calibrated prior to commencement of dredge operations, an exercise which will be repeated on a regular basis to confirm the correct position and dredging depth are being maintained.

Once a circular section segment has been completed, the dredge's bucket will be positioned on the seabed to fix the heading of the pontoon. The spuds will then be lifted and a step made. After it is verified that the pontoon is level and has the correct heading, dredging in the new area can commence (Figure 17).

Figure 17. Movement of the backhoe dredge after a circular section segment has been completed



The dredge material removed by the BHD bucket, will then be placed into a flattop barge, moored alongside the BHD's pontoon deck. The backhoe dredge will excavate the material from the dredging area by means of its bucket and place the dredged material into the hopper on/in the barge.

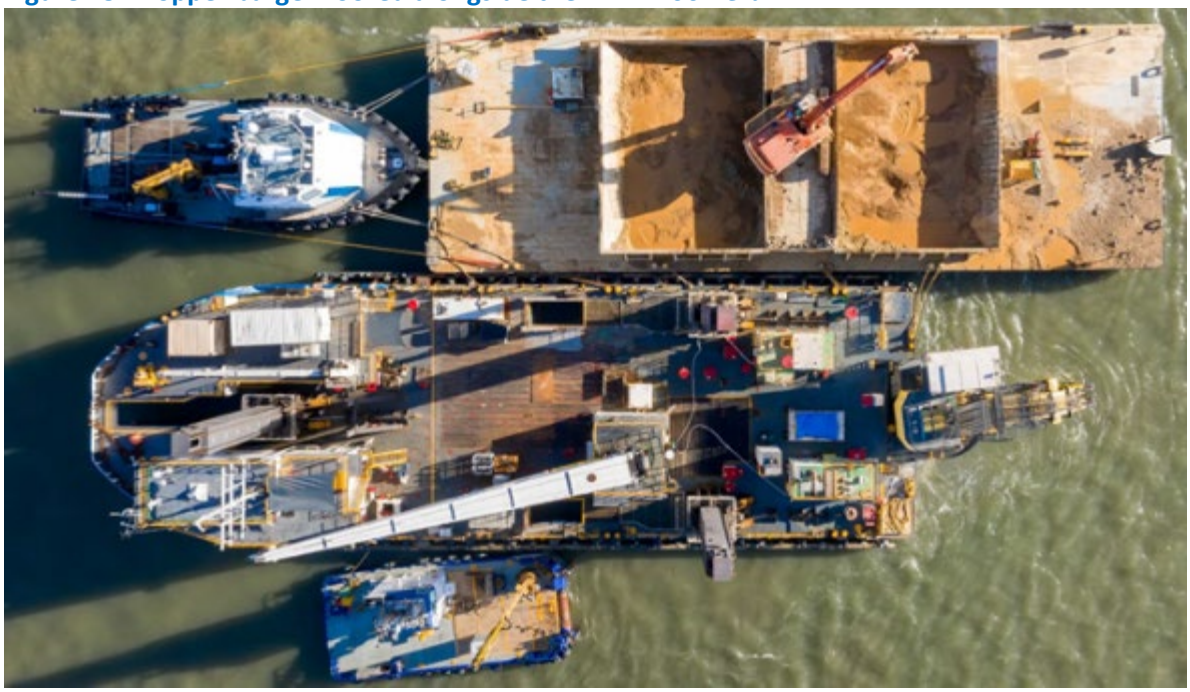
A tug vessel will be positioned either in front, behind or on the side of the hopper barge upon completion of the loading operations. The hopper barge will then cast off from the backhoe dredge's pontoon and the tug will tow or push the hopper barge to the Temporary Unloading Facility. Figure 18 shows the barge moored alongside the BHD and supported by a tugboat.

The hopper barge will be unloaded by excavator(s) once moored at the unloading facility. Unloading excavators are positioned on land with smaller excavators positioned on the transport barges to assist access by the excavators based on the unloading facility. The excavators place the material into dump trucks for final placement into the reclamation area. One or two excavators will empty one hopper. The transport barges will be moored alongside the unloading jetty adjacent to the reclamation area, until the barges have been unloaded.

A second hopper barge will then moored alongside the backhoe dredge once the first barge has headed to the unloading facility. Loading of the second hopper barge occurs, while the first hopper barge is being transported/unloaded, this allows for an uninterrupted dredging and loading process.

Upon completion of the unloading operations, the tug with the now empty hopper barge will sail back to the BHD and the dredging cycle will start again. Whilst generally 2 barges are used, additional hopper barges can be deployed if required to optimise the dredging time of the BHD and minimise delays to the dredging program. It is currently proposed that up to three barges will be utilised on this project; however, the number of tugs and barges deployed at any given time is depending on several parameters and can vary throughout the project, depending on: dredge digging rate, dredge material, sea state, sailing distance, offloading rate, and vessel traffic, etc.

Figure 18. Hopper barge moored alongside the BHD *Woomera*



9.3 Temporary Unloading Facility and Placement Activities

The CU Project required the development of a temporary facility for the unloading of capital dredged material from the dredge barges to the reclamation area. The facility consists of a platform constructed perpendicular to the CU reclamation area and an access channel and swing basin to allow for all-tide safe access by tugs and barges (shown in Figure 10). The facility incorporates a rock breakwater on the ocean side (including geotextile), sheet piling to create the unloading area and infill of the facility with sand and gravel to create a working platform. These facilities are temporary and do not form part of the final PEP structure; it will be removed when not required.

The unloading facility was constructed from the land side using articulated vehicles and excavators for the breakwater, with marine-based plant utilised to install piling. Construction used stockpiled rock and sand from the reclamation construction works/Port lands, or new material imported to site from local quarries as required.

Sheetpiles and cylinder piles (for tieback and mooring arrangements) were installed with controls implemented in accordance with the Environmental Procedure for Pile Driving (Appendix I of MEMP).

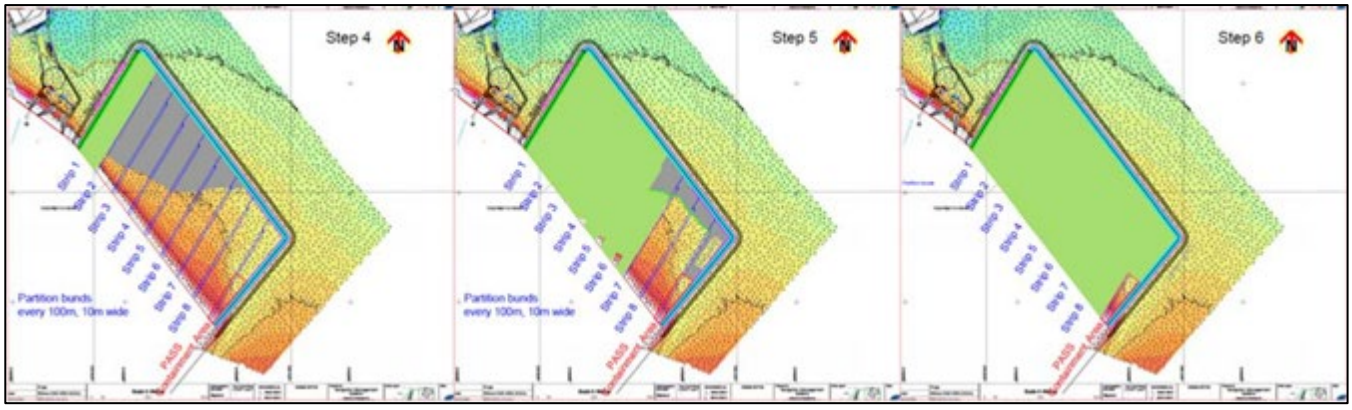
The design of the facility and breakwater has been subject to design criteria assessments, based primarily on weather and tidal conditions and geotechnical and rock stability, in accordance with relevant Australian Standards or design guidelines. Note that these works are separate to the rockwall construction, are temporary in nature and are not retaining dredge material as such are not incorporated in the Reclamation Integrity Plan.

A wide perpendicular setup allows for full dump truck manoeuvring on the platform without the need for multiple access points. This facilitates queuing of dump trucks and continuous unloading of the dredge material from the barge. Unloading is undertaken using an excavator, located on the platform, rather than utilising barge-mounted excavators, though barge-mounted excavators support the unloading process by moving material to balance the barge and ensure the land based excavators can reach all the material.

Dredging was required to be undertaken prior to the completion of the unloading facility (e.g. for the facility access). This dredging was undertaken with the *Woomera,* which dredged material into hopper barges. As the unloading facility was not yet operational these barges were unloaded at an existing barge ramp / offloading facilities within the port, which is used for similar barge loading and unloading operations (including unloading of dredge material). From these facilities, dredged material was transported to the new reclamation area and material placed by articulated dump trucks. Management controls were implemented to minimise loss of material to waters at the unloading location, and to address spillage from the dump trucks during transit to the placement area.

Placement of dredge material from the *Woomera* will generally occur within the reclamation area from West to East. The stiff to hard material was placed along the inside of the rock-wall to provide additional sealing of the rock-wall prior to the main filling operations; where possible acid sulphate soils (ASS)/potential ASS (PASS) material will be preferentially managed by placing under the water to avoid ASS issues (Figure 19). However day to day sequencing will change in response to the material as it is dredged, this is because material can range from stiff to hard material through to self-leveling material so that needs to be managed for operational and on ground safety.

Figure 19. Proposed reclamation filling sequence



Once the barges have docked at the Temporary unloading Facility (or other facility), the environmental management controls for the activity is covered by the CEMP (POT 2135) (as required by Condition 10 of the EPBC Controlled Action Approval). The CEMP document includes the Acid Sulfate Soil Management Plan (POT 2100); and Tailwater Management Plan (POT 2101).

All dredge operations including the transport of barges to and from the reclamation/dredge area are to be coordinated with Port of Townsville to prevent any hindrance to the other port users or to shipping. The contractor project team will meet with the Port as a minimum on a weekly basis, or more frequently if required to ensure delays in commercial operations are avoided. Meetings with RHM or other relevant parties are to be held as required to ensure good communication for any simultaneous operations.

Bunkering

All fuel bunkering operations will only commence/proceed when approval has been obtained from Port Control. It is anticipated that the tugboats will refuel alongside a berth or at the temporary unloading facility. The tugboats will transfer fuel to the backhoe dredge in the dredge area.

All Ship Oil Pollution Emergency Plans (SOPEP) and port regulations will be strictly adhered to during bunkering. Spill kits of sufficient quantities will be available during bunkering ready for deployment. A bunkering procedure has been developed by the contractor for use on the project.

Maintenance

General maintenance on the dredge will be carried out regularly for the duration of the project. General maintenance does not require berth space and will be carried out in the dredge area. For specific repair days, or major breakdown the backhoe dredge will be moored alongside a berth or the Temporary Unloading Facility to facilitate loading/unloading of equipment, spares and undergo repairs to guarantee a more efficient repair of the equipment.

Capital Dredging to Maintenance Dredging Hand Over

Given the 2+ year duration of the CU Project, dredging there will be natural infill of sediment into the dredged areas once dredged during the capital dredge campaign. Completed sections of the dredge footprint will be progressively handed over to the Port of Townsville once sections have been completed, following confirmation by a post-dredge survey by the Contractor and a Clearance Notice has been issued by the Port.

All maintenance dredging will then be undertaken in line with the Port's LMDMP and existing maintenance approvals. No maintenance dredging or placement will be undertaken under this document.

10 Potential Environmental Impacts and Risks

10.1 Threats to Matters Protected Under the EPBC Act

As described earlier, the EIS/AEIS were assessed under EPBC Act, as it was considered the project may impact upon both MSES and MNES, including:

- World Heritage properties
- National Heritage places
- Wetlands of international importance
- Listed threatened species and communities
- Listed migratory species
- Commonwealth marine areas
- GBRMP.

And more specifically seagrass, coral, marine megafauna (including turtles, whales, dolphins, and dugongs), and water quality of protected areas.

10.2 Potential Impacts

Capital dredging activities have the potential to impact on environmental values in the marine environment and MNES to varying levels (shown pictorially in Figure 20). The risk posed to key elements has been assessed for the CU Project, based on the risk management guidelines within the Port's Quality Management System (risk tables reproduced in Appendix 1) and the DCCEEW's Environmental Management Plan Guidelines.

The residual risk level for each element has been detailed in Table 12 in Section 10.4. These elements and risks have been subject to detailed analysis in the EIS and AEIS, with key issues to be addressed also governed by the Stated Conditions of the CGER and the EPBC Controlled Action Approval conditions for the PEP. This residual risk level has been included for each element to ensure that it effectively links to actual mitigation and management actions that will be undertaken as part of the CU project.

The individual elements of the DMP (presented in Section 11) correspond to the key risk issues identified in Table 12 and provide further detail and description around the application of relevant mitigation and management measures. Section 11 provides the mitigation measures, controls and performance targets for each potential threat element of risk; which are:

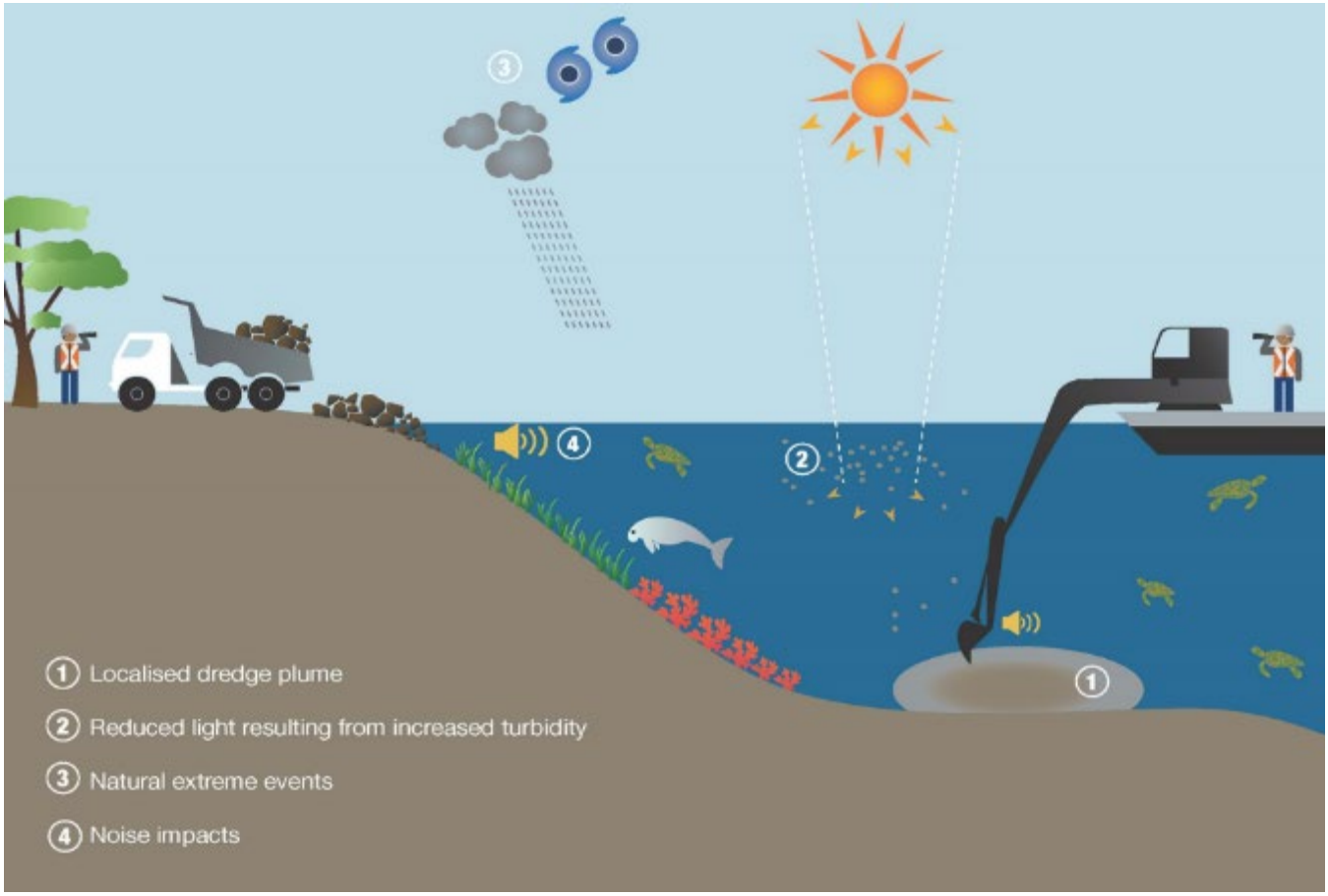
1. Sediment Quality and Contamination
2. Marine Water Quality - Dredging-related impacts
3. Marine Ecology – Benthic habitat
4. Marine Ecology - Marine fauna
5. Vessel Operations - Ballast water management and invasive marine pest species
6. Vessel Operations - Emissions
    - Air quality

- Noise / vibration
- Visual amenity and lighting

7. Vessel Operations - Hazardous material / waste discharges (including fuel bunkering)
8. Vessel Operations - Solid waste management
9. Cultural Heritage
10. Vessel Maritime Safety and Emergency Management.

It should be noted that the risk assessment does not address the management of the reclamation area in terms of the bunded containment area and associated management of acid sulfate soils, stormwater and tailwater as these matters are addressed in the CEMP (POT 2135).

Figure 20. Pictorial of the potential impacts associated with Capital dredging



10.3 Dredge Plume Dispersion Modelling

To understand potential risks, dredge modelling was undertaken in the EIS/AEIS to predict the potential impacts to water quality from potential dredge turbidity. The EIS/AEIS modelling was undertaken based on use of a Trailer Suction Hopper dredge. Since the initial EPBC and CGER approvals were granted, the contracting for the capital dredging and reclamation works for the CU Project has been awarded, and the information regarding the plant and dredge rates to be applied during this stage of works became available. Given the change in dredging methodology this modelling was refined and re-run using the inputs from the dredge equipment for the CU Project.

To assess potential impacts to marine water quality and ecologically sensitive areas from the dredging works as part of the revised design, "zones of impact" were developed as part of the AEIS process by comparing the modelled increases to the turbidity to site-specific threshold values. The zones of impact, which are recommended in the Great Barrier Reef Marine Park Authority (GBRMPA) Modelling Guidelines and are generally based on environmental assessment guidelines for dredging produced by the Western Australian Environmental Protection Authority (2011).

To determine the zones of impact in the AEIS, site-specific threshold values were developed using a combination of water quality (turbidity) and biological tolerances methods. This entailed using baseline water quality monitoring data to set initial threshold values. These values were then compared to biological tolerances from literature values as a 'reality check' to confirm that the threshold values are biologically meaningful. The same process has been applied to the re-modelling for the CU Project. This modelling provides a good understanding of the expected areas of influence and will be field validated during dredging.

The revised modelling of the dredging activity proposed for the Channel Upgrade Project included updated dredging methodology details and an improved representation of the geotechnical properties and particle size distribution of the material to be dredged. The modelling also encompassed a wider variety of possible meteorological conditions, and the periods used for the modelling simulations were selected to ensure a mixture of different seasonal, wind and climatic conditions. The revised modelling included tailwater release, based on approved limits which is considered to over represent the actual tailwater discharge and has not included the barge movement and operation of the Temporary Unloading Facility due to the significant uncertainty of the source rates of these activities. These will be refined following in field validation and monitoring, and are considered to add only a minor component to the sediment levels in the broader scheme of the Project.

Table 11 presents a summary of changes to the dredge methodology between the AEIS and the current CU program.

Table 11. Changes in dredge methodology between AEIS and CU project

Parameter	Port Expansion AEIS	CU Project
Dredging Method	TSHD + BHD	BHD only
Duration	4.5 year	2.5 year
Volume of dredging	5.6million m^3 (including berth 12	3.9million m^3
Sea Channel width	135m tapering to 120	120m for full length
Average design depth	-12.8m LAT + tolerances	-12.5m LAT + tolerances
Reclamation shape	Interim and Final reclamation	Smaller interim reclamation

Figure 21 provides the Zone of Impact outputs from the re-modelling for the CU Project. The expected case results only in a zone of influence, (where plumes maybe noticeable, but unlikely to have any ecological effects), which extends along the coastline from the project footprint to Rowes Bay.

The results of the modelling were processed and analysed using a methodology consistent with that presented in the AEIS (BMT, 2016). As mentioned above, the exception is that this CU project modelling utilised a larger range of meteorological conditions (25 simulations compared to five in the AEIS) and thus presents a more comprehensive and targeted approach than the AEIS.

The aim of the additional modelling study was to confirm that the modelled outcomes were consistent or reduced from what had been assessed (in the EIS/AEIS). Due to the change in dredge, with all the dredging being undertaken by BHD and no work being undertaken by the TSHD this modelling showed significantly reduced dredge-related impacts compared to the AEIS modelling, with:

- no low, medium or high water quality zones of impact (Note 1) was predicted in either the expected case or the worst case for CU dredging; and
- the zone of influence (Note 2) was greatly reduced in size and extent compared to the modelling in EIS/AEIS due to changes in the dredge plant and methodology.

Note (1) The Zones of Impact are defined (as per the methodology in the AEIS) as follows -

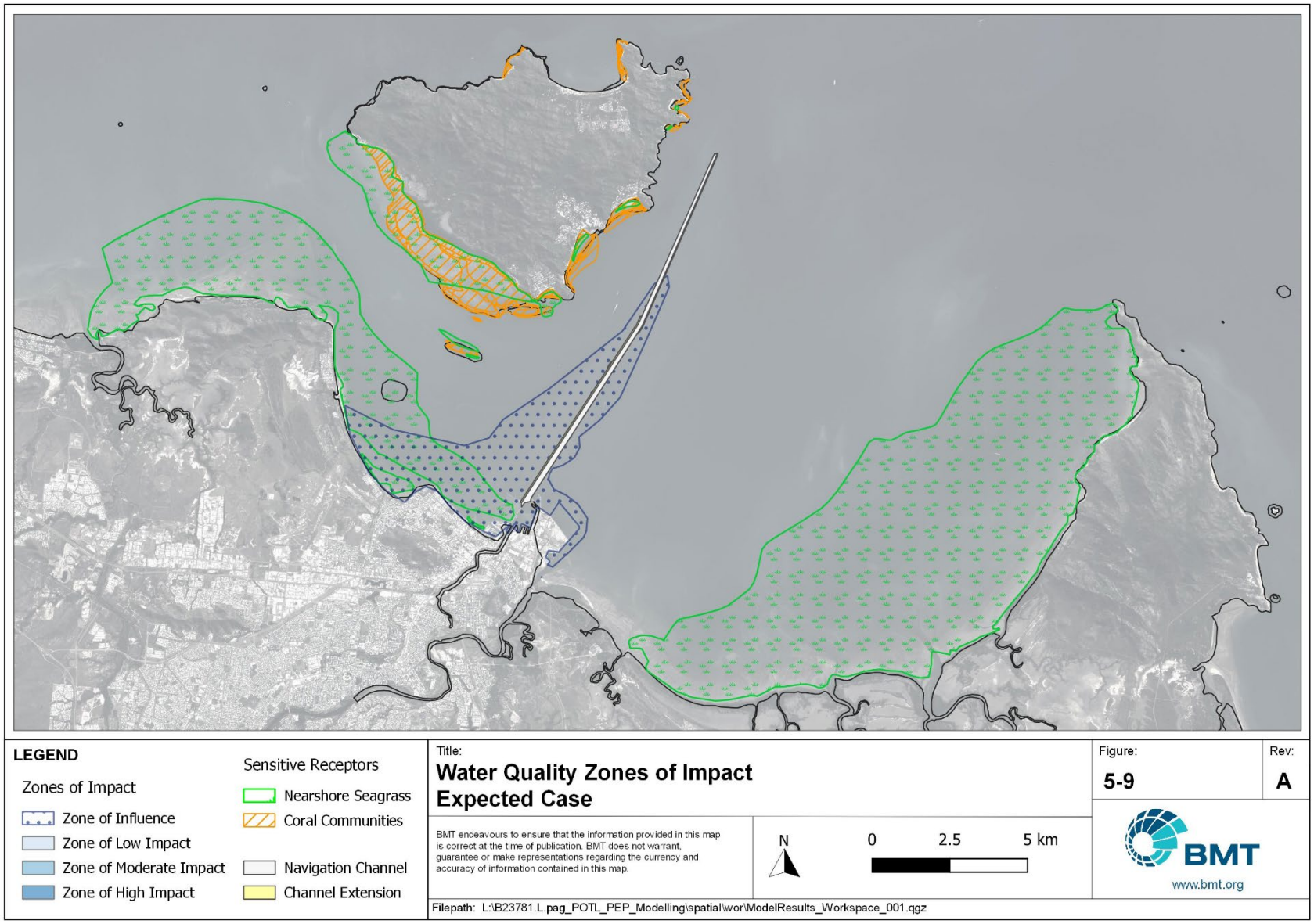
- Zone of Low Impact - water quality may be pushed beyond natural variation potentially resulting in sub-lethal impacts to ecological receptors with a nominal recovery time of approximately 6 months.
- Zone of Moderate Impact - water quality likely to be pushed beyond natural variation potentially resulting in sub-lethal impacts to ecological receptors and/or mortality with a nominal recovery time up to 24 months.
- Zone of High Impact - water quality will most likely be pushed beyond natural variation (excluding extreme weather events) potentially resulting in mortality of ecological receptors with recovery greater than 24 months.

Note (2) The 'Zone of Influence' is defined (as per the methodology in the AEIS) as the modelled area where dredge plumes would be expected to occur and be detectable with water quality instruments, but the concentration and duration of plumes are not expected to result in any ecological impacts to sensitive receptor environments.

These definitions have not changed from the AEIS.

It is important to note these zones are generated by an accumulation of multiple dredge runs, and don't represent an expected dredge plume. This zone of influence represents areas where the modelling indicates a dredge plume may be present at detectable with water quality instruments at a given time.

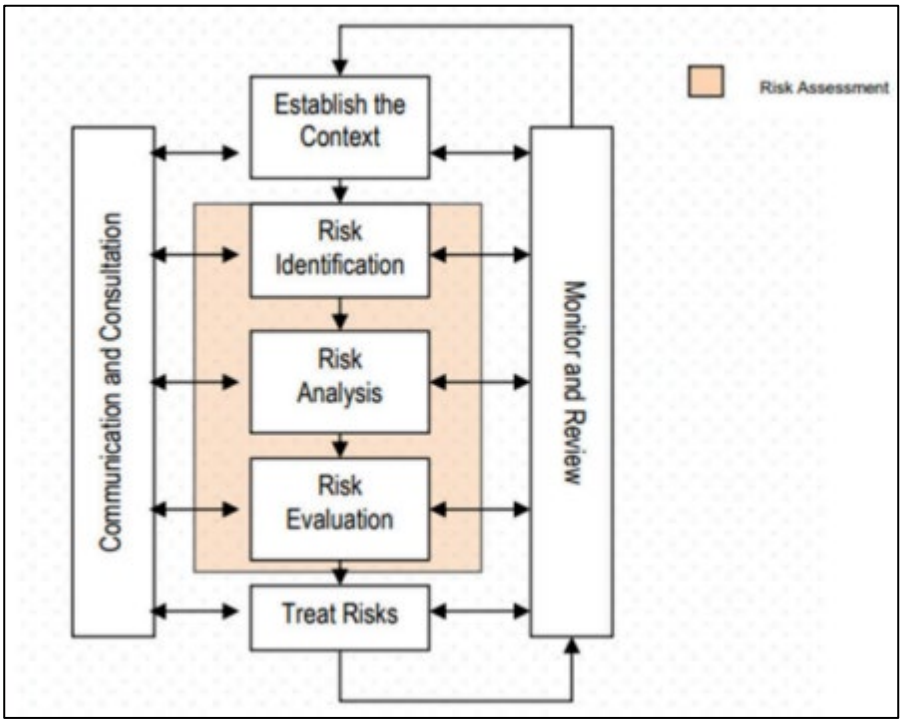
Figure 21. Water Quality Zones of Impact Channel Upgrade Project



10.4 Risk Assessment

The Port of Townsville is committed to the effective management of risks arising for the environment in which it operates. The Port's Risk Management Policy and Risk Management guidelines are consistent with the International Risk Management Standards (AS/NZ ISO 31000-2009). Figure 22 shows the Port's Risk Assessment process. See Appendix 1 for a full list of risk descriptors.

Figure 22. Port of Townsville Risk Assessment Process



The residual risk level identified for each element is in relation to the CU Project specifically, and therefore may be refined in the context of scope of works being delivered in CU Project (Stage 1) when compared to the AEIS assessment (which was for the entire PEP and inclusive of TSHD operations). This residual risk level has been included to ensure that it effectively links to actual mitigation and management actions.

As per the EPBC approval environmental offsets are required for the release of fine sediment as part of the dredging as well as any residual impact to seagrass or inshore dolphin species. As these offsets apply to the *residual* impact of the CU Project, they are not considered a mitigation measure in Table 12 and Section 11. The identification and delivery of offset requirements is set out in the OMS (POT 2094)

Table 12. Risk Overview for the Key Activities and Elements for the CU Project

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Sediment Quality and contamination	Contaminated sediment is encountered and then released into the water column as a result of dredging	Decrease in water quality Indirect potential impacts to human health	Marine water quality Sensitive marine habitats (seagrass and coral) Marine fauna	Unlikely	Serious	Medium	SAP testing of capital dredge sediments prior to dredging[1] See Sediment Quality element in section 11.1	Rare	Serious	Low
Marine Water quality (dredge plume)	Dredging and transferring dredged material may lead to mobilisation and/or spill of sediment into the marine environment	Decrease in water quality Indirect sediment impacts on seagrass and coral habitats (increased turbidity, decreased light, sedimentation)	Marine water quality Sensitive marine habitats (seagrass and corals)	Likely	Minor	Medium (local scale)	Use of a BHD dredge (no TSHD). Receiving Water Quality Monitoring Program incorporating the SPAM	Unlikely	Minor	Low

[1] Based on maintenance dredge material testing over the past three decades, there is a low incidence of contamination historically in the inner and outer port surficial sediments and no material that has been encountered in the outer channels has been unsuitable for unconfined ocean placement.

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
							See Marine Water Quality element in section 11.2			
Marine ecology – benthic habitats	Excavation of the seabed using the BHD	Direct loss of seagrass outside of the dredge footprint / approved impact area	Sensitive marine habitats (seagrass) – outside dredge footprint	Unlikely	Minor	Low	Seagrass survey undertaken seagrass only present in proximity to western breakwater The dredge vessel will only undertake dredging within the approved footprint. See Marine Ecology – Benthic Habitat element section 11.3	Rare	Minor	Low
	Dredging and transferring dredged material may lead to mobilisation and/or spill of	Indirect sediment impacts on seagrass and coral habitats (increased turbidity,	Sensitive marine habitats (seagrass) – local scale	Likely	Minor	Medium	As per Receiving Water Quality Monitoring Program incorporating the	Unlikely	Minor	Low

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	sediment onto benthic habitats of significance	decreased light, sedimentation)	Sensitive marine habitats (seagrass) – broader scale	Unlikely	Minor	Low	SPAM (Section 12.2) Minimising / avoiding dredging in sea channel during defined coral spawning periods in Cleveland Bay See Marine Ecology – Benthic Habitat element section 11.3	Unlikely	Minor	Low
Marine ecology – marine megafauna	Vessel movement and operation may increase interactions between dredge and marine megafauna	Interactions and strikes with vessels may result in disturbance, injury or death of marine megafauna	Marine megafauna	Unlikely	Major	Medium	Measures adopted from MEMP that apply to dredging include staff awareness training; vessel lookouts, observation and avoidance measures; creation of exclusion zones; and reporting of	Unlikely	Serious	Medium
	Underwater noise emissions and vibration from	Noise and vibration may lead to behavioural disturbance to		Likely	Minor	Medium		Unlikely	Minor	Low

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	dredging activities	marine megafauna, including temporarily avoiding affected area					incidents and wildlife stranding procedures See Marine Ecology – Marine Megafauna element in section 11.4			
Vessel Operations - ballast water management and invasive marine pest species	Incursion of marine pest species in ballast water and other dredge equipment	Introduction of marine pest species on endemic marine ecology including fishery species of commercial and recreational significance	Marine habitats	Rare	Major	Low	Selection of domestic (non-overseas) dredge vessel to undertake works Compliance with State and Commonwealth biosecurity regulations including hull and equipment inspections prior to commencement of works See Vessel Operations -	Rare	Major	Low
			Marine fauna	Possible	Serious	Medium		Rare	Serious	Low

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
							Marine Pest species element in section 11.5			
Vessel Operations - Emissions	Air Quality	Air quality reduction through visible exhaust from vessel	Impacts on (human) sensitive receptors	Unlikely	Minor	Low	Dredge vessel (including offloading platform) will not be operating close to sensitive (human) receptors Maintain plant and equipment in good working order The vessel will be operating in areas similar to other vessels using the port. See Vessel Operations - Emissions element in section 11.6	Rare	Minor	Low
	Nuisance Noise	Dredge vessel generating noise during noise sensitive hours (between 6 PM and 6 AM)	Impacts on (human) sensitive receptors							

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	Light spill	Artificial light from the vessel.	Impacts on (human) sensitive receptors Marine and terrestrial fauna	Likely	Serious	Substantial	See Vessel Operations - Emissions element in section 11.6	Possible	Minor	Medium
Vessel Operations - Hazardous materials handling and storage	Accidental fuel spills during fuel bunkering Spills or leakage of fuel/oil and other hazardous materials or dangerous goods from the vessel may cause contamination. Incorrect storage and handling of hazardous	Incidents may occur whereby contaminants are accidentally released to the marine environment	Marine water quality Marine habitats Marine fauna	Likely	Minor	Medium	Fuel bunkering procedures to occur in port under controlled conditions and away from sensitive receptor areas Where bunkering at sea is required, it is to be subject to all port and MSQ controls See Vessel Operations - Hazardous material element in section 11.7	Likely	Insignificant	Low
		Indirect potential impacts to human health.	Human health	Unlikely	Minor	Low		Rare	Minor	Low

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	substances on the vessel may result in release to surrounding marine environment.									
Vessel Operations - Solid Waste generation and management	Incorrect handling and storage on the vessel may introduce solid wastes into the marine environment.	Release of waste may increase the risk of entanglement and/or ingestion by marine fauna.	Marine water quality Marine megafauna	Possible	Minor	Medium	See Vessel Operations - Solid Waste element in section 11.8	Unlikely	Minor	Low
Cultural heritage	Dredging activities have the potential to disturb/ destroy items of cultural significance.	Disturbance of culturally significant items.	Traditional owners	Unlikely	Serious	Medium	No known items of historic or indigenous heritage in dredge footprint Discovery and management protocols if items encountered On-going engagement with	Unlikely	Minor	Medium
	Disturbance or loss of significant Traditional Owner cultural heritage values,			Possible	Serious	Medium		Unlikely	Minor	Medium

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	artefacts or places may occur.						Traditional Owners groups re. concerns or protocols under CHMP See Cultural Heritage element in section 11.9			
	Degradation or loss of general cultural heritage items or places may occur.	Loss or diminishing of cultural values	Non-traditional cultural heritage	Rare	Minor	Low		Rare	Minor	Low

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Vessel maritime safety and emergency management	Operation of the dredge vessel over a long period (2-3 years) in a working port Effects of extreme weather events (cyclones and other natural hazards) on operations and overall resilience of the environment to impact	Vessel collisions leading to loss of dredge material, cargo, fuel or other hazardous substances Ship incidents, damage or collisions due to extreme weather events Reduced resilience of natural values to anthropogenic impacts as a result of natural hazards (loss of seagrass from cyclones/flooding, coral bleaching events)	Marine water quality Marine habitats Marine fauna Impacts on human receptors (loss of life or serious injury)	Rare	Major	Low	Dredging to be undertaken in accordance with vessel movement plans and protocols approved by the QLD Regional Harbour Master including emergency management, spill kits and similar Clear triggers for suspension of dredging activities due to inclement weather and implementation of the Port's cyclone readiness plan Regular audit and review of environmental baseline conditions and	Rare	Major	Low

Element	Primary Impacting Process	Potential Impact(s)	Risk Receptor	Raw Risk Rating			Mitigation Measures	Residual Risk Rating		
				Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
							trends including long term changes to ambient conditions (reported as part of annual compliance report) Monitoring GRBRMPA advice re bleaching Routine coral monitoring include consideration of bleaching See Maritime Safety and Emergency Management element in section 11.10			

[1] Based on maintenance dredge material testing over the past three decades, there is a low incidence of contamination historically in the inner and outer port surficial sediments and no material that has been encountered in the outer channels has been unsuitable for unconfined ocean placement.

10.5 Uncertainty Associated with DMP Success

The CU Project will not be without uncertainties that could influence the ability of the Port of Townsville to fully implement the DMP and associated actions. These uncertainties are varied, with the key risks to the achievement of the plan detailed in Table 13. Control measures and risk ratings are also presented.

Table 13. Key uncertainties associated with Management of the CU Project.

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
Data uncertainty / Inaccuracy	Failure to anticipate impacting activities due to data or information inaccuracies Environmental impacts occur due to incomplete understanding/ misunderstanding of impact, including underrepresentation of impacts in modelling.	Sensitive receptors of Cleveland Bay	Likely	Major	High	The Port will use experienced contractors to design and implement monitoring programs to ensure accuracy and rigorousness. Extensive data collection occurred prior to commencement and externally reviewed through EIS/AEIS. Baseline data collected from	Rare	Serious	Low

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						key monitoring programs prior to commencement for comparison (in most cases 12 months of 'new' data). Adaptive framework to inform ongoing review of appropriate triggers and baselines during the program as new information is collected. Expert input into ongoing monitoring programs to ensure robustness of data, particularly through ITAC review and involvement, and through peer review of			

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						monitoring plans. CU Environmental staff (Manager, Advisors and External Advisors) remain across all monitoring programs to ensure continuation of programs in the absence of a staff member.			
Failure to deliver controls detailed in the plan	Management Controls not delivering mitigation measures Environmental impacts occur due to failure to implement adequate controls.	Sensitive Receptors of Cleveland Bay	Likely	Major	Substantial	Experienced contractors engaged to deliver the dredging. The Port will implement a comprehensive monitoring and auditing	Rare	Serious	Low

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						program to review and confirm compliance with implementation of the controls in the plan. Implementation of key monitoring programs of sensitive receptors to monitor for any potential environmental impacts from the project.			
	Breach of approval condition	Compliance record /Public Reputation				Annual compliance review against approval conditions and approved documents (Management Plans etc) will be undertaken to			

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						demonstrate compliance. Dedicated environmental resources on the Project, by contractors and Port. CU Environmental staff (Manager and Advisors) remain across all approval requirements to ensure continuation in the absence of a staff member. Oversight by Port, ITAC and Project regulatory committee			
Project monitoring not delivered	Monitoring programs not implemented due to lack of commitment,	Sensitive receptors of Cleveland Bay	Likely	Serious	Medium	The Port will use experienced contractors to design and	Rare	Serious	Low

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	funding and resourcing Monitoring program not conducted due to failure to engage contractors or contractor poor performance Environmental impacts occur due to incomplete understanding of impact	Consultant responsibilities Compliance & complaints record				implement monitoring programs. Baseline data collected from key monitoring programs prior to commencement for comparison. Expert input into ongoing monitoring programs to ensure robustness of data, particularly through ITAC review and involvement, and through peer review of monitoring plans.			

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						Detailed contract management process for key monitoring programs to ensure delivery of the program and identification of any limitations early. CU Environmental staff (Manager, Advisors and External Advisors) remain across all monitoring programs to ensure continuation of programs in the absence of a staff member.			
Loss of funding	Project ceases part way through	Workforce	Unlikely	Major	Medium	Funding arrangements	Unlikely	Minor	Low

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
commitment to deliver project	delivery, or delivery reduced due to loss of funding. Environmental impacts occur due to incomplete delivery of project and controls.	Sensitive receptors of Cleveland Bay				established prior to project commencement, including significant Government funding commitments (both Qld and Commonwealth) Regular reporting to Government to justify funding and demonstrating delivery of the project. The Port's commitment to deliver project and will be responsible for any funding shortfall.			

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	Breach of approval condition	Compliance record / Public reputation				Annual compliance review against approval conditions and approved documents (management plans etc) will be undertaken to demonstrate compliance Dedicated environmental resources on the Project, by contractors and Port. CU Environmental staff (Manager and Advisors) remain across all approval requirements to ensure continuation in the absence of a staff member.			

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						Oversight by Port, ITAC and Project regulatory committee			
Severe / Extreme weather	Severe and extreme weather events result in damage to partially constructed infrastructure, which in turn can impact on MNES and marine environment Severe/extreme weather results in loss of contaminants and sediment to the marine environment Severe/extreme weather events personally impacting upon the Port /contractors /monitoring consultants and	Port infrastructure Sensitive Receptors of Cleveland Bay Port employees, Port contractors, Port monitoring consultants	Likely	Major	High	Implement Port of Townsville Cyclone Response Plan which establishes clear actions and steps to be taken in the preparation for, response to and recovery from a cyclone event for the Port of Townsville. The Contractor will develop and implement a site cyclone plan Experienced contractors engaged to	Possible	Serious	Medium

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	equipment – significantly delaying deliverables Severe/extreme weather results in reduced resilience in the coral/seagrass community in Cleveland Bay					deliver the dredging with direct experience working in tropical conditions. Contingency monitoring events for sensitive receptors (seagrass/ coral) CU Environmental staff (Manager, Advisors and External Advisors) remain across all monitoring programs to ensure continuation of programs in the absence of a staff member.			

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						A review of the DMP will be triggered following severe / extreme weather events to determine if there needs to be a significant change in management or monitoring approach (including performance criteria) due to the change caused by the event. This review will occur in conjunction with the ITAC.			
Pandemic outbreak (e.g. COVID 19)	Management controls not delivered due to lack of access to site/ personnel movement controlled.	Port employees, Port contractors, Port monitoring consultants	Likely	Serious	Medium	The Port will engage experienced contractors to deliver the key construction fronts, with	Rare	Serious	Low

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
	Environmental impacts occur due to incomplete delivery of project and controls.	Sensitive receptors of Cleveland Bay				locally based staff where possible. Contractors have COVID 19 response plans to provide contingency and continuity should border restrictions apply.			
	Monitoring program not conducted due to failure to be able to access site/personnel movement controlled	Sensitive receptors of Cleveland Bay	Likely	Serious	Medium	Contractors develop COVID 19 response plans to provide contingency and continuity should border restrictions apply. Detailed contract management process for key monitoring programs to	Rare	Serious	LOW

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						ensure delivery of the program and identification of any limitations early. CU Environmental staff (Manager and Advisors) remain across all monitoring programs to ensure continuation of programs in the absence of a staff member.			
	Breach of approval condition	Compliance record/ Public reputation	Likely	Serious	Medium	Annual compliance review against approval conditions and approved documents (Management Plans etc) will be undertaken to	Rare	Serious	Low

Element	Impacting Process/	Risk Receptor	Raw Risk			Mitigation	Residual Risk		
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk
						demonstrate compliance. Dedicated environmental resources on the Project, by contractors and Port. Oversight by Port, ITAC and Project regulatory committee			

11 Environmental Management Measures

Environmental Management Measures, Activities, Controls and Performance Targets

For each environmental element of risk, environmental management and mitigation measures to address these activities are documented along with overall associated performance objective, performance criteria, monitoring, reporting, corrective actions and emergency response measures. Table 14 provides a description of what information is detailed in the individual environmental value assessments.

Table 14. DMP Element Management structure

Item	Content
Element	The environmental value at the site requiring management, consideration, response strategies and actions during capital dredging/placement
Residual Risk level	The assessed level of residual risk posed from the works on the element Note: Only the highest residual risk rating from Table 12 is included in the following element tables; recognising that it is more precautionary to identify the highest risk for each element.
Objective	The guiding performance objective that applies to the element
Aspects and impacts	The activity and potential environmental impacts that apply to the element
Performance Indicators/Criteria	The measurable performance criteria (outcomes/indicator) by which the success of the objective will be determined
Mitigation Measures	The mechanisms and actions implemented to ensure the objectives are achieved
Monitoring	Measuring actual performance to meet the objectives and Performance indicators/criteria
Corrective Actions	The actions to be implemented if performance indicators and monitoring shows the objective is not being met The contractor will lead implementation of corrective actions unless responsibility is noted as an alternate responsible party
Reporting	The format, timing and responsibility for reporting
Responsibility	Role specific to achieving management of elements

	Note: responsibility has designated to teams rather than individual positions company delegation requirements e.g. Port CU Environment / Port CU Team / Dredge and Reclaim Contractor

For ease of reference the table provided in Appendix 2 summarises the project specific management controls, performance criteria, early warning triggers and corrective actions relevant to MNES for capital dredging activities. This table incorporates relevant aspects from the Environmental Elements tables in the section below (sections 11.1 to 11.10).

11.1 Sediment Quality and Contamination

Residual Risk level	Low

Objectives

Avoid the release of potentially contaminated sediments into the marine environment as a result of capital dredging

Understand the location of any PASS and ensure that the dredging process and programme minimises the risk of oxidisation of any PASS material.

Aspects and Impacts

Impacts to water quality, and sensitive receptors through the disturbance of contaminated marine sediments

Acid generation if PASS material in dredge sediment is allowed to oxidise over extended periods between dredging and placement in the reclamation.

Performance Indicators / Criteria

a) All capital dredging and transfer of dredge material is undertaken and managed in accordance with this document (POT 2095).
b) Characterisation of marine sediments to be dredged is undertaken in accordance with the NAGD
c) PASS and contamination management procedures are implemented and effective.
d) No substantiated complaints are received from regulators or the community in relation to sediment quality and contamination as a result of capital dredging.

Mitigation	Responsibility
A sediment sampling program to be undertaken prior to the commencement of capital dredging. This will address the relevant sampling and testing requirements of the following guidelines: • National Assessment Guidelines for Dredging (NAGD) • Queensland Acid Sulfate Soil Technical Manual • National Environment Protection (Assessment of Site Contamination) Measure	Port CU Environment
The identification of contaminants, PASS or actual ASS material will be mapped and provided to the dredge contractor	Port CU Environment
Management of any identified hot spots will be undertaken via specific management or placement strategies, noting any hot spots of contamination (if relevant) may require additional controls to be implemented for the removal and may be excised separately to clean material, to be treated either in the reclamation area or on land; or transported and disposed at an appropriate onshore facility, in accordance with relevant Queensland guidelines	Port CU Environment to map hotspots and additional controls. Dredge and Reclamation Contractor to dredge and place material appropriately in accordance with management plans
All dredge material is to be managed appropriately during dredging, during transport to the unloading facility, during placement, and during reclamation to ensure releases to the environment are avoided.	Dredge and Reclamation Contractor

Implement and maintain Acid Sulfate Soil and Contamination Management Plan (POT 2100 – Appendix E of CEMP) (to meet Performance Criteria A to C).	CU Project team Dredge and Reclamation Contractor
Training (to meet Performance Criteria A to C) Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements for PASS and contaminated soil management.	Dredge and Reclamation Contractor Manager Environment CU
Monitoring Undertake regular dredge inspections and observations to determine the effectiveness of the mitigation measures (frequency of observations to be determined by sediment sampling and analysis and adapted to particular dredge area). Monitoring conducted as per the Acid Sulphate Soil and Contamination Management Plan (POT 2100). Review/audit toolbox/pre-start records for discussions on ASS and Tailwater monitoring and management where issues arise	**Responsibility** Port CU Environment; and Dredge/Reclaim Contractor Port CU Environment; and Dredge/Reclaim Contractor CU Project team

Corrective Actions

Where performance Criteria a) to d) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- Investigate all incidents in relation to dredging and transport of material to the unloading facility.
- Investigate all complaints received in relation to dredging and transport of material to the unloading facility.
- Implement the requirements of the Acid Sulfate Soil and Contamination Management Plan (ASSCMP) (POT 2100)
- Revise the DMP and implement further controls where investigations show unacceptable impacts to the marine environment directly adjacent the dredge and barges.
- Implement any other corrective actions as directed by regulators.

Reporting

The contractor will keep active dredge logs (daily)

Dredge volumes will be reported to regulatory agencies in accordance with any permits granted.

The Contractor will maintain a log of placement location of barge loads, particularly barge loads with PASS material, for specific management and monitoring as per the ASSCMP.

The Manager Environment CU will report to DCCEEW (or successor agency) any exceedance of the MNES performance criteria, including any implementation of MNES risk management, adaptive management strategies, corrective actions and emergency response measures implemented, within 21 days of the initial incident/exceedance notification.

11.2 Marine Water Quality

Residual Risk level	Low

Objectives

Avoid or minimise disturbance to seagrass and coral reef habitat from dredge related activities (including dredge plumes)
Avoid or minimise the uncontrolled release of dredge material into the marine environment.

Aspects and Impacts

The capital dredge material will be excavated using a mechanical (backhoe) dredge and transferred into barges. Spillage of sediment back into the marine environment may occur from the operation of the dredge and - to a much lesser extent - during the transfer from the backhoe dredge bucket to the barge of from the barge to trucks at the unloading facility.

Dredge material that falls onto the barge decks as material is being placed within the hoppers by the backhoe dredge poses a safety hazard. The barge decks will require washing down to ensure a safe working surface for barge workers on the deck.

The barges will move to the unloading facility where the dredge material will be transferred from the moored barges to trucks and then placed/emptied into the reclamation.

Performance Indicators / Criteria

a) Marine water quality performance limits for receiving environments set under relevant permits and authorities are not exceeded due to dredge related activities.
b) All capital dredging and transfer of dredge material is undertaken and managed in accordance with this document (POT 2095).
c) In-water validation of the dredge modelling aligns with or shows a lesser impact than what was modelled
d) No substantiated complaints are received in regards to water quality impacts from the capital dredging or transfer of material from the dredge to the unloading facility.

Mitigation	Responsibility
The use of an appropriate dredge bucket is used to ensure a clean cut; and the dredge bucket is maintained in good condition, including changing the teeth before they are fully worn.	Dredge and Reclaim Contractor
Hoisting of the bucket must be undertaken in a controlled manner to minimise spillage	Dredge and Reclaim Contractor
Dredge monitoring system implemented at all times to provide live / on line information such as dredge vessel position, position of bucket, actual seabed levels, design depth, design width etc. to accurately target the approved dredge material.	Dredge and Reclaim Contractor

Regular survey of the dredge areas to minimise over dredging as well as to minimise any remedial dredging [i.e. dredge too shallow/ not wide enough]	Dredge and Reclaim Contractor
Visual monitoring of the waters surrounding the dredge and barges for any excessive visible plume created by dredging activities, with dredging activities modified as necessary to minimise plume generation.	Dredge and Reclaim Contractor
Managed fill levels on barges to minimise risk of spill of dredge material.	Dredge and Reclaim Contractor
Cleaning of spilled dredge material from the barge decks is only to occur within the dredge footprint beside the dredge, and before the barge is taken to the unloading facility. This will ensure any turbidity created during the wash board remain in the adjacent waters to the BHD	Dredge and Reclaim Contractor
Ensure barge containing dredged material is brought as close as possible to the unloading facility to minimise risk that spilt material will directly enter the marine environment. Avoid swinging of laden excavator arm over open water.	Dredge and Reclaim Contractor
Any material spilt on the unloading facility to be recovered wherever practicable.	Dredge and Reclaim Contractor
Visual monitoring of the waters surrounding the unloading facility for any excessive visible plume created by transfer activities, transfer activities and controls modified as necessary to minimise plume generation.	Dredge and Reclaim Contractor
Active monitoring of the water quality dashboard to monitor water quality parameters at sensitive receptor sites within the Cleveland Bay.	Port CU Environment, and Dredge and Reclamation Contractor
Review on-site control measures promptly if turbidity plumes are seen beyond the expected modelling parameters	Dredge and Reclamation Contractor; and Port CU Environment
Training (to meet Performance Criteria A to D)	
Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements regarding dredge management.	Contractors Manager Environment CU
Monitoring	**Responsibility**
In-situ marine water quality monitoring to be undertaken as per permit conditions within Cleveland Bay and as outlined in the REMP later in this	Port CU Environment

document for test compliance sites and sentinel water quality monitoring sites	
Monitor weather conditions and alerts relevant to the site, including extreme weather events	Dredge and Reclamation Contractor
Regular (i.e. daily) monitoring of the water quality dashboard; monitoring for trigger alerts, trends, etc.	CU Technical Specialist (contractor), Dredge and Reclamation Contractor

Corrective Actions

- Implement the REMP (see section 12.2 for further detail)
- Mitigation measures and corrective actions by the dredge include: -
  - Relocation of dredging to another part of the dredge footprint
  - Opportunistically scheduling maintenance shutdown days
  - Installation of additional sentinel monitoring sites
  - Temporarily suspend dredging
  - A combination of any or all of the above

Review dredge management practices if adverse impacts are observed

Implement any other corrective actions as directed by regulators

Reporting

The real-time in-situ water quality monitoring data will be made available to the CU Environment Project Team as well as the Dredge and Reclamation Contractor. Weekly meetings will be held at the start of the campaign between the CU Environment Project Team and Dredge and Reclamation Contractor noting the need to provide notifications for any exceedance of trigger levels. Once the initial water quality impacts are validated, meetings are expected to reduce and will be scheduled as required.

Regular oversight of the dredge program and the water quality monitoring program is undertaken with actions considered through ITAC and / or DIAT meetings.

Visual assessments are to be maintained in the daily log with exception reporting to the Port by the Dredge and Reclamation Contractor and full logs summarised in the monthly report

Port CU Environment Team to report to ITAC on trigger level alerts (for response and actions) for test/compliance sites and sentinel sites as outlined in the REMP

The Manager Environment CU will report to DCCEEW (or successor agency) any exceedance of the MNES performance criteria, including any implementation of MNES risk management, adaptive management strategies, corrective actions and emergency response measures implemented, within 21 days of the initial incident/exceedance notification.

The Manager Environment CU will report to DES (or successor agency) any exceedance of the Test/compliance water quality limits and trigger values for receiving environments for seagrass and coral habitat sites.

11.3 Marine Ecology – Benthic Habitat

Residual Risk level	Medium

Objectives

Avoid or minimise direct/indirect impacts to benthic habitat outside the approved dredge footprint
Avoid or minimise disturbance to seagrass and coral

Aspects and Impacts

The capital dredge material will be excavated using a mechanical backhoe dredge and transferred into barges. The barges will be moved by tugs to the Temporary Unloading Facility directly adjacent the Reclamation area.

The approved dredge footprint includes small areas where seagrasses are present, dredging works will result in an estimated, direct loss of approximately 0.8 ha of seagrass habitat

The dredge footprint occurs adjacent to seagrass habitat in Cleveland Bay as well as coral reef habitat at Middle Reef and along the east coast of Magnetic Island; the closest sensitive receptor at Magnetic Island is over 1km from the dredge footprint at Geoffrey Bay

Performance Indicators / criteria

a) Dredging does not occur outside the nominated, approved dredge footprint
b) No sub-lethal or lethal impacts to seagrass and corals due to dredging, beyond the approved dredge footprint, as measured by:
- The Marine Water Monitoring Program (and REMP)
- The Seagrass Monitoring Program
- The Coral Monitoring Program
- Regular surveys to confirm dredged areas remain within the approved footprint

c) The seagrass meadows mapped within the approved dredge footprint are offset in accordance with approval and statutory requirements.
d) Test/compliance water quality limits and trigger values for receiving environments for seagrass and coral habitat sites (as outlined in the Marine Water Quality element) are not exceeded as a result of dredging.
e) No substantiated complaints are received from regulators or the community in relation to benthic habitat issues.

Mitigation	Responsibility
Active monitoring of the water quality dashboard to monitor water quality parameters at sensitive receptor sites within the Cleveland Bay.	Dredge and Reclamation Contractor; Port CU Environment
Review on-site control measures promptly if turbidity plumes are seen beyond the expected modelling parameters	Dredge and Reclaim Contractor
The dredge vessel will only undertake dredging within the approved footprint.	Dredge and Reclaim Contractor

Dredging of the sea channel (which is adjacent to Magnetic Island reefs) will mainly occur in periods of relatively calm sea state (due to vessel operational safety)). Where possible, scheduling will aim to avoid the coral spawning period (associated with the full moons in October and November) however plume generation, and zones of impact from the BHD do not reach magnetic island (figure 21).	Dredge and Reclaim Contractor
Monitoring	**Responsibility**
Dredge position logs are to be reviewed by the Port of Townsville periodically throughout the campaign as well as visual spot-checks of vessel position to ensure dredging has not occurred outside the approved footprint	CU Principal's Site Representative for Dredging and Reclamation Works
Undertake a survey of the dredging areas before the commencement of construction to determine the presence and density of seagrass within the construction footprints (as per EPBC Act Approval Condition 9). Completed in 2020.	Port CU Environment
In-situ marine water quality monitoring to continue as per permit conditions within Cleveland Bay	Port CU Environment
Undertake visual monitoring of the dredge plume around the dredge and barges.	Dredge and Reclamation Contractor
Monitor weather conditions and alerts relevant to the site, including extreme weather events	Dredge and Reclamation Contractor
Regular (minimum daily) monitoring of the water quality dashboard; monitoring for trigger alerts, trends, etc.	CU Technical Specialist (contractor), Dredge and Reclamation Contractor
Undertaken infield dredge plume validation monitoring to confirm model validity	Port CU Environment
Undertake impact validation monitoring of seagrass and coral communities as per the monitoring programs in Section 12.	Port CU Environment

Corrective Actions

Where performance Criteria a) to e) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- Review dredge management practices if adverse impacts are observed
- Implement any other corrective actions as directed by regulators (including if necessary contingency offsets)

Reporting

The Contractor will maintain an activity log, recording the type of activities occurring at different times to assist with the retrospective investigation of any incidents / complaints.

The Contractor will conduct regular spatial surveys of the dredging works to ensure it remains within the identified alignment. Infield model validation to be conducted within 3 months of the dredging commencing in the Platypus Channel. The Manager Environment CU will report to DCCEEW (or successor agency) any exceedance of the MNES performance criteria, including any implementation of MNES risk management, adaptive management strategies, corrective actions and emergency response measures implemented within 21 days of the initial incident/exceedance notification. The Manager Environment CU will report to DES (or successor agency) any exceedance of the Test/compliance water quality limits and trigger values for receiving environments for seagrass and coral habitat sites.

11.4 Marine Ecology – Marine Megafauna

Residual Risk level	Medium

Objectives

To avoid or minimise impacts to marine fauna from dredge vessels
To establish and maintain awareness of the importance of protecting marine megafauna
To protect the acoustic amenity and reduce nuisance noise that may impact upon marine megafauna

Aspects and Impacts

Interactions between project related vessels and marine megafauna may result in disturbance or injury to marine megafauna, including potential vessel strikes, entrainment in the dredge bucket, entrapment within the hopper barge

Noise emissions and vibration from dredge vessels may lead to minor behavioural disturbance in marine megafauna or marine megafauna temporarily avoiding affected areas (i.e. dredge footprint)

Localised turbidity plumes directly around the dredge may temporally affect marine water quality.

Performance Indicators / Criteria

a) All works are to be managed in accordance with the relevant management plans, the *Environmental Protection Act 1994* and all other relevant statutory documents/requirements.
b) No injury or fatality to marine megafauna as a result of dredging or barge/tug movements
c) Key members of the dredging team complete inductions and marine fauna observer training
d) Vessel master and fauna observers trained in marine fauna interaction procedures (fauna handling and reporting etc.)
e) No significant long-term behavioural impacts to marine megafauna from dredging and associated barge vessels
f) No substantiated complaints received from regulators or the community in relation to marine megafauna from dredging or underwater noise

Mitigation	Responsibility
Prior to commencement of dredging activities, employees responsible for marine megafauna spotting will be appropriately trained.	Dredge and reclamation contractor
Ensure suitably trained Marine Fauna Observers are present and active at all times on the dredge, noting observations for megafauna in low light/night time or during rough conditions will be restricted*.	Dredge and reclamation contractor
Ensure suitably trained Marine Fauna Observers are present and active on the tugs used to move the barges to and from the unloading facility; at all times.	Dredge and reclamation contractor
Conduct pre-start checks for marine megafauna in the nominated observation zone prior to commencing key activities (dredging, steaming, etc);	Dredge and reclamation contractor
During all operations on board and around the dredge and tugs, crews are to be vigilant for marine fauna (including behind the dredge/barges).	Dredge and reclamation contractor

	Dredge operations are to cease when marine megafauna are observed within an exclusion zone of 100m (for whales) and 50m (for dolphins, dugongs and turtles) of the furthest extent of the equipment (Including extended dredge arm/bucket); until the animal/s have moved further than 100/50m from the equipment or have not been sighted within the exclusion zone for 30 minutes.	Dredge and reclamation contractor
	Marine megafauna observation in low light/at night will be undertaken, recognising the limitation on being able to see megafauna with limited light* (noting the need to minimise lighting impacts at night).	Dredge and reclamation contractor
	In the event that megafauna is sighted by the tugs, adjusting vessel speed and direction is to occur within the safety constraints of the vessel, to avoid impact on the observed individuals, which are likely to move to the nearest deepwater. For vessels within the shipping channel, they are to continue until they are clear of the shipping channel, before ceasing operation (to prevent safety/hazards to commercial vessels using the shipping channel) Vessels are to remain a minimum of: • For whales 100m around, extending to 300m in front of and behind an individual • For Dolphins, dugongs and turtles: 50 meters around, extending to 150m in front of and behind an individual.	Dredge and reclamation contractor
	Enforce vessel speed limits where appropriate (i.e. less than 6 knots in waters less than 2.5m deep or within 100m of shoreline) to reduce potential marine megafauna collision. *Note: this may be exceeded during emergencies or for vessels requiring higher speed to maintain navigational safety*	Dredge and reclamation contractor
	For underwater noise, ensure that engines and equipment on-board the vessels are properly maintained and in good working order through carrying out regular routine and preventative maintenance	Dredge and reclamation contractor
	Maintain and operate all equipment on-board the vessels in a safe and efficient manner; including: • Keeping equipment well maintained according to manufacturer's instructions and recommendations; • Shutting down plant/ equipment which are used intermittently in the intervening periods between works or throttling down to minimum; • Shutting down plant and equipment when not in use; and • Ensuring that only necessary power levels are used to complete activities.	Dredge and reclamation contractor
	Review the inshore dolphin and marine megafauna monitoring survey results to capture any potentially negative trends forming in behavioural patterns associated with dredging	Port CU Environment

Adopt marine megafauna observation and response procedures (as per MEMP POT 2135, including but not limited to: • Maintaining a lookout for cetaceans, dugongs and turtles while all vessels are operating • Adjusting vessel speed and direction within safety constraints of the vessel to avoid impacts upon observed individuals, including ceasing movement if sighted within the exclusion zone for the appropriate period.	Dredge and Reclamation contractor
Training (to meet Performance Criteria A to F)	
Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements of this DMP regarding marine ecology.	Dredge and Reclamation contractor Manager Environment CU
Monitoring	**Responsibility**
Conduct observations for marine megafauna by all vessel masters and crew during vessel operations on each dredge related vessel, including maintaining a log of when megafauna is sighted (both inside and out of the observation zone), and record any/all action taken to avoid interaction. The log should include observations on conditions, time of day and distance and height from observer.	Dredge and Reclamation contractor
Undertake regular site and vessel inspections to monitor for issues that may adversely impact on marine megafauna; including to identify any need for noise suppression measures, and the effectiveness of measures undertaken.	Port CU Environment; and Dredge and Reclamation Contractor
Review marine strandings data quarterly (where available) to identify any death or injury to megafauna that could be attributed to CU construction activities	Port CU Environment
Conduct noise and/or vibration monitoring as required in approvals or in response to requests from regulators.	Port CU Environment; and Dredge and Reclamation Contractor

Corrective Actions

Where performance Criteria a) to f) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- If injury to marine megafauna occurs, the Contractor is to liaise with the Port immediately to identify rescue options.
- The Manager Environment CU will liaise with DES or GBRMPA immediately to identify rescue options, and develop future corrective actions if injury to marine megafauna occurs.
- All project staff (Port and Contractors) will be required to assist in the capture of injured animals following advice from regulators.
- The CU Environment team will commence an investigation into all incidents or complaints relating to marine megafauna within 24 hours. This includes reporting to the appropriate regulator within the appropriate regulatory timeframes.

- The CU Environment team and Contractor will undertake a review of this DMP and any associated plans to determine if further controls or mitigation measures are needed, where investigations show unacceptable impacts to marine megafauna.
- The Dredge and Reclamation Contractor will implement additional control measures (e.g. revised exclusion zones) where noise related performance criteria are exceeded or potential MNES / marine ecology issues are indicated.
- Any impacts identified via the marine fauna and inshore dolphins monitoring plans as a result of dredge related activities will be reported via the specific monitoring plans and inform reviews of the relevant management plan.
- The Port and Contractor will implement any other corrective actions as directed by the appropriate regulator.

Reporting

The Contractor will maintain an activity log, recording the type of activities occurring during various times of the day/night to demonstrate undertaking of observations and to assist with the retrospective investigation of any incidents / complaints.

All vessel crew will inform the Master as soon as possible in the event of a marine megafauna disturbance issue, or vessel strike/accident. The vessel Master is to then compile an incident report of all the details of any incident involving marine megafauna; and report to the Manager CU Environment.

Project personnel are to report to the Manager Environment CU or Environmental Advisor CU as soon as possible in the event of a marine megafauna incident or a significant underwater noise issue. The Manager Environment CU will investigate and report to the CIO with any additional investigation(s) undertaken as required.

The Manager Environment CU will report to DCCEEW (or successor agency) any exceedance of the MNES performance criteria, including any implementation of MNES risk management, adaptive management strategies, corrective actions and emergency response measures implemented within 21 days of the initial incident/exceedance notification.

Any injury to marine megafauna shall be recorded and reported immediately via the DES online incident report. Observed sick or dead marine animals shall also be reported to DES (on 1300 130 372) immediately. Details of the incident are to be compiled into a project incident report. For clarity, it is expected this reporting requirement is irrespective of whether the megafauna is dead or alive.

All marine fauna observations logs will be reported to the CU Environment Team on a regular basis to ensure a record of sighted animals is maintained, indicating the sighting of each individual animal and any actions taken. This shall be tabulated as part of a monthly report during the dredging campaign. These logs will include number of observations undertaken, all fauna observations (including those outside the exclusion zone), and note if stop works occurred, environmental delay or alternative actions undertaken to avoid fauna interaction.

The Dredge and Reclamation Contractor will maintain records of all inductions and training undertaken by Dredge vessel Masters, Tug Operators, small vessel operators, and fauna observers that included relevant marine megafauna management requirements.

* while the ability to observe megafauna at night or in rough conditions may be limited, this is offset by the reduced risk of interaction through the use of a backhoe dredge only (stationary, slow and steady movement) and no TSHD.

11.5 Vessel Operations – Ballast water management and invasive marine pest species

Residual Risk level	Medium

Objectives

To avoid the risk of translocation of introduced or invasive marine pest species in ballast water
To avoid the risk of marine pest species on the hulls of all capital dredge related vessel, including barges, tugs and small vessels associated with the project.
Ensure compliance with all quarantine and biosecurity measures for bio-fouling and ballast management is achieved

Aspects and Impacts

Project related transport of introduced or invasive marine pest species to Cleveland Bay via in-water shipping of dredge equipment (dredge, barges, small vessels etc).

Project related vessels and equipment arrive to site without adequate pest management prior to use on the CU project.

White Colonial Sea Squirt has been identified in the Townsville Marine Precinct where support vessels for the project may be moored.

Performance Indicators

a) All ballast water exchange is undertaken in accordance with legislative and requirements of the Regional Harbour Master and the relevant management plans.
b) No introduced or invasive marine pests are translocated on the under-keel hull of vessels or on dredging equipment
c) Existing populations of introduced or invasive marine pest species are controlled to prevent spread beyond known sites
d) No new introduced or invasive marine pest species occur from dredge related activities

Mitigation	Responsibility
The dredge and barges including dredge bucket and barge hoppers, are to be thoroughly cleaned and inspected at the port of origin to ensure that sediments, organic matter, or water is not transported to the Townsville port area.	Dredge and Reclamation contractor
All vessels are to be free of White Colonial Sea Squirt before commencing operations for the CU Project; and maintained as such for the duration of the project.	
In accordance with the National Bio-fouling Management Guidance for Non-Trading Vessels (Australian Government 2008), those responsible for any vessels associated with CU capital dredging activities, will: • Assess the biofouling risk of the vessel prior to departing from the port of origin;	Dredge and Reclamation contractor and sub-contractors

• Undertake regular inspections of areas most prone to biofouling (e.g. damaged paint, propellers, bow and stern thrusters, sea chests and cooling pipes); • Implement a regular schedule for maintenance and dry docking to apply antifouling coatings; • Regularly ensure marine growth prevention systems are operating efficiently and effectively; • Inspect vessel hulls, hoppers and/or dredge gear to ensure that no material which may transport organisms (sediments, organic material, or waters) is retained;	
In accordance with the International Maritime Organisation (IMO) Ballast Water Convention 2004, the contractor will ensure the following occurs during transit to the Port of Townsville: • No deep water ballast exchanges to occur within the GBRMP. • Any ballast tanks holding seawaters to be exchanged with a minimum of 150% of design volume with seawaters at a location as distant from the coastline or other shallow (<100 m) areas as possible but not less than five nautical miles from the coast. • Any waters held in barge hoppers during transit to Townsville is to be treated as for other ballast water	Dredge and Reclamation contractor
Throughout the duration of the campaign, relevant State and Commonwealth requirements pertaining to ballast water management and marine pest species are complied with	Dredge and Reclamation contractor
Implement appropriate marine pest control measures where necessary	Dredge and Reclamation contractor and specialist subcontractor (if required)
Training (to meet Performance criteria A to D)	
Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements for pest management.	Dredge and Reclamation contractor Manager Environment CU
Monitoring	**Responsibility**
Regular visual inspection of all vessel hulls and dredge equipment for the presence of marine pest species during the program	Dredge and Reclamation contractor
Undertake Marine Pest monitoring as per QSEAS program, as part of the Queensland Government's early warning surveillance program for introduced / invasive marine pest species.	Port CU Environment
Monitor National Introduced Marine Pest Information System (NIMPIS) database and Department of Agriculture and Fisheries (DAF) detections information bulletins to stay informed in regards to recent detections (emerging pests) within Qld.	Port CU Environment Dredge and Reclamation contractor

Review/audit toolbox/pre-start records for discussions on invasive marine pests (IMPs)	Port CU Environment

Corrective Actions

Where performance Criteria a) to d) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- If an unintentional release or exchange occurs, review of ballast and de-ballasting procedures and rectify immediately
- If marine pest species are encountered on ships hulls or other equipment, the Contractor is responsible for treating and removing all pests in accordance with Commonwealth and State biosecurity instructions before commencing or resuming work, to prevent the spread.
- The CU Environment Team is to undertake a review of this DMP to determine if further controls are needed where investigations show new or expanded marine pest species/locations are found
- Investigate all incidents or complaints in relation to pest infestation promptly and undertake appropriate actions, including those as directed by State or Commonwealth Regulators.

Reporting

The Contractor will maintain a log of ballast water exchanges in accordance with Regional Harbour Master and Biosecurity Queensland requirements.

A record will be kept of volumes, location and time of all ballasting and de-ballasting operations

The Dredge and reclamation contractor will maintain an activity log, recording the type of activities occurring during various times of the day to demonstrate undertaking of observations and to assist with the retrospective investigation of any incidents / complaints.

The dredge and reclamation contractor will maintain vessel maintenance logs, including regular inspections for biofouling, and any actions undertaken (drydocking/antifouling/etc).

All Project personnel are to inform the Manager Environment CU or Environmental Advisor CU of any pest outbreaks or potential infestations/incursions. The Manager Environment CU will investigate and report to the CIO, with any additional investigation(s) undertaken as required.

Identification of detections of invasive marine pests, including through the Invasive Marine Pest Monitoring Plan, NIMPIS database and DAF detections information bulletins, to be reported to the Project Manager and the Principal's Site Representative for Dredging and Reclamation Works.

11.6 Vessel Operations – Emissions (Air quality, Light and Noise)

Residual Risk level	Low

Objectives

Avoid or minimise nuisance impacts from air, noise and light emissions associated with dredging and dredging vessels.
Minimise illumination and light spillage at night, while meeting occupational health, safety and navigation requirements
To protect the acoustic amenity and reduce nuisance noise that may impact upon marine megafauna

Aspects and Impacts

Dredging and dredge related vessels have the potential to generate emissions, such as air quality, light and noise

The acts of dredging, transport of material to the unloading facility, and placement activities will generate some emissions (Air Quality, Noise, Dust, Visual Amenity & Lighting).

Noise emissions may lead to behavioural disturbances in marine megafauna or marine megafauna temporally avoiding the area

Lighting may negatively impact on marine fauna

Scenic amenity could be adversely affected by an increase in artificial light used during night time activities

Performance Indicators

a) All works are managed in accordance with the relevant management plans, the *Environmental Protection Act 1994*, the *Environmental Protection (Air) Policy 2019*, *Environmental Protection (Noise) Policy 2019, Environmental Protection Regulations 2019,* and all relevant Australian Standards.
b) No impacts to air quality in the receiving environment as a result of dredging related activities.
c) No direct residual impacts to sensitive receptors, including marine megafauna as a result of noise or light emissions from dredging related activities; as measured through the MEMP (POT 2135) monitoring programs.
d) There are no substantiated complaints received about emissions associated with dredge operations

Mitigation	Responsibility
Ensure that engines and equipment on board the dredge are properly maintained in good working order through carrying out routine and preventative maintenance.	Dredge and Reclamation contractor
Maintain and operate equipment on board the dredge in a safe and efficient manner.	Dredge and Reclamation contractor
Consider noise mitigation measures when operating vessels, including but not limited to: • Keeping equipment well maintained and any silencers fitted meet design specifications on plant • Keeping equipment well maintained according to manufactures instructions and recommendations	Dredge and Reclamation contractor

• Shutting down plant/equipment which are used intermittently in the intervening periods between works or throttling down to minimise emissions • Shutting down equipment when not in use • Ensuring that only necessary power levels are used to complete activities	
Light levels from the dredging works will be limited to those lights that are necessary for the safe operation of the vessel and the health and safety of those on board	Dredge and Reclamation contractor
The contractor staff are aware of air and noise quality requirements and performance standards as set out in the Environmental Authority	Dredge and Reclamation contractor
Operate and maintain a complaints management system	Corporate Affairs and Capital Works PR Officer CU and Dredge and Reclamation contractor
Adopt marine megafauna observation and response procedures (as per MEMP POT 2135, including but not limited to: • Maintaining a lookout for marine megafauna while all vessels are operating • Adjusting vessel speed and direction within safety constraints of the vessel to avoid impacts upon observed individuals, including ceasing movement if sighted within the exclusion zone for the appropriate period.	Dredge and Reclamation contractor CU Project Team Marine Megafauna Observers
Training (to meet Performance Criteria A to D). Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements regarding nuisance impacts from air, noise and light emissions.	Dredge and Reclamation contractor Manager Environment CU
Monitoring	**Responsibility**
Marine megafauna observations undertaken by vessel masters/fauna observers on each project related vessel	Dredge and Reclamation contractor
Regular observations / audits / inspections undertaken to identify the need for noise suppression measures and the effectiveness of any mitigation measures undertaken	Dredge and Reclamation contractor; and Port CU Environment
Regular observations / audits / inspections undertaken to identify the need for air emission rectification measures, and the effectiveness of any mitigation measures undertaken	Dredge and Reclamation contractor; and Port CU Environment

Regular observations / audits / inspections undertaken to identify the need for light emission rectification measures, and the effectiveness of any mitigation measures undertaken	Dredge and Reclamation contractor; and Port CU Environment
Review the outcomes of the MEMP monitoring programs (POT 2135) to determine if any project related impacts occur on megafauna behaviour.	Port CU Environment
Implementation of noise monitoring protocols in response to non-vexatious noise complaints received during the dredging operations.	Dredge and Reclamation contractor
Investigation of any complaint and review of equipment to mitigate further complaints	Dredge and Reclamation contractor
Review/audit toolbox/pre-start records for discussions on artificial light impacts and management where issues arise	Port CU Environment

Corrective Actions

Where performance Criteria a) to d) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- The CU Environment team will commence an investigation into all incidents or complaints relating to emission impacts within 24 hours. This includes reporting to the appropriate regulator (within the statutory timeframes).
- The CU Environment team and Contractor will undertake a review of this DMP and any associated plans to determine if further controls or mitigation measures are needed, where investigations show dredge related impacts.
- The Dredge and Reclamation Contractor will implement additional control measures (e.g. revised exclusion zones) where performance criteria are exceeded or potential MNES / marine ecology issues are indicated.
- The Dredge and Reclamation Contractor will review and modify plant, equipment, vessel movement practices where noise, air or light issues have been identified, or have the potential to occur in the future.
- The Port is to revise notification procedures and times to allow adequate consideration of potential emission impacts by the community if issues are reported.
- The Port and Contractor will implement any other corrective actions as directed by the appropriate regulator.

Reporting

The Contractor will maintain an activity log, recording the type of activities occurring during various times of the day to demonstrate undertaking of observations and to assist with the retrospective investigation of any incidents / complaints.

The results of any air or noise quality monitoring are to be provided to the Port within one week following completion of any monitoring / investigation.

All CU Project personnel will inform the Manager Environment CU and Principal's Site Representative for Dredging and Reclamation Works as soon as possible in the event of a significant emissions management issue that could disturb sensitive receptors. The Manager Environment CU will investigate and report to the CIO, with any additional investigation(s) undertaken as required.

The Manager Environment CU will report to DCCEEW (or successor agency) any exceedance of the MNES performance criteria, including any implementation of MNES risk management, adaptive management strategies, corrective actions and emergency response measures implemented, within 21 days of the initial incident/exceedance notification.

The Manager Environment CU will report to DES (or successor agency) any exceedance of the state approvals.

Any impacts identified via the MEMP/CEMP monitoring programs (marine megafauna, inshore dolphins and shorebirds) because of dredge related activities will be reported via the specific monitoring plans and inform reviews of the relevant Management Plan (MEMP and CEMP).

11.7 Vessel Operations – Hazardous material / liquid waste discharges

Residual Risk level	Low

Objectives

Avoid release and or spills of fuels, oils and other hazardous materials to the marine environment

Aspects and Impacts

Operation of the dredge and support vessels creates the potential for ship collisions, groundings or other maritime incidents that could result in an oil or other hazardous material spill.

Fuel bunkering of the vessels will be undertaken within the dredge footprint, the transfer of fuel could result in spills to the marine environment.

The backhoe dredge excavator arm uses hydraulic oil which if not properly managed, could release large volumes of hydraulic oil into the marine environment.

Incorrect storage and handling of hazardous substances may result in contamination of the marine environment.

Performance Indicators

a) All works are managed in accordance with the relevant management plans, the *Environmental Protection Act 1994*, Australian Standards, material safety data sheets (MSDSs), and equipment manufacturer's instructions.
b) Bunkering is undertaken as per written protocols and permits
c) Fuel and/or chemical storage is kept in a secure area, and suitably bunded to prevent spills.
d) All spills are reported to the Port and adequately contained and promptly cleaned up
e) No marine contamination from leaks or spill from vessels occurs
f) No inappropriate storage or disposal of hazardous waste occurs.

Mitigation	Responsibility
All equipment is maintained in good working order, and regularly undergo maintenance checks; All hoses, connections, seals are in good condition. Hoses, seals replaced as per manufacturers advise or when wear becomes visible; Refuelling to take place as per company, port authority and international accepted procedures; Drip trays or containment bunds are used when during refuelling, oil exchange, oil top up is undertaken on all dredge related vessels/equipment; Dirty oil to be disposed of via approved waste oil disposal companies onshore;	Dredge and Reclamation contractor
Refuelling/bunkering of vessels to be conducted in compliance with the MSQ Port Procedures requirements and Port procedures and controls.	Dredge and Reclamation contractor

Minimise the use of hazardous materials and implement alternatives where feasible	Dredge and Reclamation contractor
Plan the delivery of hazardous materials to site & on board vessels to avoid the need to store significant quantities of hazardous materials on site/onboard	Dredge and Reclamation contractor
Hazardous waste must be stored in an appropriate and secure manner and clearly marked in accordance with legislative requirements. These materials are to be disposed of via an appropriate facility onshore.	Dredge and Reclamation contractor
Collection and transport of designated hazardous wastes is to be undertaken only by a licensed contractor	Dredge and Reclamation contractor
SDSs for hazardous materials readily available in a prominent location for ease of access.	Dredge and Reclamation contractor
Appropriate spill kits, personal protective equipment and relevant operator instructions / emergency procedures are in place for the management of hazardous materials on all vessels in an easily accessible location. This includes an appropriately sized oil boom for large scale spills to the marine environment.	Dredge and Reclamation contractor
All existing Port procedures to reduce spills or leakage during storage and transfer shall be followed by the contractor	Dredge and Reclamation contractor
All vessel crew are appropriately trained in emergency response procedures onboard each vessel.	Dredge and Reclamation contractor
Training (to meet Performance Criteria A to F)	
Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements of the DMP regarding hazardous materials handling and storage and spill response.	Dredge and Reclamation contractor; and Manager Environment CU
Ensure that relevant Project personnel are trained in spill response, including the use of spill kits and spill control materials.	Dredge and Reclamation contractor
Monitoring	**Responsibility**
Undertake opportunistic visual observations throughout the day for any slicks, spills or other indications of contamination of the waters surrounding each vessel	Dredge and Reclamation contractor;
Undertake routine inspections to monitor all vessels for compliance with hazardous material handling and storage requirements, including	Dredge and Reclamation contractor; and

maintenance of spill kits, checking for leaks, spillage and damage to bunded/storage/refuelling areas and plant and equipment.	Port CU Environment
Undertake regular visual inspections of hazardous waste storage containers to determine their integrity and identify if any spills or leakage has or is occurring.	Dredge and Reclamation contractor; and Port CU Environment
Undertake visual inspections of fuel transferring equipment and surrounding water during and after fuel transfer	Dredge and Reclamation contractor
Inspect the SDS register regularly for currency and completeness	Dredge and Reclamation contractor; and Port CU Safety
Undertake checks of compliance against the relevant management plan through auditing processes.	Dredge and Reclamation contractor; and Port CU Environment

Corrective Actions

Where performance Criteria a) to f) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- The Dredge and Reclamation contractor will commence an investigation into all incidents relating to hazardous materials and/or fuel bunkering and undertake appropriate corrective or remedial actions to the satisfaction of the Port, to render the area safe and avoid or minimise environmental harm.
- The Dredge and Reclamation contractor is to implement emergency spill responses in accordance with approved plans and in consultation with relevant authorities including the Port and MSQ.
- Maintain and repair any damage to storage areas and/or bunds promptly.
- Implement additional control measures as soon as practicable where performance criteria are exceeded or hazardous materials issues are identified.
- The Dredge and Reclamation contractor will review fuelling practices and rectify immediately if an unintentional release or spill occurs.
- Undertake a review of all relevant management plans to determine if further controls are required where investigations show control measures are not fit for purpose.
- Review procedures if procedures breakdown or a spill occurs and re-train staff about appropriate responses.
- Implement any other corrective actions and mitigation measures as directed by the appropriate regulators.

Reporting

The Dredge and Reclamation contractor will maintain an activity log, recording the type of activities occurring at different times to assist with the retrospective investigation of any incidents / complaints / land contamination issues.

Dredge and Reclamation contractor to report (within 12 hours) any spill or loss of hazardous material waste, fuel bunkering and clean-up operations, or any community complaints received about hazardous waste to the Port

If spill contingency measures are implemented, regular (daily) reporting of progress associated with clean up or at a greater frequency as required by the Port or relevant authorities

All CU Project personnel will inform the Manager Environment CU and Principal's Site Representative for Dredging and Reclamation Works immediately of any incidents caused by the handling and storage of hazardous materials resulting in potential or actual environmental harm.

The Manager Environment CU will report to the appropriate regulators any release of contaminants or other significant incident, including any follow up actions/remediation/adaptive management undertaken.

11.8 Vessel Operations – Solid Waste Management

Residual Risk level	Low

Objectives

To avoid impacts from general waste impacting upon MNES from dredge related activities

To appropriately handle, store, recycle and dispose of all waste materials generated during construction activities to prevent impacts on the marine environment, including Matters of State and National Environmental Significance

To prevent litter or waste generated by the construction activities from causing a hazard or nuisance

Aspects and Impacts

Incorrect handling and storage of waste may result in the introduction of wastes into the marine environment.

Performance Indicators

a) All waste is managed in accordance with the relevant management plans, the *Environmental Protection Act 1994,* Australian Standards*,* and any other relevant approvals, guidelines and statutory requirements.
b) No injury of death to marine megafauna / MNES / MSES because of waste generated from construction activities.
c) No substantiated complaints are received from regulators or the community in relation to waste issues from dredge related activities

Mitigation	Responsibility
Adopt the waste management hierarchy (avoid, re-use, recycle, energy recover and dispose) on board all vessels.	Dredge and Reclamation contractor
Minimise (where practical) the amount of material/packaging etc bought on board and stored on / in each vessel	Dredge and Reclamation contractor
Vessel fitted with appropriately sized waste disposal bins; and all bins to be secured and fitted with secure lids to prevent material being blown overboard during storage or handling.	Dredge and Reclamation contractor
Ensure the bins are collected and emptied while at berth at appropriate intervals (e.g. emptied at 75% capacity or below).	Dredge and Reclamation contractor
Segregation of waste is to occur as per Queensland requirements prior to transfer	Dredge and Reclamation contractor
Disposal of waste onshore is to occur only in accordance with Port of Townsville protocols or through licensed waste disposal companies	Dredge and Reclamation contractor
No waste shall be thrown into the sea;	

	Dredge and Reclamation contractor
No burning or incineration of waste on board the dredge or barges is permitted within port limits.	Dredge and Reclamation contractor
Training (to meet Performance Criteria A to C)	
Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements of the DMP regarding waste management.	Dredge and Reclamation contractor Manager Environment CU
Monitoring	**Responsibility**
All dredge related vessel crews are to carry out regular visual inspections of on-deck bins and are transfer of waste to shore facilities.	Dredge and Reclamation contractor
Dredge contractor to report any loss of solid waste material or any community complaints received about solid waste management to Port of Townsville	Dredge and Reclamation contractor
Undertake regular visual inspections of waste storage containers to determine their integrity and identify if any spills or leaks have occurred.	Dredge and Reclamation contractor
Undertake inspections of the effectiveness of waste management controls after significant rainfall events.	Dredge and Reclamation contractor; and Port CU Environment
Undertake regular inspections of on-site facilities to ensure all waste is being stored, handled, disposed and transported in accordance with regulations.	Dredge and Reclamation contractor; and Port CU Environment
Review toolbox/pre-start records for discussions on minimising waste generation and management where issues arise.	Port CU Environment

Corrective Actions

Where performance Criteria a) to c) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- If practicable, take measures to retrieve any solid waste material that is lost overboard.
- Review waste management practices causing material loss and take immediate action to rectify.

- Implement additional waste management control measures and training where performance criteria are exceeded or waste issues are identified.
- The Manager Environment CU will commence an investigation into all incidents in relation to waste management within five business days, including reporting to the appropriate regulator, where MNES are involved, within statutory timeframes.
- The Manager Environment CU will respond to all complaints received in relation to waste management within five business days and address valid concerns.
- Undertake a review of the DMP to determine if further controls are needed where investigations show unacceptable waste issues.
- Implement any other corrective actions as directed by the Port and other appropriate regulators

Reporting

Dredge Contractor to report any loss of waste material or any community complaints received about solid waste management to the Port as soon as practicable and no later than 12 hours after occurrence.

The Contractor will maintain a waste tracking system, recording the movement of waste to assist with the retrospective investigation of any incidents / complaints.

All CU Project personnel will inform the Manager Environment CU and Principal's Site Representative for Dredging and Reclamation Works as soon as possible in the event of any significant waste management issue.

The Manager Environment CU report to DCCEEW (or successor agency) any exceedance of the MNES performance criteria, including any implementation of MNES risk management, adaptive management strategies, corrective actions and emergency response measures implemented, within 21 days of the initial incident/exceedance notification.

The Manager Environment CU will report to the appropriate regulators any release of contaminants or other significant incident, including any follow up actions/remediation/adaptive management undertaken.

11.9 Cultural Heritage

Residual Risk level	Medium	
Objectives		
Not to disturb any items or objects of indigenous or historic cultural heritage as part of dredging To conduct all dredging related activities in accordance with the *Aboriginal and Cultural Heritage Act 2003 Duty of Care Guidelines* and Cultural Heritage Management Plan.		
Aspects and Impacts		
Dredging may encounter or uncover items or objects of cultural heritage or archaeological significance on or in the seabed. These may be observed in the dredge bucket, in the dredge material barges, in transfer trucks, or following placement in the reclamation area.		
Performance Indicators		
a) Cultural heritage values are managed in accordance with the Cultural Heritage Management Plan (CHMPs) between the Port of Townsville and relevant Aboriginal Parties. b) No substantiated complaints are received from persons likely to be affected by the discovery/damage to Traditional Owner areas, sites or items of cultural heritage value are received.		
Mitigation		**Responsibility**
The dredging works will at all times be undertaken with regard to the cultural heritage duty of care outlined in the *Aboriginal Cultural Heritage Act 2003* and existing CHMP including notification and engagement with relevant Aboriginal Parties to this agreement(s).		Dredge and Reclamation contractor
Provide cultural heritage inductions relevant to the CU Project to all project staff before they commence work on the project.		Dredge and Reclamation contractor
Cease work immediately if any Cultural Heritage sites or materials are discovered during dredging activities (in a minimum 20m radius of the location) pending inspection by Traditional owner representative/s or appropriately qualified persons to determine the level of significance. Appropriate action in accordance with the CHMP or relevant State and Commonwealth legislation is to be undertaken.		Dredge and Reclamation contractor
Cease work immediately (within 100 m of the remains) if human skeletal material is discovered during construction activities. Contact immediately the Queensland Police, Cultural Heritage Coordination Unit (ph 1300 378 401) and Traditional Owner representative(s).		Dredge and Reclamation contractor
Training (to meet Performance Criteria A and B).		

Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements of the DMP regarding cultural heritage.	Dredge and Reclamation contractor; and Manager Environment CU
Monitoring	**Responsibility**
Undertaken opportunistic visual observation of the dredge material in the backhoe bucket, barge hoppers and during transfer for any sightings of cultural heritage artifacts.	Dredge and Reclamation contractor; and CU Project Team
Attend toolbox / pre-start meetings for discussions on cultural heritage matters if changes to arrangements are required.	Dredge and Reclamation contractor; and CU Project Team

Corrective Actions

Where performance Criteria a) or b) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- Port Legal Team to review the CHMP and consultation protocol if there are risks of unexpected adverse impacts or in response to complaints.
- All staff to follow advice provided after site inspections by a representative from the Traditional Owners.
- Follow advice provided by Queensland Police, DES and a representative from the Traditional Owners regarding established policy and procedures for dealing with human remains.
- CU Team to investigate all incidents in relation to cultural heritage within five business days of initial notification and undertaken appropriate actions.
- Port Legal Team to respond to all complaints relating to cultural heritage within five business days and rectify legitimate problems.
- Undertake a review of the CEMP and implement further controls where investigations show nonconformances in relation to cultural heritage or cultural heritage issues are identified or have the potential to occur in the future and rectify in an appropriate manner and in consultation with the Traditional Owners / DES.
- Implement any other corrective actions as directed by the appropriate regulators.

Reporting

As per the requirements outlined in the CHMP or as directed following a discovery or an item or object

All project staff will notify the Principal's Site Representative for Dredging and Reclamation Works immediately of any findings of potential cultural heritage significance. An investigation will be undertaken and a report provided to the CIO and Contractors Representative; with any additional investigations undertaken as required.

Port Legal Team will provide notification of relevant authorities and instigate management planning to manage the discovery including the need for additional identification and analysis of cultural heritage significance; ensure all commitments that the Port is responsible for under registered CHMPs are fully met.

11.10 Vessel Maritime Safety and Emergency Management

Residual Risk level	Low

Objectives

To avoid or minimise the potential for marine accidents that could result in environmental harm.

To avoid or minimise the effects of extreme weather events on operations

Aspects and Impacts

Key maritime safety risks associated the with dredging campaign that could results in associated environmental impacts include:

- Vessel collision into another vessel
- Vessel collision into port infrastructure (such as the reclamation wall, berth wall, navigation beacons, etc.)
- Vessel grounding
- Oil or fuel spill
- Vessel strike with wildlife causing significant damage to the vessel or sinking
- Vessel fire or
- Other mechanical faults/failures causing a vessel to sink

Natural hazards and extreme weather events such as cyclones or major rainfall and floods that occur during the campaign may also increase these maritime safety risks as well as impacting on the overall resilience of the marine environment to the impacts from the project

Performance Indicators / Criteria

a) No significant or material safety and environment incidents occur during the dredging campaign
b) In the event of an incident, there is a rapid response to minimise impacts on the environment
c) The implications of natural hazards and contingencies are developed for the project including consideration of long term resilience
d) No substantiated complaints are received in relation to vessel maritime safety or emergency management and response

Mitigation measures	Responsibility
Dredge Contractor is to meet all requirements of the Regional Harbour Master. This includes preparation of a CVTMP under State Guidelines to the satisfaction of the RHM and observing all Notice to Mariners	Dredge and reclamation contractor; and sub-contractors
Contingency planning for the vessel (stop work triggers, cyclone mooring) must be consistent with the broader Cyclone Readiness Plan prepared by the Port of Townsville	Dredge and reclamation contractor; and sub-contractors
All on-board procedures related to incidents and contingency planning for natural hazards are to be made available to all crew and included in training and safety protocols for the vessels.	Dredge and reclamation contractor; and sub-contractors

The vessel is to have at least two lines of communication (VHF and mobile phone) with Port Control and maintain constant contact	Dredge and reclamation contractor; and sub-contractors
Training (to meet Performance Criteria A to D). Ensure that the relevant Project personnel undertake environmental awareness and training covering the requirements of the DMP regarding vessel safety and emergency management.	Dredge and reclamation contractor; and sub-contractors

Monitoring

Maritime safety and operations will be subject to the CDIT made up of representatives from the Port, the Dredge Contractor and the MSQ Regional Harbour Master. This committee will meet periodically over the dredge campaign to ensure maritime safety is being maintained and to investigate incidents or near misses.

Regular review of all near miss or hazard reports to determine trends and inform change

Corrective Actions

Where performance Criteria a) to d) are not met at any point throughout the dredge program, the following corrective actions must be undertaken:

- If an incident occurs – Implement contingency and/or clean-up procedures as set out in relevant plans;
- Review procedures and actions following the incident and make any changes as required to plans and procedures
- Port of Townsville – review of Contractor documentation to ensure it addresses maritime safety, extreme weather and contingency measures; consideration of broader resilience issues; chairing and participating in the CDIT
- Dredge and Reclamation Contractor – preparation of a risk assessment and contingency measures for major safety and environment risks; development of a CVTMP to the satisfaction of the RHM; attendance and participation in the CDIT

Reporting

Port of Townsville to be provided with copies of the following prior to the commencement of work:

- The risk assessment register and action plan as prepared by the Dredge Contractor
- The construction vessel management plan as approved by the RHM

Incident reporting including any near misses shall be lodged with the Port of Townsville within 12 hours of the incident occurring over the duration of the campaign.

12 Environmental Monitoring

12.1 Environmental Monitoring Programs

Both State and Commonwealth government approvals for the CU Project require environmental monitoring to be undertaken prior to capital dredging commencing. This includes providing the methodology and results of the surveys, assessments and/or analysis of the monitoring programs undertaken.

This section provides the methodology and results for the following programs:

- Section 12.1.1 Marine Water Monitoring Program
- Section 12.1.2 Coral Monitoring Program
- Section 12.1.3 Seagrass Monitoring Program
- Section 12.1.4 Seagrass Dredge Footprint survey
- Section 12.1.5 Sediment Sampling and Analysis

12.1.1 Marine Water Monitoring Program – Methodology and Results

Overview

Receptors present in Cleveland Bay that are sensitive to water quality change include benthic primary producer communities (seagrass meadows and fringing reef), marine megafauna, and fisheries resources.

There are a number of water quality impact pathways for these receptors that may be realised as a result of CU dredging activities (McCook et al., 2015). These include increased turbidity and suspended sediments, reduced light availability, deposition of sediments on sensitive receptors (Fisher et al., 2017; Erftemeijer and Lewis, 2006) and mobilisation of any contaminants bound to the dredged sediments (Roberts, 2012; McCook et al., 2015). Natural exposure pathways associated with extreme weather events, such as severe storms, extreme temperatures or freshwater input, also have the potential to influence sensitive receptors throughout the dredge program (Jones et al., 2016).

The marine water monitoring program (MWMP) has been designed to monitor parameters across the range of potential impact exposure pathways identified. The program incorporates monitoring at sensitive receptor and reference locations and has included over 18 months of baseline data collection.

Monitoring locations

Monitoring is being undertaken across sixteen locations (Figure 23). Table 15 provides an overview of each location, including information that has informed selection for inclusion in this MWMP. The design comprises of sensitive receptor locations (coral/seagrass or both) specified in the State approval conditions, intertidal seagrass sensitive receptor monitoring locations, and comparable subtidal and intertidal reference locations.

Each of the monitoring locations is co-located with either coral or seagrass monitoring (refer Section 12.1.2 and 12.1.3) to support data feedback to those programs. Physical site restrictions have also been considered in the placement of the monitoring locations. A water depth of at least -3 m LAT is required for the safe operation of the telemetered marker buoys at the subtidal monitoring locations. Further, mobile phone reception is required at each location for the communication of real-time data during dredging. These subtidal locations provide data in near-real time to inform reactive management intervention actions, should any impacts on water quality from dredging works that may affect sensitive receptors be detected.

Placement of the monitoring locations has been reviewed by the ITAC and was confirmed appropriate to achieve the objectives of the marine water monitoring program.

Figure 23. Marine Water Monitoring locations

Based on or contains data provided by the State of QLD (DNRME) 2020. In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for marketing or be used in breach of the privacy laws.

Paper Size ISO A4

0 1 2 3 4 5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

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Port of Townsville Limited
Channel Upgrade Marine
Water Monitoring Program

Project No. 41-32347
Revision No. 3
Date 08/09/2021

Monitoring Locations

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Revision: 08 Nov 2021 - 11:05

Data source: DoR Places (2016); POTL: GBRMP Boundary, Existing Port Land, Port Limits (2018), Reclamation Area, Channel, Proposed Channel Dredging (2019); GHD: Monitoring Locations (2021); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community. Created by: kee

Table 15. Marine Water Monitoring Location Metadata

Location	Type	GBRMP Zone	Nominated in State approval conditions	Equipment Telemetered	CU Coral MP location	CU Seagrass MP location
Subtidal monitoring locations						
Florence Bay - 19.12229, 146.882036	Sensitive receptor (Water, Coral & Seagrass)	Marine National Park	Yes – associated monitoring only	Yes	Yes	Yes
Geoffrey Bay - 19.15531, 146.868214	Sensitive receptor (Water, Coral & Seagrass)	Marine National Park	Yes– associated monitoring only	Yes	Yes	Yes
Picnic Bay - 19.18670, 146.838969	Sensitive receptor (Water, Coral & Seagrass)	Conservation Park	Yes– associated monitoring only	Yes	Yes	Yes
Virago Shoal - 19.21307, 146.792598	Sensitive receptor (Water, Coral & Seagrass)	Conservation Park	Yes - compliance location	Yes	Yes	Yes
Cleveland Bay -19.22649, 146.949531	Reference (Water & Seagrass)	General Use	No	Yes	No	Yes
The Strand -19.24610 146.814586	Sensitive receptor (seagrass)	n/a	Yes - compliance location	Yes	No	Yes
The Strand (deep) -19.234156, 146.824849	Sensitive receptor (Water)	n/a	Yes– associated monitoring only	Yes	No	No
Cape Cleveland -19.20309, 146.990575	Reference (Water & Seagrass)	Conservation Park	No	Yes	No	Yes

Location	Type	GBRMP Zone	Nominated in State approval conditions	Equipment Telemetered	CU Coral MP location	CU Seagrass MP location
Middle Reef -19.19682, 146.817747	Sensitive receptor (Water, Coral & Seagrass)	Conservation Park	Yes- compliance location	Yes	Yes	Yes
Bay Rock - 19.11727, 146.751727	Reference (Water & Coral)	Habitat Protection	No	No	Yes	No
Rattlesnake Island - 19.03904, 146.615520	Reference (Water & Coral)	Habitat Protection	No	Yes	Yes	No
Paluma Shoal - 19.107425, 146.564278	Reference (Water & Coral)	Habitat Protection	No	Yes	Yes	No
Intertidal monitoring locations						
Cockle Bay - 19.170459, 146.815239	Sensitive receptor (Seagrass)	Conservation Park	Yes	No	No	Yes
Geoffrey Bay -19.155283, 146.86835	Sensitive receptor (Seagrass)	Marine National Park	No	No	No	Yes
Cape Cleveland -19.202867, 146.99075	Reference (Seagrass)	Conservation Park	No	No	No	Yes
Shelly Beach -19.179333, 146.749	Reference (Seagrass)	Conservation Park	No	No	No	Yes

Monitoring equipment

Monitoring equipment deployed at each location is detailed in Table 16.

Subtidal monitoring equipment is attached to an instrument frame that is deployed on the seabed. Equipment is connected to a surface telemetry buoy via a stainless-steel cable, with collected data being uploaded to an online Data Storage and Visualisation Platform (DVSP). Equipment is serviced on a monthly basis to manage biofouling, calibration requirements, and general maintenance needs.

Instruments also have built-in mechanical wipers to minimise potential for biofouling to occur on sensors. Noting on some occasions timing of servicing is impacted by weather, depending on location.

Intertidal monitoring equipment is similarly attached to an instrument frame, placed on the seabed in the intertidal zone. Data is recorded and stored on the equipment, with data downloads occurring during monthly servicing events.

Physical water samples are collected from the surface, middle and bottom of the water column during monthly servicing events. Samples are sent to a NATA accredited laboratory for analysis.

Table 16. Marine water monitoring equipment

Parameter	Units of measure	Collection method	Data collection frequency
Subtidal monitoring			
Turbidity (NTU)	NTU	Telemetered seabed logger* *Bay rock data is collected when equipment is serviced	Every 10 minutes
Multi-spectral light (including PAR)	µW cm^2 nm^{-1}		
Dissolved Oxygen (DO)	mg/L		
pH	pH units		
Conductivity	µS/cm		
Temperature	°C		
Depth	m		
Sedimentation	mg/cm^2		Every 2 hours
Intertidal monitoring			
Intertidal PAR	mol m^{-2} day^{-1}	Intertidal sentinel logger	Every 15 minutes
Intertidal temperature	°C		
Physical sampling			
Trace metals	µg/L	Physical sample collection	Monthly (typically)
Nutrients	µg/L		
TSS	mg/L		
Secchi disk	m		

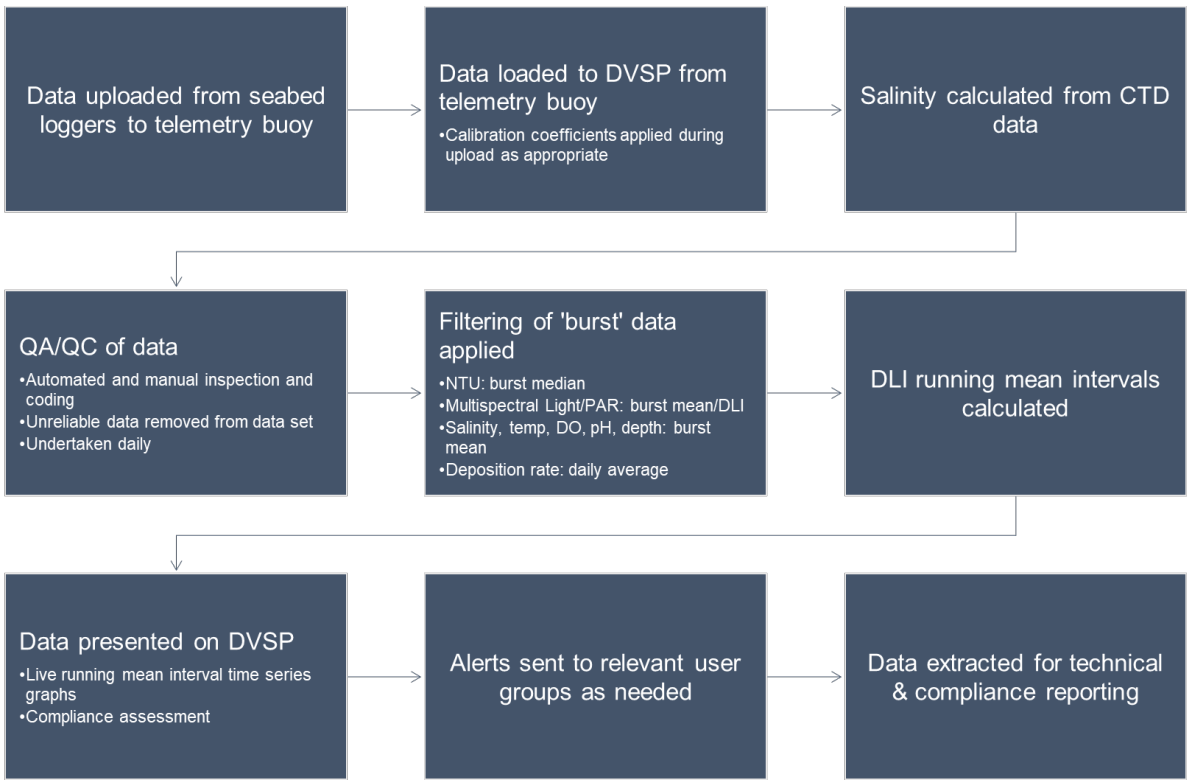
Note:
NTU = Nephelometric Turbidity Units
PAR = Photosynthetically Active Radiation

Data handling

Subtidal data

Figure 24 provides the workflow for the data handling procedure applied to subtidal monitoring data.

Figure 24. Data handling workflow



Note:
DVSP = Data Visualisation and Storage Platform

CTD = Conductivity/Temperature/Depth logger

Burst mean DLI includes conversion of μW cm^{2} nm^{-1} to PAR
DLI = Daily Light Integral
GUI = Graphical User Interface
QA/QC = quality assurance/quality control[2]

[2] Note: QA/QC processes are described in Section 12.2.

Intertidal data

Intertidal data is downloaded on a monthly basis to inform seagrass monitoring data interpretation. The data handling workflow applied is similar to that described for the subtidal loggers, however the intertidal data also has a correction factor applied to PAR measurements to take into account the differences when the sensors are submerged or exposed. This correction factor follows the recommendations of Kirk (1994), to account for the additional backscatter of light that occurs underwater. Data outputs collated from intertidal monitoring are not loaded to the DVSP, rather data is forwarded to the seagrass monitoring team to support data interpretation.

Laboratory supplied data

Physical samples are collected in accordance with the requirements outlined in the DES Monitoring and Sampling Manual (2018). Samples are analysed by a NATA accredited laboratory in accordance with their certified QA/QC practices, and reports are provided by the laboratory each month. Results are uploaded to an ESDAT database to assist in managing QA/QC and data outputs. Data is incorporated into six-monthly and annual reports to support interpretation of changes in water quality conditions.

Baseline results

Cleveland Bay is a large, relatively shallow, soft-bottomed embayment. The water quality of Cleveland Bay is influenced via multiple pathways. The dominant driver of turbidity and associated underwater light climate in Cleveland Bay during the dry season is wave-induced bed shear-stress which resuspends bottom sediments (Larcombe et al., 1995; MacDonald, 2015). Cleveland bay is known to be a naturally turbid, low light system (Luther et al., 2021). Larcombe et al. (1995) recorded suspended sediment concentrations in the bays of Magnetic Island in excess of 5 mg/L for 30-40% of the time. Further, at 5 m water depth, resuspension of bottom sediment by waves occurs an estimated 220 days per year in Cleveland Bay (Orpin et al., 1999).

In the wet season this is augmented by riverine inputs. Ross River and Alligator Creek feed directly into the bay delivering sediment-laden waters to the coast. Both of these systems have monsoonal dominated flows with very low movement during the dry season, and high-flow conditions associated with summer monsoon rainfall. In addition, approximately 80 km to the south of Cleveland Bay is the Burdekin River. This is the largest sediment contributor to the central GBR region.

The wet season influence on water quality varies from year to year, depending on the frequency and severity of tropical low pressure systems and/or cyclones. Widespread flooding onshore, particularly in the Burdekin catchment, has the potential to deliver large volumes (on average 3.93 million tonnes annually (Bainbridge, 2015)) of suspended sediment to the GBR lagoon, including the Cleveland Bay region.

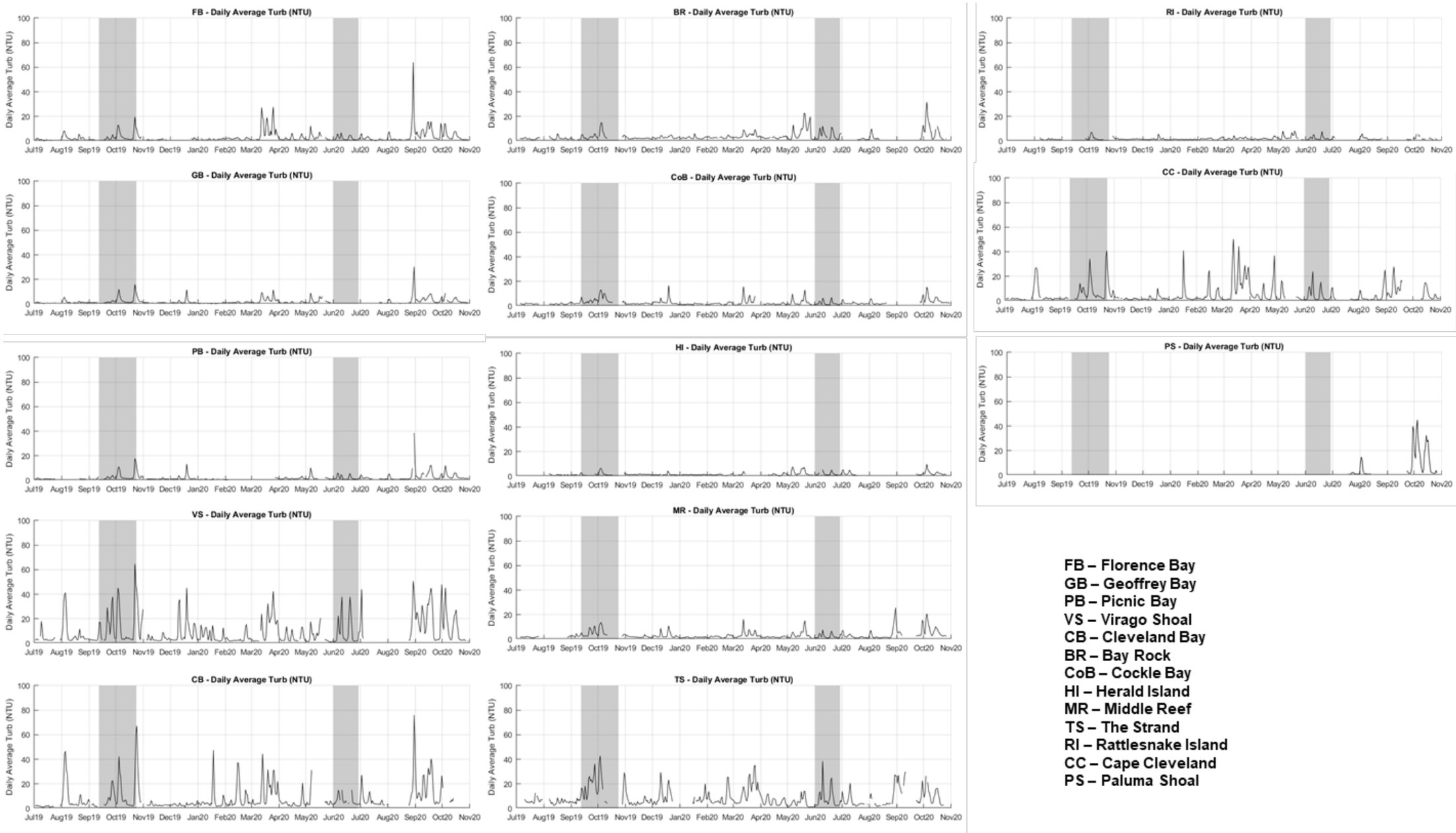
The amount of light that reaches the seabed is a limiting factor influencing the presence and ongoing persistence of benthic primary producer communities such as seagrasses and corals. Suspension of sediments into the water from dredging activities or extreme weather events reduces the amount of light available for photosynthesis. If these conditions persist past critical time thresholds of species

tolerance limits (associated with energy store depletion), sub-lethal or lethal effects can be realised (Jones et al., 2020, Luther et al. 2021).

Baseline monitoring commenced at most locations in July 2019 (with the exception of Paluma Shoals which commenced in August 2020 and the strand seagrass which was added to the program in June 2021). Herald Island was removed from the program in June 2021 as it was identified an additional strand site was beneficial due to the limited number of sites in the smaller zone of influence. Turbidity and underwater light data collected throughout the baseline period is presented for each monitoring location in Figures 25 and 26, respectively. Grey shading on the graphs indicates periods of Port maintenance dredging activities. Periods of reduced underwater light at sensitive receptor locations, associated with elevated suspended sediments (turbidity), were commonly observed during baseline monitoring. These events varied between locations, however they were often associated with periods of elevated wind conditions. The longest consecutive duration of DLI less than 0.5 mol/m2 (i.e. very low light) was 12 days. The depositional environment within Cleveland Bay is active but similarly variable across locations. During baseline monitoring some locations typically experienced deposition events of a short duration (5-10 days), whilst others typically experienced longer duration events (>42 days).

Figure 25. Baseline turbidity time series data; grey shading indicates maintenance dredge periods

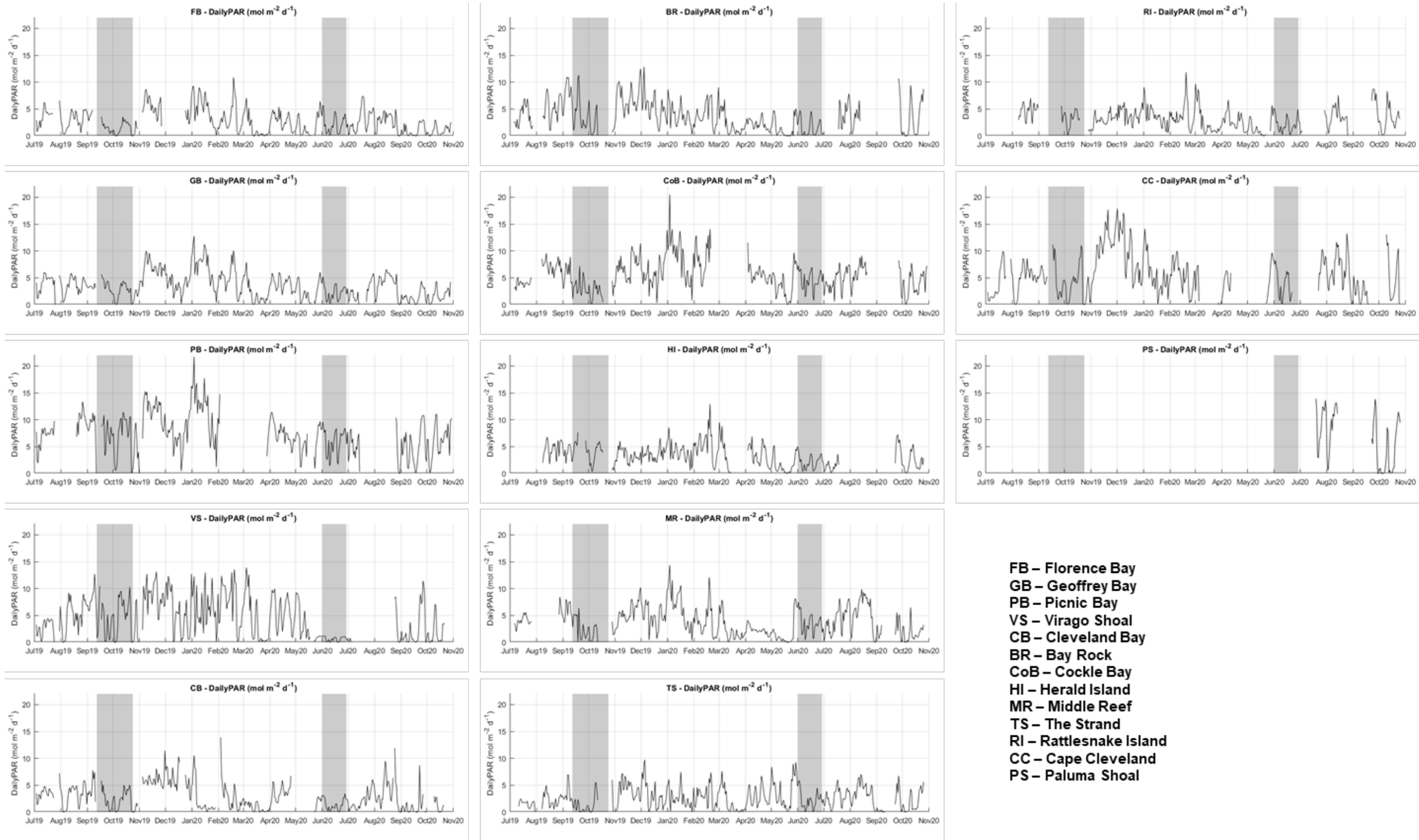
**Gaps represent periods where data was not able to be collected or analysed due to weather, quality control etc.*



FB – Florence Bay
GB – Geoffrey Bay
PB – Picnic Bay
VS – Virago Shoal
CB – Cleveland Bay
BR – Bay Rock
CoB – Cockle Bay
HI – Herald Island
MR – Middle Reef
TS – The Strand
RI – Rattlesnake Island
CC – Cape Cleveland
PS – Paluma Shoal

Figure 26. Baseline daily light integral time series data; grey shading indicates maintenance dredge periods

**Gaps represent periods where data was not able to be collected or analysed due to weather, quality control etc.*



FB – Florence Bay
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12.1.2 Coral Monitoring Program – Methodology and Results

Overview

Reef habitats in Cleveland Bay include shallow fringing reefs and rocky shores around Magnetic Island; the well-developed reef platform of Middle Reef; and smaller, less developed nearshore patch reef areas. These are turbid-zone coral reef communities and these reefs comprise coral communities susceptible to the attenuation of light from suspended sediments in the water column; which can inhibit the quality and quantity of light available for photosynthesis. The settlement of sediment out of suspension may also result in smothering of corals (Jones et al. 2017). Dredging activities disturb sediments and have the potential to affect surrounding coral reefs indirectly should currents transport suspended sediments towards these reefs (Erftemeijer et al. 2012). The biological responses of corals to these effects varies from signs of stress (sublethal) to complete mortality (lethal), resulting in impacts ranging from minor at an individual level to severe at a whole of community level (Gilmour et al. 2007).

The coral monitoring program (CMP) outlined following has been designed to monitor the condition of coral communities in Cleveland Bay at areas where water quality has potential to be affected by dredging conducted for the CU Project. Results will enable adaptive management during dredging for mitigation of potential impacts. The program incorporates monitoring at both potentially affected and reference sites and has included 12 months of pre-dredge data collection.

Monitoring Locations

Monitoring is undertaken at nine sites during each quarterly monitoring event. Details regarding each monitoring site are provided in Table 17 and sites are shown in Figure 27. The geographic location of each impact site and the selection of reference sites was informed by preliminary field reconnaissance surveys that took account of coral cover that was present up to twelve months prior to commencement of the monitoring program. The coral sites are also co-located with water quality monitoring. Field reconnaissance surveys selected coral sites that were in proximity to appropriate seabed habitat and water depth in support of co-locating water quality monitoring equipment. The reference sites were selected on basis of their representativeness of the suite of physical conditions present across impact sites inclusive of depth, location on the reef and exposure to oceanographic conditions (i.e. waves, tidal currents). All sites were examined by snorkel to confirm suitable coral cover and diversity for use as a reference. Herald Island was included in the baseline but has subsequently removed as a reference site location due to the reduced zone of influence predicted due to the use of a Mechanical dredge only.

The layout at each monitoring site is comprised of four 20 m transects consistent with and adapted from scientifically rigorous and globally recognised coral monitoring programs reviewed in Hill and Wilkinson (2004). Methods using four 20 m transects is also consistent with that applied during historical coral monitoring programs conducted in Cleveland Bay and at Magnetic Island for projects such as the Townsville Ocean Terminal and the Nelly Bay Harbour Development.

Table 17. Coordinates of monitoring sites for the Coral Monitoring Program

Site Name	Site code	Type	Latitude	Longitude	Marine Park Zoning	Dominant Coral
Middle Reef	MIDR	Compliance	19°11'53.1''S	146°49'6.3''E	Conservation Park	Acropora, Montipora, Dipsastrea, Poritidae
Virago Shoal	VIRS	Compliance	19°12'37.5''S	146°47'30.5''E	Conservation Park	Goniastrea, Montipora
Florence Bay	FLOB	Sentinel	19°7'19.4''S	146°52'53.3''E	Marine National Park	Acropora, Montipora, Dipsastrea, Galaxea
Geoffrey Bay	GEOB	Sentinel	19°9'17.7''S	146°52'0.5''E	Marine National Park	Acropora, Montipora, Porites
Picnic Bay	PICB	Sentinel	19°11'11.70''S	146°49'59.88''E	Conservation Park	Acropora, Montipora
Cockle Bay	COCB	Sentinel	19°11'15.8''S	146°49'7.1''E	Conservation Park	Monitpora, Porites, Faviidae
Bay Rock	BAYR	Reference	19°7'2.5''S	146°45'07.4''E	Habitat Protection	Acropora, Montipora, Soft Coral
Paluma Shoal	PALS	Reference	19°6'19.5"S	146°33'50.5"E	Habitat Protection	Montipora, Turbinaria
Rattlesnake Island	RATI	Reference	19°2'17.5''S	146°36'56.6''E	Habitat Protection	Turbinaria, Acropora, Montipora

* Herald island was removed from the program in June 2021

Figure 27. Site locations for the Coral Monitoring Program

Survey Schedule

Baseline - Four surveys were undertaken quarterly throughout the pre-dredging period, each survey was conducted over four-days. Survey 1 April 2020 (4,5,6,12); Survey 2 June (12,14,15,23); Survey 3 September (23,24,25,26) and Survey 4 December (1,5,7 and 8). All field surveys were targeted for optimal weather conditions allocating 48 hours following strong winds to allow suspended sediments to settle and improved water clarity for post-processing accuracy of the imagery captured. The first field survey was intended to be conducted in March 2020 although a combination of Coronavirus and weather interrupted plans and the survey was delayed until early April 2020. Subsequent surveys were undertaken as per the planned quarterly schedule.

Planned Coral Monitoring Program surveys are undertaken quarterly during back-hoe dredging activities. Surveys will also continue post-dredging at selected sites, as per permit conditions, to ensure no lethal/sublethal impacts occur from capital dredging associated with the CU Project.

Sampling Indicators

The Coral Monitoring Program collects information on the coral community/health indicators that are scientifically relevant for detecting change in the condition of corals and coral communities in response to key anthropogenic stressors (Gilmour et al. 2007). Measurements will be conducted to inform both sublethal changes in coral cover and health as well as community level (lethal) changes. These indicators are:

- Photo-point Intercept Transects (Lethal indicators):
    - Percent total coral cover;
    - Changes in cover of coral taxa; and
    - Changes in cover of other benthic community.
- Repeat Colonies (Sublethal indicators):
    - Partial mortality;
    - Sediment cover;
    - Coral bleaching;
    - Physical damage;
    - Mucous production;
    - Predation; and
    - Disease.

Sampling Methods

Three different methods were originally implemented and assessed as part of the pre-dredge CMP. The methods measure the condition of coral communities through collection of information relevant to both sublethal changes in coral health as well as community level (lethal) changes. Results are designed to enable adaptive management intervention during dredging for mitigation of potential impacts as prescribed in Conditions. The sampling methods applied during the pre-dredge CMP included: Photo-point intercept (PIT), Line intercept (LIT) and Repeat Colony. It was noted that methodology implemented during dredging the program may be varied from time to time in consultation with the ITAC.

Following review of the early baseline field data only two survey methods continue to be implemented using SCUBA by appropriately trained and qualified divers:

1. Repeat colony analysis – approximately 20 coral colonies per transect (~80 per location, ~720 total) are photographed for assessment and allocation of coral health scores per predefined criteria.

2. Line intercept transects – four 20 m line intercept transects are undertaken at each site (9 sites, 36 transects total). Benthic substrate is recorded in situ on each transect using a predefined classification system. Photographs of the substrate observed along each transect is also recorded.

REPEAT COLONIES

Repeatedly surveying individual colonies for monitoring potential sublethal impacts on coral during dredging was employed for environmental management during the Townsville Port Authority Capital Dredging Works in 1993 (Benson et al. 1994) and the Nelly Bay Harbour Development dredging program (Chin & Marshall, 2003). The success of this survey technique and its use as an appropriate tool for environmental impact management across dredging programs, such as the Chevron Gorgon Project capital dredging program, was confirmed in the review by Jones and Twomey (2019).

This survey method requires one diver to take representative photos of all repeat colonies that have been identified for each transect. These photographic records are made prior to the collection of the line intercept transect survey data and field imagery. A standard nomenclature has been developed to assist in locating and identifying the coral colonies targeted for repeated image analysis, outlined below.

Site code *-****Transect Number*** *(Tx)-****Coral Colony number****(#), Coral Colony Species,* ***Location(distance (m) along the transect / distance from transect (cm))*** *[where R – Right of transect downstream; L – Left of transect downstream; U – Under transect].*

For example:

A diver is surveying **Flo**rence **B**ay on **Transect one** and finds the **fifth** previously identified coral colony, which is a **Dipsastrea,** located **6.9** meters from the start of the transect and is to the **right**-hand side of the transect approximately **60** cm away from the transect tape. The nomenclature is as follows:

FLOB-T1-5-Dipsastrea 6.9/R60

The coral colonies are photographed in sequential order. To date all coral colonies have been photographed across all transects in sequential order (starting at 0 m on each transect, progressing from transect 1 through to four) prior to commencing line intercept data capture.

Post fieldwork, the digital images of each colony are assessed using the classification details for sublethal coral indicators provided in Table 18. Partial mortality, sediment deposition, colony damage and bleaching coral health indicators are quantified into seven levels of impact, which are based on previous tables used to describe levels of bleaching, including Hughes et al. (2016) and Morgan et al. (2017). For each colony, observations of physical damage, mucous production, disease and predation are categorised as either present or absent, with further notes of the type of disease or predation observed. Each image is also compared with the reference image of the same colony collected during prior surveys to assist in classifying the level of observed change foreach colony and each indicator. Field observations provide context to also inform classification derived from review of digital images.

Table 18. Classification *Indicators of lethal and sub-lethal stressors* recorded for each colony during each survey

Indicator Severity	0 Nil	1 Low	2 Moderate	3 High	4 Severe	5 Extreme	6 Total
Partial Mortality (PM) Sediment deposition (Sed)	0%	<10%	10-30%	30-60%	60-80%	>80%	100%
Coral colour (bleaching) (Bl)	normal	paling	0-30%	30-60%	60-80%	80-99%	100%
Mucous Production (Muc)	Presence/absence (P/A)						
Damage (Dam)	Presence/absence (P/A)						
Disease (Dis)	Presence/absence (P/A) & Type (White syndrome, black band, brown band, other)						
Predation/Type (Pred)	Presence/absence (P/A) & Type (*Acanthaster*, *Drupella*, fish scars, polychaetes, tremetodes)						

The images collected during the recent survey were compared to the set of coral reference photographs taken during the prior surveys to assess coral health indicators, particularly for defining the boundary of the original colony for determining partial mortality. Notes of coral health indicators recorded in the field were also reviewed during post-hoc analysis to assist classification of colonies in images. The coral health classification results were entered into excel.

The coral health sub-lethal quantitative classification results are analysed to identify the severity of partial mortality, sediment cover and coral bleaching at the time of each survey within repeatedly sampled colonies per site. Data is analysed as per the monitoring program to consider the relative abundance of colonies as well as detecting bleaching intensity across sites than percent of bleached colonies.

LINE-INTERCEPT TRANSECTS

For each 20 m LIT, benthic substrate is recorded in situ by divers onto the field slates/underwater paper using a predefined classification system as per Table 19. Line intercept survey methods are a standard scientific method for survey of coral reefs and benthic habitats; numerous references are available online that describe this method in detail.

Photos of the substrate along each transect should be undertaken in 0.5 m increments; totalling ~40 photos per transect. Photos are at a standard distance from the substrate, and of the same aspect. The transect tape is central to the images.

The cumulative distance measures to 20 m recorded in the field were first calculated into the distance of each individual change in benthic cover by subtracting the change distance from the previous distance measurement. The cumulative distance of each benthic group code within each transect was calculated into a proportion of benthic cover within a transect, with means and standard deviations/errors calculated across transects at each site.

Table 19. Benthic classification for line intercept transects

Functional Groups:	Taxon/category	Growth Forms:	Other Labels:
Algae	Algae - other		
	Algal turf		
	Macroalgae		
	Cyanobacteria		
	CCA		
Hard coral	*Acropora*	branching	Bleached
	Fungidae	corymbose	
	Galaxea	columnar	
	Goniopora/Alveopora	encrusting	
	Lobophyllia	foliose	
	Montipora	free living	
	Other Hard coral	massive	
	Pachyseris	submassive	
	Pocillopora	tabulate	
	Porites		
	Turbinaria		
Hard substrate	Rock		
	Recently Dead Coral		
	Other		
	Spare		
Other	Rubble		
	Shadow		
	Tape		
	Water		
	Other		
Other invertebrates	SPARE		
	Ascidian		
	Bivalve		
	Bryozoan		
	Crown of Thorns Sea Star		
	Echinoderms		
	Hydrozoa		
	Molluscs		
	Soft Coral		
	Sponge		
	Tunicate		
	Zoanthid		
	Other		
Seagrass	Seagrass		
Soft substrate	Sand		
	Sediment		

Data Handling

Repeat Colonies

The sublethal coral health quantitative classification results are analysed to identify the severity of partial mortality, sediment cover and coral bleaching at the time of each survey within repeatedly sampled colonies per site using an industry standard statistical analysis software package.

Presence/absence indicators are analysed for the incidence of physical damage, mucous production, predation and disease at the time of the survey within repeatedly sampled colonies per site. These indicators are assessed for each colony. Methodology in capturing repeat colony data can be modified in line with ITAC consultation and review.

Statistical Analysis

The same statistical tests are performed on both lethal and sublethal monitoring data. Statistical analysis is typically completed for the following primary indicators to provide information in support of dredge management:

- Percent total coral cover (Lethal)
- Partial mortality (Sublethal)
- Coral bleaching (Sublethal)
- Sedimentation (Sublethal).

The remaining indicators are reviewed and presented in tables and graphs to support data interpretation. Should it be needed, statistical tests or further interrogation of results from additional information collected can be performed in the following circumstances:

- if changes are observed in additional indicators; or
- further investigation is required to determine what has driven a significant change in primary indicators.

The first step of the statistical analysis is a multi-factorial Analysis of Variance (ANOVA) performed using a Generalised Linear Model (GLM) fitted with a suitable selected distribution to determine pairwise contrasts of the gross change in cover at each site between surveys through time. This uses a null hypothesis of no difference between the impact site at time 'x' compared to baseline or previous surveys from the same site to identify if the change at time 'x' is significantly different. The 95% confidence interval and p-value results inform whether a statistically significant change has occurred.

In the event the first step identifies a statistically significant change of an increase in coral health indicators or decrease in coral cover, this is followed by a similar test, but of net change at the impact site (i.e. factoring in change in cover that occurred concurrently at both impact and reference sites). This process involves first calculating the difference between time 'x' and the baseline or other previous surveys at the impact site, then calculating the difference across reference sites during the same period. The test is then run on the difference in cover or health observed between surveys at impact and reference sites.

The hypothesis being tested is the difference in the change at the impact site is not greater or less than the change among reference sites. ANOVA is performed on the relevant coral cover and quantitative coral health results using a GLM fitted with a suitable selected distribution to determine pairwise contrasts of the net change between impact and reference sites. The 95% confidence interval and p-value results inform whether a statistically significant change has occurred.

Survey Quality Assurance/Quality Control

Standard Operating Procedures and QA/QC Protocols (e.g. ISO 9000) for monitoring methods, site maintenance, and data capture, analysis and interpretation is implemented throughout. These are employed to provide confidence in the quality of data captured. As a minimum these protocols require:

- fieldwork undertaken by qualified scientific divers experienced in tropical ecological reef studies

- training for personnel and procedures developed prior to mobilisation for field surveys to ensure consistent methods for locating and photographing repeat colonies and transects and minimising diver-related disturbance.
- regular maintenance of site infrastructure (site markers), monitoring equipment and dive gear prior to or during, quarterly surveys
- Implementing procedures for image and data management, data security and data quality, including but not, limited to:
    - Capture of site codes at the start of each site and transect for accurate coding of data during post-field processing
    - Checklist field sheets for repeat colonies to support accurate location of colonies
    - Check of digital image capture at completion of each day during download of images onto a secure server
    - Fieldsheets to be scanned and saved on the server at the end of each field survey
    - Data entry reviewed for accuracy against field sheets prior to analysis
    - Training for analysts for processing images and consistency in scoring with frequent cross-referencing and testing.

Preliminary field investigations (prior to baseline)

Preliminary field investigations in March and July 2019 undertaken prior to the commencement of the pre-dredge Coral Monitoring Program provided observations that major recent impacts had occurred on shallow nearshore coral reef communities in Cleveland Bay and Halifax Bay. These impacts were suspected to be attributable to the Townsville flood event in February 2019.

Snorkel observations of live coral cover and diversity at Picnic Bay, Cockle Bay and Virago Shoal in March 2019 were very low (≤5%). Quantitative data collected in July 2019 at Paluma Shoals, a shallow reference reef in Halifax Bay, recorded a mean coral cover of 17%. Comparison of results with monitoring undertaken at the same location in 2013/14 and 2015/16 indicates coral cover declined by up to ~40% at Paluma Shoals between 2016 and 2019 (Morgan et al. 2016, Morgan et al. 2017). This site experiences high levels of fresh water flow from surrounding creeks and coastal movement of freshwater discharges from adjacent areas.

The shallow depth and proximity to sources of flood discharge into the marine environment supports the theory that coral communities from Picnic Bay, Cockle Bay, Virago Shoal and Paluma Shoals were influenced by lower surface water salinity concentrations during the flood event, which likely caused the recent coral mortality and substantial loss of coral cover at these reefs.

Evidence of recent coral stress indicators such as discolouration, bleaching, sediment, partial mortality and algal overgrowth were also observed at Middle Reef and Bay Rock, possibly attributable to increased sediment and nutrients from the flood plumes. Indications of impacts at remaining monitoring locations to the East of Magnetic Island and in Halifax Bay were not observed during preliminary field investigations.

Pre Dredge baseline Results

The results are presented to provide both a synopsis of broadscale trends in coral conditions as well as site-specific characteristics of the coral community at each monitoring location. The results presented below provided for the two methods considered most suitable to address the objectives of the CMP and to establish an up-to-date, pre-dredge, baseline of the coral communities at each monitoring site.

The pre-dredge CMP commenced in April 2020 and subsequent surveys were conducted in June, September and December 2020. Note the monitoring program has additional data points from March 2021 and June 2021 and soon to be September. Currently the program collects field data to allow the PIT, LIT and repeat colonies to be analysed with final analysis approach to be resolved in consultation with ITAC.

Photo-point Intercept Overview

Total coral cover across reference sites is higher in April 2020 than at impacts sites. Reference sites record a mean of 31.1% compared to 19.0% across impact sites. The reference sites in clearer waters offshore (Bay Rock, Herald and Rattlesnake Islands) record coral cover between 31.6% and 44.9%, whilst the nearshore Paluma Shoals reference site is comparably lower at 13.8% cover. Comparison with quantitative coral cover estimates recorded at Paluma Shoals in July 2019 indicates cover decreased by 3.2%, or 18.8% relative cover, during the seven-month period prior to the pre-dredge survey in April 2020 (O2M 2019b). The highest cover of all sites in April 2020 at 64.5% is recorded at Middle Reef. This is considerably higher cover than the remaining impact sites, with a moderate cover (16.9%-19.5%) recorded at Florence and Geoffrey Bays and very low cover (3.0%-6.0%) at the shallow nearshore reefs Picnic Bay, Cockle Bay and Virago Shoal, consistent with snorkelling observations recorded during the reconnaissance survey in March 2019 (O2M 2019a).

Higher levels of bleaching at reference sites than at impact sites corresponds with substantial declines in coral cover between April and September 2020. Mean cover of coral recorded across reference sites decreasing to 23.3% in June and 16.3% in September, indicating a loss of 14.8% mean coral cover, or 47.6% relative cover since April across reference sites. Coral cover loss at each reference site during this period ranges from 1.0% at Paluma Shoals, and between 15.8% and 21.5% at Bay Rock, Herald and Rattlesnake Islands. However, coral cover stabilised between September and December surveys with a mean increase in coral cover of 1.5% and minor increases in cover at all reference sites.

Mean coral cover at impact sites remains relatively stable during the pre-dredge period in comparison to reference sites, ranging between 19.0% and 20.8% throughout all surveys. Impact sites Middle Reef and Florence Bay record the highest losses of 2.4% and 2.1% between April and September, respectively, although this is equivalent to only 4% of relative coral cover from Middle Reef compared to 12% loss at Florence Bay. A slight increase in mean coral cover between April and June 2020 is primarily attributable to changes in the prevalence of seasonal fleshy macroalgae (e.g., Sargassum) that likely obscured underlying coral in images from Geoffrey Bay in April, but which was not as abundant during subsequent surveys (exposing more underlying coral).

The benthic communities in both impact and reference sites are dominated by algal cover, which comprises between 50.9% and 70.0% of the total cover across all sites and surveys. The algal community in these sites is typically composed of more than 50% of cover classified as Turf Algae, with macroalgae and “Other” making up the majority of the remaining algal cover. The proportion of “Other invertebrates” is generally low among sites, although it comprises a higher proportion of the benthic community among reference sites primarily due to between 17.6% and 25.3% of cover at Bay Rock being classified as Soft Coral. Raw data indicates that the majority of bare hard substrate is covered with a thin layer of turf algae, whilst soft substrate generally comprises between 7% to 10.2% of the benthic composition.

Marine heatwave conditions and subsequent coral bleaching occurred in February 2020 immediately prior to commencement of the pre-dredge CMP. Coral bleaching levels are higher among reference sites than impact sites in April 2020, with mean relative cover of 53.6% and 25.8%, respectively. The reference sites in clearer waters offshore (Bay Rock, Herald and Rattlesnake Islands) record bleaching levels between 53.7% and 71.3%, whilst the nearshore Paluma Shoals reference site is comparably lower at 26.5%. Similarly, bleaching is low

(<5%) at the more turbid nearshore impact reefs Middle Reef and Cockle Bay in April. Moderate bleaching (26.6%-36.0%) occurs at Virago Shoal, Picnic and Geoffrey Bays, whilst higher bleaching cover is observed at Florence Bay (54.4%).

The results indicate the effects of coral bleaching persisted at some sites until December 2020. The relative proportion of bleached corals reduces rapidly between April and June, then more gradually during subsequent surveys. The reference sites mean cover of bleached coral decreases to 20.7% in June, 5.3% in September and 3.0% in December, compared to impact site means of 9.9%, 3.2% and 1.7%, respectively. Bleaching cover reduces proportionally similar to reference and impact site means between April and December among all sites relative to the levels of bleaching recorded in April.

Taxonomic classification of coral communities identifies a difference in the dominant assemblages between impact and reference sites. Plate, foliose and encrusting Montipora is the dominant community among impact sites, averaging between 45.0% and 53.4% of relative coral cover throughout all surveys. Massive/submassive 'other hard coral' and Porites are subdominant across impact sites. Other hard coral was the only noticeable taxa recording a loss in relative coral cover across impact sites between April and December of up to 14.9%, predominantly in the submassive growth form.

The dominant coral across reference sites in April 2020 is branching Acropora. Acropora relative cover declines from 43.6% to 32.0% across reference sites during the pre-dredge period, while branching cover declines from 43.9% to 24.9% . Plate and foliose Montipora and Turbinaria are subdominant, with the relative cover of Montipora declining slightly from 26.6% in April to 23.8% in December whilst Turbinaria increases from 14.6% to 22.5% of the coral community. Other observed coral taxa groups are either found in low proportions across both impact and reference sites or are subdominant in only a single site.

Photo-Point Intercept Transects

The pre-dredge Coral Monitoring Program commenced in April 2020 and surveys were conducted in June, September and December 2020. Graphs of the change in mean coral cover and relative coral bleaching levels between April and December 2020 at impact and reference sites are provided in Figure 28. A summary of the coral taxa recorded during each survey at impact and reference sites are summarised in Figure 29.

Marine heatwave conditions and subsequent coral bleaching occurred in February 2020 immediately prior to commencement of the pre-dredge Coral Monitoring Program. Coral bleaching levels observed during the April 2020 survey ranged from 1% to 71% across all sites. Bleaching was highest at the reference sites located in clear waters further offshore in Halifax Bay and lower bleaching levels occurred on more turbid nearshore reefs such as Cockle Bay and Middle Reef. Coral bleaching levels declined gradually during subsequent surveys in June and September to low cover of bleached coral recorded throughout all sites in December 2020.

Highest coral cover of the impact sites was recorded at Middle Reef in April 2020 ranging from 65.5% in June to 58.5% in December, with minor declines in cover recorded between June and December 2020. The coral community at Middle Reef comprises ~90% relative cover of laminar/foliose *Montipora* corals. Moderate and patchy cover (14.8-27.2%) of a more diverse coral community was recorded at Florence Bay and Geoffrey Bay. A decline in coral cover was recorded at Florence Bay from 16.9% in April to 14.8% in September, which subsequently recovered slightly in December to 16.4%. A macroalgal canopy obscured underlying coral in images from Geoffrey Bay in April, resulting in lower recorded coral cover of 19.5% in April compared to coral cover averaging 25.7% and 27.2% between June and December.

Coral cover at shallow nearshore sites Picnic Bay, Cockle Bay and Virago Shoal was low (3.0%-8.7%) throughout pre-dredge surveys, consistent with observations recorded during preliminary field investigations. Picnic Bay coral cover was lowest at between 3-4% during surveys and dominated by *Turbinaria* and *Lobophillidae* corals. *Montipora* was dominant at Cockle Bay with mean coral cover between 6-9% and Virago Shoal cover ranged between 4-5% and was dominated by *Montipora* and *Merulinidae* taxa classified as "other hard coral".

Substantial coral cover losses were recorded at offshore reference sites Bay Rock, Herald Island and Rattlesnake Island between April and September consistent with high levels of bleaching in April, ranging from 15.8% to 21.4% cover. These sites were typically high in cover in April 2020 (31% and 45%) and comprised of a higher proportion of coral taxa more sensitive to the effects of bleaching, such as large stands of branching *Acropora*.

The coral cover in the December survey at the three sites was either slightly higher, or similar to cover recorded in September. Paluma Shoals occurs in waters typically more turbid than reefs further offshore, similar to shallow nearshore reefs in Cleveland Bay, with a more resilient community to the effects of bleaching dominated by *Monitpora* and *Turbinaria* corals. Thus, the effects on coral cover observed from the bleaching event were reduced compared to other reference site, ranging from 14.4% in June to 12.8% in September.

Figure 28. Summary of changes in coral cover and relative cover of bleached coral between April and December 2020

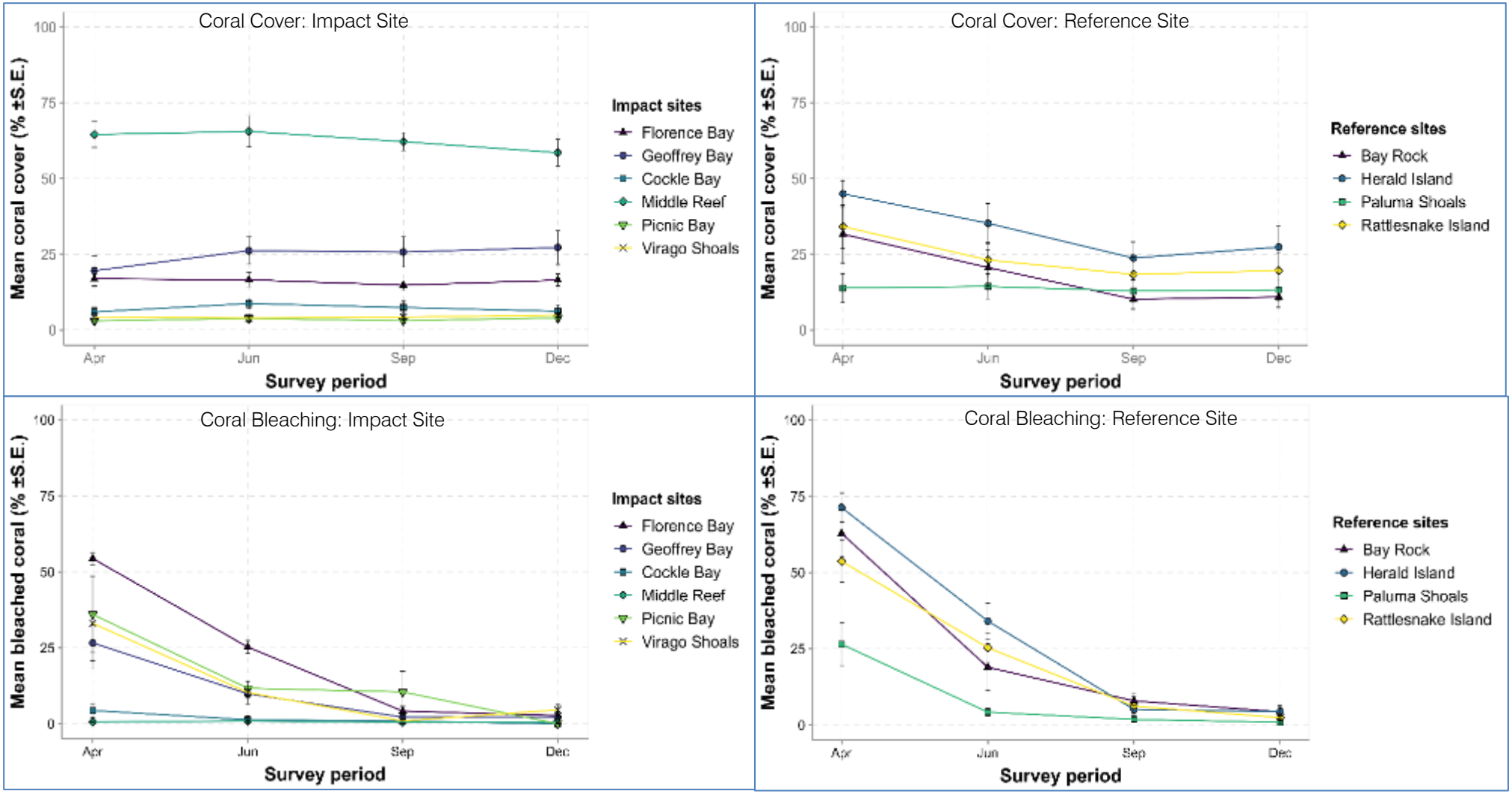
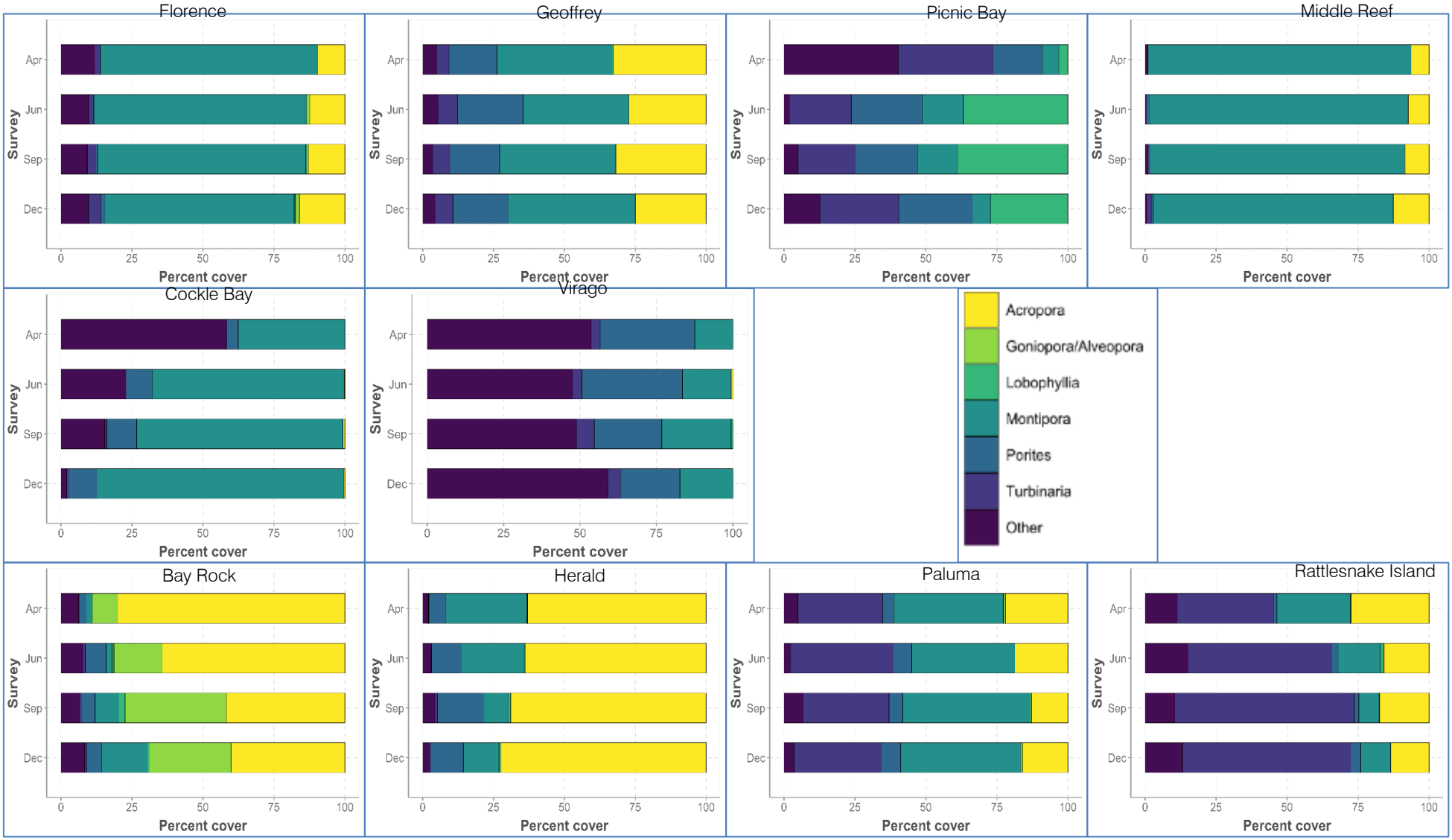


Figure 29. Relative changes in coral taxonomic classification groups (g) at impact (a-f) and reference (h-k) sites between April and December 2020



Changes in coral cover, as well as the GLM p-value and power analysis results are provided in Table 20. The statistical analysis was conducted for the period between April and September 2020. Data for the December survey were not available at the time analysis was undertaken. However, graphs have been updated to present results for the December 2020 survey for the overall summary of the condition of the coral community during the pre-dredge period.

Statistical tests performed via a GLM ANOVA identified Herald Island was the only location that recorded a statistically significant change in coral cover between April and September with a power of 0.61, or probability of 61% that a change size is detected with significance. A statistical power of 0.8 or higher is generally accepted. Despite substantial loss in coral cover at Bay Rock and Rattlesnake Island, significant changes were not detected with loss in coral cover up to 21.4%. The high degree of variability in cover recorded likely contributed to changes not being detected as statistically significant. Power analysis results indicate detection of significant change in coral cover will be even more difficult at monitoring locations where coral cover is low, as has also been found by previous studies (Stoddart and Stoddart 2005).

Cover of coral in the Project area is now low and spatially variable, making it very difficult to obtain precise measurements of change in coral cover for adaptive management of the dredging program. However, the photo-point intercept transects (PIT) method provides useful information for determining long-term trends and changes within the benthic community. The community results will therefore be utilised to support the sublethal analysis for adaptive management of the dredging program.

Table 20. Summary of changes in total coral cover (±SE) between April and September 2020 recorded during surveys using the Photo-point intercept transects method, and results for the Generalised Linear Model p-value and power analysis. Sites in bold identify a significant change.

Site	Imp/Ref	April	June	September	Change	p-value	Power
Florence Bay	Impact	16.9 (2.5)	16.6 (2.3)	14.8 (1.5)	-2.1	0.77	0.09
Geoffrey Bay		19.5 (4.9)	26.2 (4.5)	25.7 (5.0)	6.2	0.64	0.12
Picnic Bay		3.0 (0.8)	3.8 (0.9)	3.0 (0.9)	0	1.00	0.05
Middle Reef		64.5 (4.2)	65.5 (5.1)	62.2 (3.0)	-2.3	0.92	0.06
Cockle Bay		6.0 (1.4)	8.7 (1.6)	7.4 (2.0)	1.4	0.81	0.08
Virago Shoal		4.3 (1.4)	4.0 (1.3)	4.2 (1.0)	-0.1	1.00	0.05
Bay Rock	Reference	31.6 (9.5)	20.6 (6.0)	10.2 (3.2)	-21.4	0.06	0.48
Herald Island		**44.9 (4.4)**	**35.2 (6.6)**	**23.7 (5.4)**	**-21.2**	**0.02**	**0.61**
Rattlesnake Island		34.1 (7.2)	23.1 (5.8)	18.3 (5.6)	-15.8	0.17	0.33
Paluma Shoals		13.8 (4.8)	14.4 (4.2)	12.8 (3.6)	-1	0.98	0.05

Repeat Colonies

Coral colonies to be repeatedly sampled for health indicators were selected during the first survey in April 2020 across all sites and established the long-term monitoring program sites. This survey was conducted immediately following a marine heatwave event; the strategy for colony selection therefore actively avoided choosing bleached corals for which the prospect of whole colony mortality is likely. Complete exclusion of bleached or stressed colonies in April was unavoidable at many sites due to high levels of bleaching and/or low coral cover.

The active selection against bleached corals may, however, present bias in data compared to levels of bleaching and mortality recorded using the PIT method.

The classification ranking applied to partial mortality, bleaching and sediment cover during the pre-dredge surveys is presented in Table 21 with six categories. The classification system proposed for application during dredging as described earlier in Table 19 has been modified from the pre-dredge survey (Table 21 below). Analysis of the pre-dredge results identified a category for whole colony (100%) mortality/sediment will also be a useful inclusion for classification and aligns quantitative values for coral bleaching. However, the results presented here recorded during pre-dredge surveys are based on classification rankings in Table 21.

Table 21. Classification rankings of indicator parameters recorded for each colony during pre-dredge surveys

Indicator	0	1	2	3	4	5
Partial Mortality	No effect	<10%	10-30%	30-60%	60-80%	>80%
Sediment deposition						
Coral bleaching	No effect	paling	focal bleaching	non-focal bleaching	partial bleaching	total bleaching

The results for the mean change in partial mortality, coral bleaching and sediment cover on repeatedly sampled colonies between April and December 2020 are shown in Figure 30. A positive change result represents an increase in detection of coral health indicators and, therefore, increased stress on corals. The proportion of colonies among impact and reference sites in each classification score for coral bleaching, partial mortality and sediment cover is presented in Table 22.

Partial mortality scores typically increased across monitoring locations during surveys between April and December 2020. The largest increases in mean partial mortality occurred at the reference sites Bay Rock (2.1), and Herald Island (1.4), as well as the nearshore shallow site Cockle Bay (1.4). The proportion of colonies with >10% partial mortality between April and December increased from 9.2% to 22.7% and 9.7% to 30.1% across impact and reference sites, respectively. At sites with the highest weighted mean scores, the proportion of colonies with >10% partial mortality between April and December increased by 47.5% at Bay Rock, 31.3% at Herald Island and 32.5% at Cockle Bay. The increase in partial mortality at the reference sites aligns with a loss in coral cover recorded using the PIT method in Section 5.2 of approximately 21% during the same period.

Florence Bay and the reference location Rattlesnake Island recorded an increase in partial mortality between 0.7-0.9 between April and December. The proportion of colonies recording >10% partial mortality at these sites during the pre-dredge period increased by 18.8% and 17.5%, respectively. The remaining monitoring locations recorded minor increases in weighted mean scores from 0.3 at Picnic Bay, 0.5 at Middle Reef to 0.6 at Geoffrey Bay and Paluma Shoals. Picnic Bay recorded the highest mortality levels in April at 1.1, although this is primarily attributable to inclusion of assessment of coral remnants which had to be selected due to very low coral cover at the site (~3%). However, Picnic Bay recorded the lowest increase in partial mortality (0.3) between April and December 2020.

A score for whole colony mortality is useful for interpretation in the classification scheme. All colonies with >80% partial mortality were allocated into Cat5 for weighted means and statistical analysis, although comments enable separate evaluation of the proportion of colonies that either suffered complete mortality or were missing. The observations indicate total mortality of approximately 7% (6 colonies per site) and 13% (11 colonies per site) of colonies had occurred between April and December across impact and reference sites, respectively, ranging from 2.5% (2 colonies) at Virago Shoal to 20% (16 colonies) at Bay Rock.

Mean weighted coral bleaching scores in Figure 30 for April range from 0.7 at Middle Reef to 2.7 at Rattlesnake Island. All reference site scores were >2 indicating generally higher bleaching levels across reference sites similar to findings using PIT methods. From the distribution of scores, 37.6% of colonies across reference sites were classified with partial or total bleaching (Cat4-5) in April compared to 13.5% of colonies from impact sites (Table 22). This is an important indicator linking a higher proportion of colonies regressing in condition during subsequent surveys and resulting in higher coral mortality among reference sites.

Coral bleaching observations on repeat colonies declined gradually within the pre-dredge period to means of 0.2 and 0.3 recorded in December 2020 at impact and reference sites, respectively. Similar trends of a gradual decline in the observed bleaching effects on corals across monitoring events was also recorded using the PIT method. 'No effect' scores indicate ~50% of colonies from impact and reference sites recovered from the effects of bleaching by December 2020. The proportion of colonies exhibiting paling, focal or non-focal bleaching among impact and reference sites are comparable in December at 11.2% and 13.0%, respectively.

Sediment cover at all sites was generally low and variable during surveys between April to December ranging between 0 and 1.0. This is equivalent to no observed sediment cover at the site through to all colonies recording between 0-10% deposited sediment (Cat 1). The mean scores across impact and reference sites range from 0.3 to 0.6 and the proportion of colonies recording <10% sediment cover ranges from 91.0% to 99.1%. There in a slight trend in both results of increasing sediment cover during the pre-dredge period at reference sites whilst impact results remain relatively stable and variable. Bay Rock in particular exhibits an increasing sediment score between April and December of 1.0, combined with an increasing proportion of 18.5% (15 colonies) of colonies recording >10% sediment cover.

The mean incidence of colonies observed with the sublethal coral health indicators of physical damage, disease, mucous production and predation are presented in Table 23. Except for predation, the occurrence of the other indicators across sites and surveys were low and variable. Observations of physical damage during the pre-dredge period is highest at Rattlesnake Island ($\bar{x}$ = 4.6%), disease at sites Florence Bay ($\bar{x}$ = 2.6%) and Rattlesnake Island ($\bar{x}$ = 2.3%), and mucous at Florence and Picnic Bays ($\bar{x}$ = 1.9%).

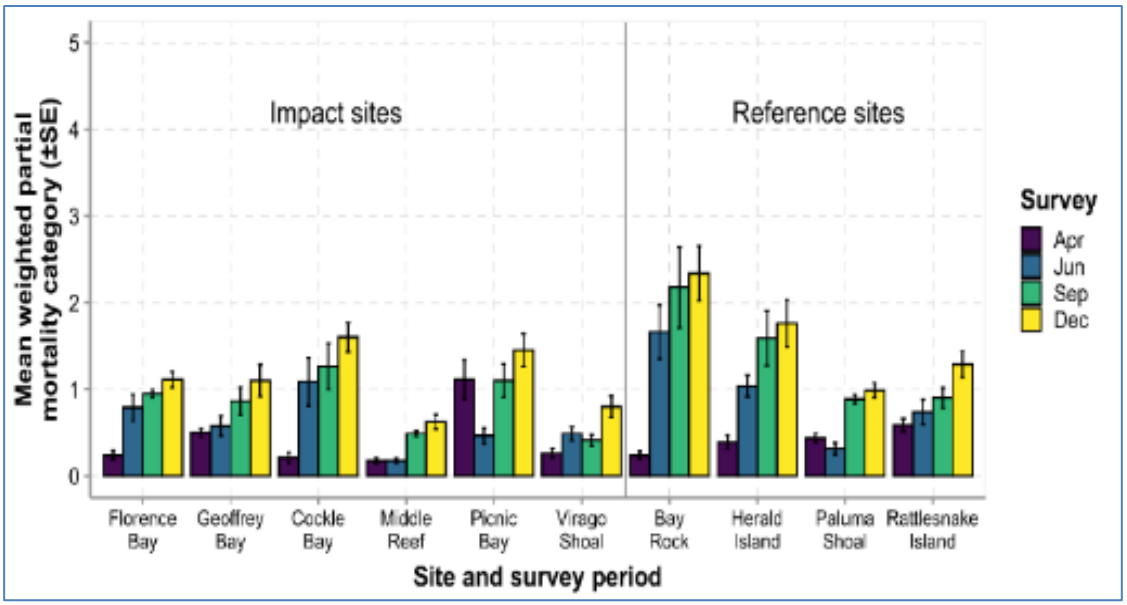
Predation is recorded with a higher incidence of occurrence than other indicators, as well as higher values across impact sites than compared to reference. Fish scars, burrowing polychaetes, bivalves and other coral boring invertebrates were the most frequently recorded types of predation present. The highest incidence of predation among impact sites is recorded during the April and June surveys following the coral bleaching event, whilst reference site results tend to be more variable between surveys. Sites recording a high incidence of predation include Geoffrey ($\bar{x}$ = 19.2%), Florence ($\bar{x}$ = 17.3%), Picnic ($\bar{x}$ = 13.7%) and Cockle Bays ($\bar{x}$ = 12.9%). Middle Reef recorded the lowest predation levels of all sites ($\bar{x}$ = 1.9%).

Table 22. Proportion of colonies with partial mortality, coral bleaching and sediment cover classification scores among impact and reference sites during the pre-dredge period.

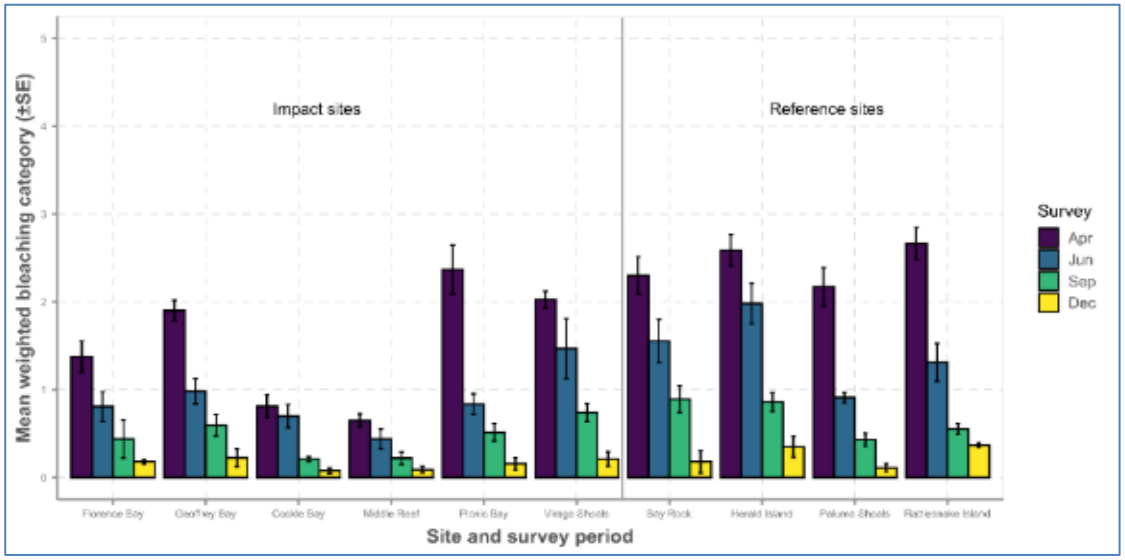
Survey	Imp/Ref	0	1	2	3	4	5
Partial Mortality							
April	Imp	76.3%	14.0%	3.3%	3.8%	1.7%	0.6%
	Ref	68.7%	21.6%	8.5%	0.9%	0.0%	0.0%
June	Imp	69.2%	19.4%	3.3%	1.5%	0.0%	0.0%
	Ref	60.2%	19.1%	5.3%	4.1%	1.6%	6.0%
September	Imp	57.7%	23.5%	7.1%	4.2%	1.0%	1.9%
	Ref	47.3%	21.3%	8.2%	5.6%	3.1%	7.2%
December	Imp	48.3%	27.3%	8.8%	4.8%	1.9%	1.7%
	Ref	42.9%	20.7%	9.4%	5.6%	1.6%	6.3%
Coral Bleaching							
April	Imp	35.8%	20.9%	17.6%	12.1%	6.3%	7.3%
	Ref	21.4%	23.3%	11.6%	6.0%	9.1%	28.6%
June	Imp	49.1%	25.2%	18.1%	4.7%	1.8%	1.1%
	Ref	48.5%	18.2%	11.1%	5.2%	5.5%	11.4%
September	Imp	64.4%	27.3%	7.4%	0.4%	0.2%	0.2%
	Ref	58.7%	25.9%	10.6%	3.8%	1.0%	0.0%
December	Imp	82.3%	6.5%	4.0%	0.0%	0.0%	0.0%
	Ref	88.8%	7.0%	4.3%	0.0%	0.0%	0.0%
Sediment Cover							
April	Imp	56.5%	38.5%	2.3%	1.9%	0.8%	0.0%
	Ref	73.0%	26.0%	0.9%	0.0%	0.0%	0.0%
June	Imp	68.8%	29.0%	2.2%	0.0%	0.0%	0.0%
	Ref	64.8%	30.9%	2.9%	1.3%	0.0%	0.0%
September	Imp	48.5%	46.1%	3.3%	1.3%	0.2%	0.7%
	Ref	49.8%	43.7%	1.7%	2.7%	0.7%	1.4%
December	Imp	52.8%	42.5%	2.9%	1.3%	0.4%	0.0%
	Ref	58.1%	32.9%	4.7%	3.2%	1.1%	0.0%

Figure 30. Summary of changes in weighted mean coral heath parameters units recorded during surveys using repeat colony methods for a) Partial mortality, b) Bleaching, and c) Sediment deposition.

a)



b)



c)

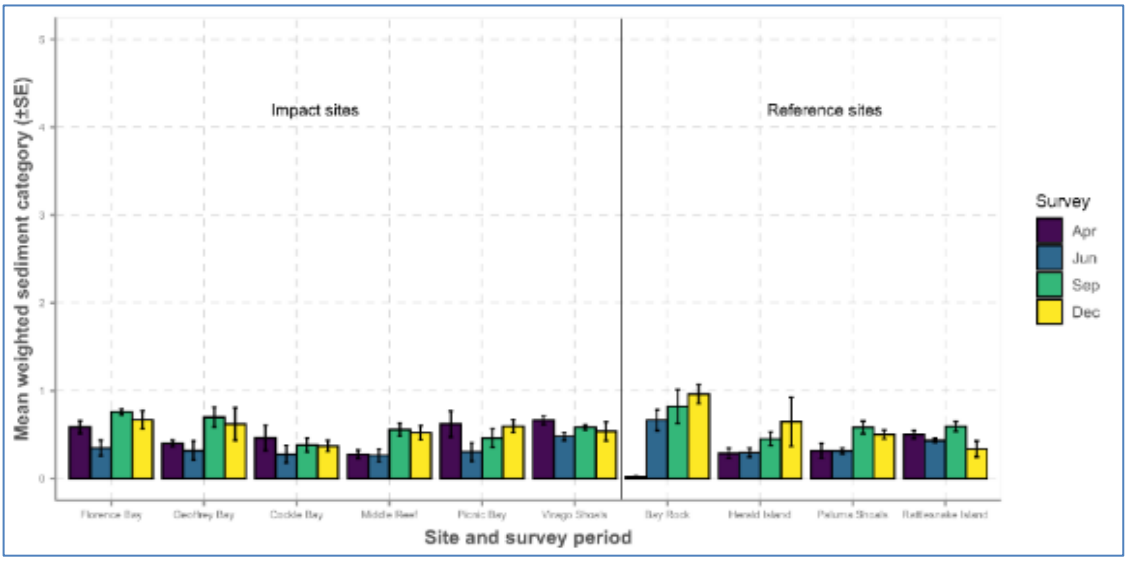


Table 23. Mean (±SE) colonies recorded with physical damage, disease, mucous and predation during each survey

Site	Imp/Ref	Survey	Damage	Disease	Mucous	Predation
Florence Bay	Impact Sites	Apr	2.5%	3.8%	7.5%	27.5%
		Jun	0.0%	4.1%	0.0%	19.2%
		Sep	2.6%	0.0%	0.0%	13.0%
		Dec	0.0%	2.7%	0.0%	9.6%
Geoffrey Bay		Apr	0.0%	2.5%	0.0%	15.0%
		Jun	0.0%	2.7%	6.8%	24.3%
		Sep	0.0%	0.0%	0.0%	20.0%
		Dec	4.0%	2.7%	0.0%	17.3%
Picnic Bay		Apr	0.0%	1.3%	5.1%	6.3%
		Jun	2.6%	1.3%	0.0%	28.6%
		Sep	1.3%	0.0%	2.6%	9.1%
		Dec	2.7%	1.4%	0.0%	11.0%
Middle Reef		Apr	2.5%	2.5%	1.3%	3.8%
		Jun	1.3%	0.0%	0.0%	1.3%
		Sep	1.3%	0.0%	1.3%	1.3%
		Dec	0.0%	0.0%	0.0%	1.3%
Cockle Bay		Apr	1.3%	0.0%	2.5%	0.0%
		Jun	1.4%	0.0%	0.0%	26.1%
		Sep	0.0%	0.0%	0.0%	12.7%
		Dec	5.7%	0.0%	0.0%	12.9%
Virago Shoal		Apr	0.0%	1.3%	2.5%	17.7%
		Jun	5.3%	1.3%	0.0%	6.7%
		Sep	1.3%	0.0%	0.0%	1.3%
		Dec	3.8%	0.0%	0.0%	3.8%
Bay Rock	Reference Sites	Apr	0.0%	0.0%	0.0%	1.3%
		Jun	0.0%	1.3%	0.0%	5.3%
		Sep	1.3%	0.0%	1.3%	3.8%
		Dec	1.6%	1.6%	1.6%	6.3%
Herald Island		Apr	1.3%	1.3%	5.0%	2.5%
		Jun	0.0%	0.0%	1.3%	16.9%
		Sep	3.1%	1.6%	0.0%	12.5%
		Dec	5.9%	1.5%	0.0%	14.7%
Rattlesnake Island		Apr	2.5%	2.5%	2.5%	13.9%
		Jun	9.1%	1.3%	1.3%	9.1%
		Sep	3.9%	2.6%	0.0%	3.9%
		Dec	2.8%	2.8%	0.0%	2.8%

Paluma Shoals		Apr	0.0%	0.0%	1.3%	7.5%
		Jun	2.5%	0.0%	0.0%	2.5%
		Sep	0.0%	0.0%	1.4%	8.1%
		Dec	0.0%	0.0%	0.0%	8.2%

Changes in mean partial mortality scores, as well as the GLM p-value and power analysis results are provided in Table 24. Statistical analysis was conducted for the period between April and September 2020. Data from the December survey were not available at the time the analysis was undertaken. However, graphs and tables have been updated to present results for the December 2020 survey for the overall summary of the condition of the coral community during the pre-dredge period.

Six sites recorded a significant gross change in partial mortality between April and September 2020: Florence Bay, Middle Reef, Cockle Bay, Bay Rock, Herald Island and Paluma Shoals. The results indicate that the repeat colony data can detect small changes in partial mortality with a high power ranging between 0.79 and 0.99, indicating this is an effective method for adaptive management of the dredging program.

A step 2 comparison of the net change in partial mortality against reference sites using a GLM for the impact sites Cockle Bay, Florence Bay and Middle Reef did not provide a significant result. The change in partial mortality between April and September was higher across reference sites than recorded within any impact site, providing evidence the marine heatwave event generated system wide pressure on coral communities as opposed to the source of pressure emanating from within the impact zone where dredging is planned to occur.

Table 24. Summary of changes in partial mortality (±SE) between April and September 2020 recorded during surveys using the Repeat colony method, and results for the Generalised Linear Model p-value and power analysis. Sites in bold identify a significant change.

Site	Imp/Ref	Partial Mortality			Difference (PM scale)	p-value	Power
		Apr	Jun	Sep			
Florence Bay	Impact	**0.2 (0.1)**	**0.8 (0.2)**	**1.0 (0.0)**	**0.7 (0.1%)**	**0.00**	**0.99**
Geoffrey Bay		0.5 (0.0)	0.6 (0.1)	0.9 (0.2)	0.4 (0.2%)	0.07	0.45
Picnic Bay		1.1 (0.2)	0.5 (0.1)	1.1 (0.2)	-0.0 (0.3%)	1.00	0.05
Middle Reef		**0.2 (0.0)**	**0.2 (0.0)**	**0.5 (0.0)**	**0.3 (0.0%)**	**0.00**	**0.99**
Cockle Bay		**0.2 (0.1)**	**1.1 (0.3)**	**1.3 (0.3)**	**1.1 (0.3%)**	**0.00**	**0.79**
Virago Shoal		0.3 (0.1)	0.5 (0.1)	0.4 (0.1)	0.2 (0.1%)	0.25	0.23
Bay Rock	Reference	**0.2 (0.0)**	**1.7 (0.3)**	**2.2 (0.5)**	**1.9 (0.5%)**	**0.00**	**0.94**
Herald Island		**0.4 (0.1)**	**1.0 (0.1)**	**1.6 (0.3)**	**1.2 (0.3%)**	**0.00**	**0.94**
Rattlesnake Island		0.6 (0.1)	0.7 (0.1)	0.9 (0.1)	0.3 (0.2%)	0.13	0.37
Paluma Shoals		**0.4 (0.1)**	**0.3 (0.1)**	**0.9 (0.1)**	**0.5 (0.1%)**	**0.00**	**0.99**

12.1.3 Seagrass Monitoring Program – Methodology and Results

Overview

The Port of Townsville in partnership with James Cook University's TropWATER Seagrass Ecology Group established a long-term seagrass monitoring program (LTSMP) in 2007 to assess seagrass around Townsville and Magnetic Island. Each year the program examines a sub-set of representative seagrass meadows (10 meadows) and in some years (2007, 2008, 2013, 2016, 2019, 2020) all seagrass in the broader port area are re-assessed. The program has mapped up to 25,000 ha (2007) of coastal and deep-water seagrass in the Townsville region.

In 2019 the LTSMP was modified to a fit-for-purpose program specific to the Channel Upgrade Project (CU Project): the Channel Upgrade Seagrass Program. This specified monitoring program builds on the established LTSMP and is designed to assess and monitor seagrass habitat surrounding Townsville, Cleveland Bay and Magnetic Island before, during and after the planned works at a priori nominated reference and impact meadows. The Channel Upgrade Seagrass Program includes the monitoring meadows that form the LTSMP, but also includes expanded areas of seagrass in assessments (Table 25) to meet regulatory requirements and conditions associated with the CU Project. In April/May 2021 the density of seagrasses in the Strand to Pallarenda Meadow (meadows 10, 12 and 14) was increased to capture any variation or impact within this meadow as it was the only sensitive receptor within the modelled zone of influence from the mechanical dredge. The increased density sampling was undertaken from April 2021 to September 2022, with TropWATER undertaking a review of the increased sampling density based on the data and proposed a focused density approach that provided the same level of information with less on water effort. This proposed focused density approach was tabled and accepted by ITAC. This allows the Port and ITAC to resolve if an actual lethal or sub-lethal impact occurred on seagrasses (EPBC requirement) as the smaller plume requires greater resolution.

The inclusion of the long term monitoring data from existing monitoring meadows is one of the key strengths of the program; 14 years of pre-dredge data for the majority of the monitoring meadows. This allows the port to more effectively ascertain the condition of seagrasses relative to their historical variability. This adds an important element to assessing potential impacts of capital dredging and adds greater certainty around the expected condition of seagrasses, placing any changes occurring into a historical perspective and providing strong statistical support for determining if impacts have occurred as a result of Project works.

Key points of the approach to monitoring for the Channel Upgrade Seagrass Program is that there are multiple avenues to assess seagrass change in relation to capital dredging and natural drivers, including:

- Examining seagrass condition against the existing long term (14 year) history of the monitoring meadows (i.e. incorporating LTSMP data);
- Analysing changes in relation to a network of a priori nominated reference and impact meadows at given points in time (traditional BACI approach);
- Annual holistic assessment of the total seagrass resources within the wider Townsville area to place individual meadow scale changes into a wider local context (i.e. whole-of-port surveys);
- Placing changes in the Channel Upgrade Seagrass Program within the wider context of regional or state-wide seagrass change by direct reference to monitoring conducted using the same methods in other Queensland locations (e.g. identify seagrass change due to region-wide events - La Niña climate etc.)
- The Channel Upgrade Seagrass Program is a reactive, adaptive and scalable program dependent on the evolution of the CU Project and requirements at any given time.

Overall the Channel Upgrade Seagrass Program involves:

- Establishing baseline conditions of seagrass communities at a priori nominated reference and impact meadows before project works begin (seagrass senescent and peak season conditions – incorporating 14 years of pre-dredge data);
- Assessing and monitoring the condition of seagrass communities before, during and after project works;
- Assessing seagrass condition at selected monitoring meadows biannually, and at the whole-of-port scale annually;
- Delineating changes/impacts to seagrass communities due to project works, climate/weather or natural background changes.

Monitoring Location & Frequency

Seagrass monitoring is undertaken at 11 seagrass meadows (Table 25, Figure 31). The deep-water seagrass meadow in the middle of Cleveland Bay (meadow 19) is only assessed once a year, during the whole-of-port survey (September-November). The reasoning is that the deeper seagrass areas within Cleveland Bay are made up of highly ephemeral species that are only present for part of the year and that have massive year to year variability in their presence and location. As such they require a different approach to monitoring and interpretation of change than their shallower counterparts.

Monitoring meadows selected for the Channel Upgrade Seagrass Program are representative of the range of seagrass species/community and habitat types (intertidal and subtidal) found within the greater Townsville area, and are present in the CU Project impact and reference areas. The project design was based on AEIS expected zones of impact. With the change in scope and methods of the project dredging, this has resulted in substantial change to the status of the monitoring locations however they still provide a representative network of meadows to ensure that the range of potential responses disturbance (dredging/dredge plumes) by various seagrass species and communities is adequately captured.

For the Channel Upgrade Seagrass Program there is a mix of replicated reference and impact locations which provide data appropriate to assess seagrass condition before, during and after the capital dredge campaign within and outside of the zones of impact (if applicable) and zones of influence (ZoI) (Table 25; Figure 31). For each meadow community/species type and habitat type (intertidal/subtidal) there is an appropriate corresponding reference/impact meadow. The network of monitoring meadows that form the Channel Upgrade Seagrass Program is extensive enough however, that if the dredge plume footprint shifts from the modelling, seagrass meadows can easily be re-assigned as reference or impact meadows.

The nomination of reference/impact meadows has evolved with the CU Program pre-dredge plume modelling. The most up-to-date plume modelling shows that seagrass meadows are no longer in “zones of impact” only “zones of influence”. The seagrass meadows in the “zone of influence” are seagrasses between the Strand/Breakwater Marina wall and Cape Pallarenda (Meadows 12 & 14; Table 25, Figure 31). These two monitoring meadows have sections that are inside and outside the “zone of influence” and run along a gradient from high to low exposure (distance from dredge and/or plume) of various modelled plume scenarios. Columns 2 and 3 in Table 25 describe each meadow as reference/impact/gradient according to the original EIS and AEIS modelling, and updated plume modelling as a result of a change in dredge method.

Seagrass assessments for the Channel Upgrade Seagrass Program occur twice a year; once in the post-wet season (April/May) when natural environmental conditions are most likely to have impacted seagrass, then again in the dry season (October/November). This timing will allow both an assessment of the likely resilience of seagrasses at the high point of their annual seasonal cycle, but importantly also identify potential issues in

resilience due to accumulated natural stressors following the wet season which may have implications for their management and interpretation of seagrass change during capital dredging.

Bi-annual assessments of seagrass in the program are considered adequate in scope to address the expected level of risk posed by the dredging operations to seagrass, considering that the management, method (backhoe) and design of the dredging is such that direct impacts to seagrasses are expected to be minimal. Additional seagrass assessments can be conducted if there is a requirement (i.e. an exceedance in light thresholds triggers an additional survey).

Figure 31. Location of survey extent and meadows assessed in the bi-annual Channel Upgrade Seagrass Program and annual whole-of- port surveys

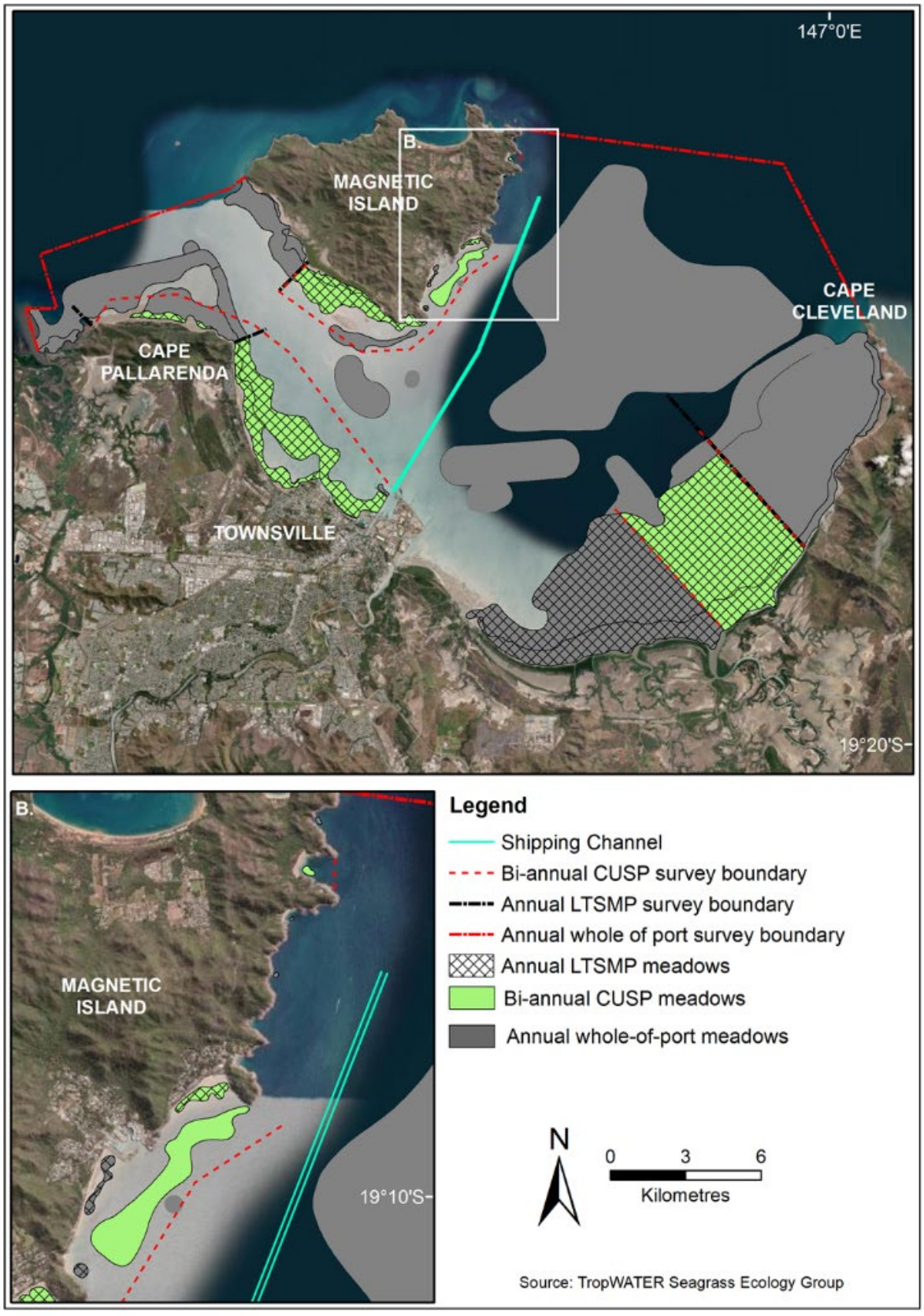


Table 25. Channel Upgrade Seagrass Program (CUSP) monitoring meadow details.

Monitoring Location (Meadow ID)	Monitoring location type based on original EIS & AEIS	Monitoring location type based on updated Dredge Plume Modelling	Seagrass Meadow Depth	Seagrass Meadow Type (dominant species)	Species Present	Common to CUSP & LTSMP	Monitoring History	Comments / Considerations
Florence Bay (1)	Impact	Reference	Intertidal/ shallow subtidal	Halodule uninervis	HU	N	Limited: (2007, 08, 16, 19, 20)	Surveyed approx. every 3 yrs as part of whole-of-port survey
Geoffrey Bay (3)	Impact	Reference	Intertidal	Halodule uninervis	HU, HO	Y	Detailed Annual >10 years	
Geoffrey Bay (24)	Impact	Reference	Subtidal	Halophila spinulosa	HS	N	Limited: (2013, 16, 19, 20)	Surveyed approx. every 3 yrs as part of whole-of-port survey
Cockle/Picnic Bay (5)	Impact	Reference	Intertidal/ shallow subtidal	Halodule uninervis	CS, HU, HO, HS, HD	Y	Detailed Annual >10 years	
Cockle Bay (6)	Impact	Reference	Intertidal	Zostera muelleri	ZM, HU, HO	Y	Detailed Annual >10 years	
Shelly Beach (10)	Reference	Reference	Intertidal	Zostera muelleri	ZM, HU, HO	Y	Detailed Annual >10 years	
Rowes Bay (12)	Impact	Gradient (inside & outside zone of influence)	Intertidal/ shallow subtidal	Halodule uninervis	HU, HO, HD, ZM, HS, CS	Y	Detailed Annual >10 years	
Pallarenda inc. Virago Shoal) (14)	Impact	Gradient (inside & outside zone of influence)	Subtidal	Halophila spinulosa	HS, HU, HO, HD, CS	Y	Detailed Annual >10 years	

Cleveland Bay (16)	Reference	Reference	Intertidal	Zostera muelleri	ZM, HU, CS	Y	Detailed Annual >10 years	
Cleveland Bay (17/18)	Reference	Reference	Subtidal	Halodule uninervis / Cymodocea serrulata / Halophila spinulosa	HU, CS, HD, HS	Y	Detailed Annual >10 years	
Deep-water seagrass -Cleveland Bay to Magnetic Is. (19)	Gradient (inside & outside zone of influence)	Gradient (inside & outside zones of impact & influence)	Subtidal	Halophila decipiens/ Halophila spinulosa	HD, HS	N	Limited: (2007, 08, 13, 16, 19, 20)	Surveyed approx. every 3 yrs as part of whole-of-port survey

Monitoring Scale

Monitoring will be conducted at the seagrass meadow scale, or for the very large meadows (i.e. Cleveland Bay meadows 16 & 17/18), substantial areas of the meadow that are large enough to estimate the known shifting spatial variability in seagrass characteristics (sections of the meadows).

Meadow scale monitoring is critical as results from over a decade of monitoring in Townsville show substantial shifts of where biomass hotspots occur within meadow boundaries as well as spatial change in the footprint of where seagrass meadows occur from year to year. Larger "meadow-scale" monitoring assures that an accurate picture of seagrass condition is obtained rather than the danger of simply measuring within the "noise" of variability that can occur with smaller fixed site monitoring approaches (i.e. transects) (Figure 32). The larger meadow-scale monitoring also allows a better ability to assess the impacts of larger scale natural events such as wind/wave driven resuspension of sediments in Cleveland Bay. Taking this approach also means the substantial monitoring history at the site, conducted at this same scale, can be used to assist in analysing seagrass change during the CU project. Monitoring at the meadow scale also allows meadows to be analysed at the "intra-meadow" scale if required.

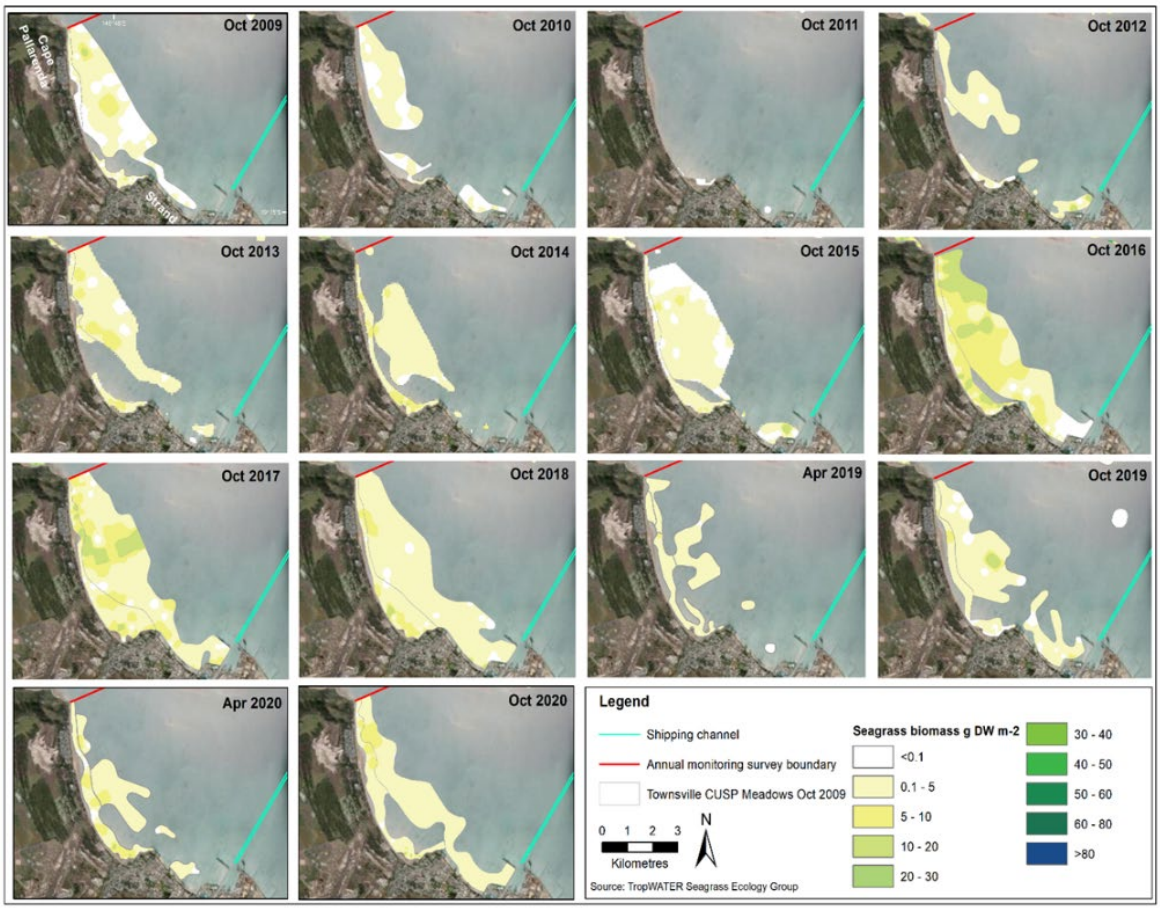


Figure 32. Temporal variation in seagrass meadow footprint, area and biomass in the Strand – Cape Pallarenda seagrass meadows.

The Channel Upgrade Seagrass Program is structured using two levels of monitoring:

- Annual whole-of-port seagrass assessments – The annual whole-of-port surveys are conducted across the broader port area in September-November during the peak seagrass growing season (Figure 31). Assessing seagrass at the "whole-of-port" scale provides better context for the changes observed within the Channel Upgrade Seagrass Program meadows. Annual "whole-of-port" monitoring ensures trends observed in the "monitoring meadows" represent the broader port limit and Townsville area, and conversely the changes in seagrasses in the broader area add important perspective and confidence to any changes seen in the "monitoring meadows". It is at this "whole-of-port" scale that the deep-water highly variable seagrasses between Cleveland Bay and Magnetic Island are assessed (Figure 31).

- Biannual Channel Upgrade Seagrass Program monitoring meadow assessments – These meadows/meadow sections are monitored biannually (post wet-season (April/May) and dry season (September-November) and capture the recommended reference and impact areas for the Channel Upgrade Seagrass Program (Figure 31). These surveys complement the annual whole-of-port surveys by providing more frequent and economical evaluations of seagrass in impact and control sites.

Sampling Indicators

The Channel Upgrade Seagrass Program uses a set of standard, proven and peer reviewed, indicators and metrics for measuring seagrass change. This allows results to be compared with historical data from the project area and also to be compared for context with other seagrass monitoring conducted in the region and Queensland wide.

Three principal indicators of seagrass condition are assessed in each survey; seagrass biomass, species composition and seagrass meadow area (hectares). These are fundamental indicators used to answer questions surrounding seagrass condition, i.e. Is seagrass present? What is the spatial footprint of the meadow? How dense is the seagrass? What species define the meadow? The importance of these indicators in seagrass habitat and health assessments was highlighted by the Seagrass Expert Group's recommendations for monitoring seagrass within the Reef 2050 Integrated Monitoring and Reporting Program (Udy et al. 2018).

Baseline conditions for seagrass biomass, species composition and meadow area have been established for all Channel Upgrade Seagrass Program monitoring meadows. Baselines are informed by annual means of each indicator calculated over the first ten years of monitoring (2007 – 2016) for eight of the Channel Upgrade Seagrass Program meadows (3, 5, 6, 10, 12, 14, 16, 17/18). For meadows 1 (Florence Bay) and 24 (Geoffrey Bay) interim baselines have been developed based on five and four years of data respectively. Baseline conditions for these meadows will continue to be adjusted with additional years of monitoring data as appropriate. Baseline conditions for the new v sub-section of the Cleveland Bay meadows (meadows 16 and 17/18) have been extracted from the historical data available and calculated for the Channel Upgrade Seagrass Program section (10 years of data).

A condition index has been developed for all the seagrass monitoring meadows based on changes in mean above-ground biomass, total meadow area and species composition relative to their baselines.

Seagrass condition for each indicator in Townsville is scored from 0 to 1 and assigned one of five grades: A (very good), B (good), C (satisfactory), D (poor) and E (very poor). The flow chart in Figure 33 summarises the methods used to calculate seagrass condition. See McKenna et al. 2021 Appendix 1 and 2 for full details of score calculation.

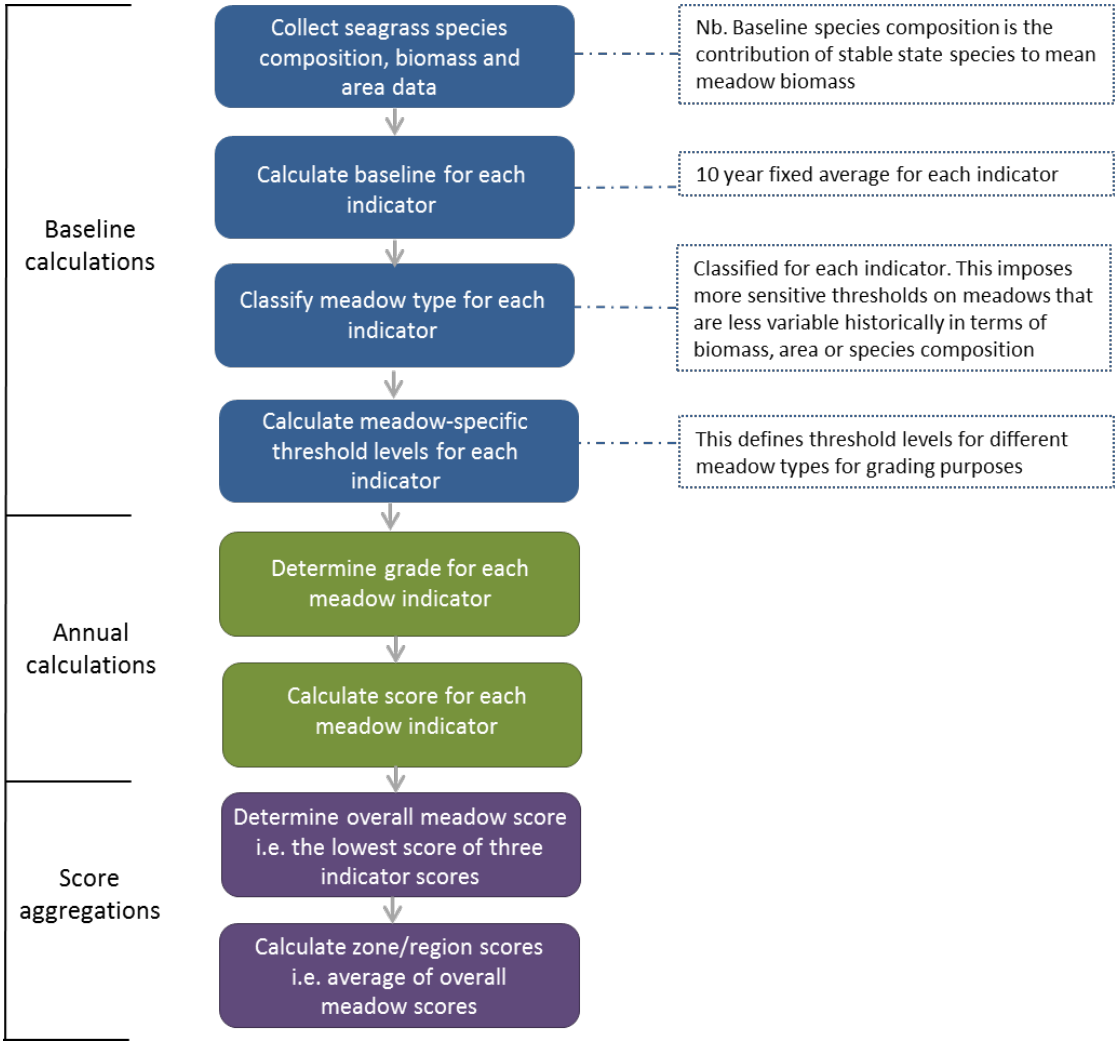


Figure 33. Flow chart to develop Townsville seagrass grades and scores.

Sampling Methods

The Channel Upgrade Seagrass Program uses a set of standard, proven and peer reviewed sampling methods for measuring seagrass change. This will allow results to be compared with historical data from the project area and also to be compared for context with other seagrass monitoring conducted in the region and Queensland wide.

Sampling techniques include:

1. *Intertidal seagrass*: helicopter survey of exposed banks during low tide (Figure 34) – sites are scattered throughout the seagrass meadow and sampled when the helicopter comes into a low hover <1m from substrate. Sites are sampled using a 0.25m^{-2} quadrat with three replicates at each site.
2. *Shallow subtidal seagrass*: boat-based free diving or camera drop surveys (Figure 34) – sites are sampled perpendicular to the shoreline approximately every 50-500 m or where major changes in bottom topography occur. Sites extend to the offshore edge of seagrass meadows and measure continuity of seagrass communities. Sites are sampled using a 0.25m^{-2} quadrat with three replicates at each site.
3. *Deep-water seagrass*: boat-based CCTV camera sled tows (Figure 34) – sites are sampled using an underwater camera system towed for approximately 100 m while footage is observed on a monitor. Surface benthos is captured in a towed net and used to confirm seagrass, species and habitat characteristics observed on the monitor. The technique ensures that a large area of seafloor is surveyed and integrated at each site so that patchily distributed small species of seagrass typically found in deep-water habitats is detected.

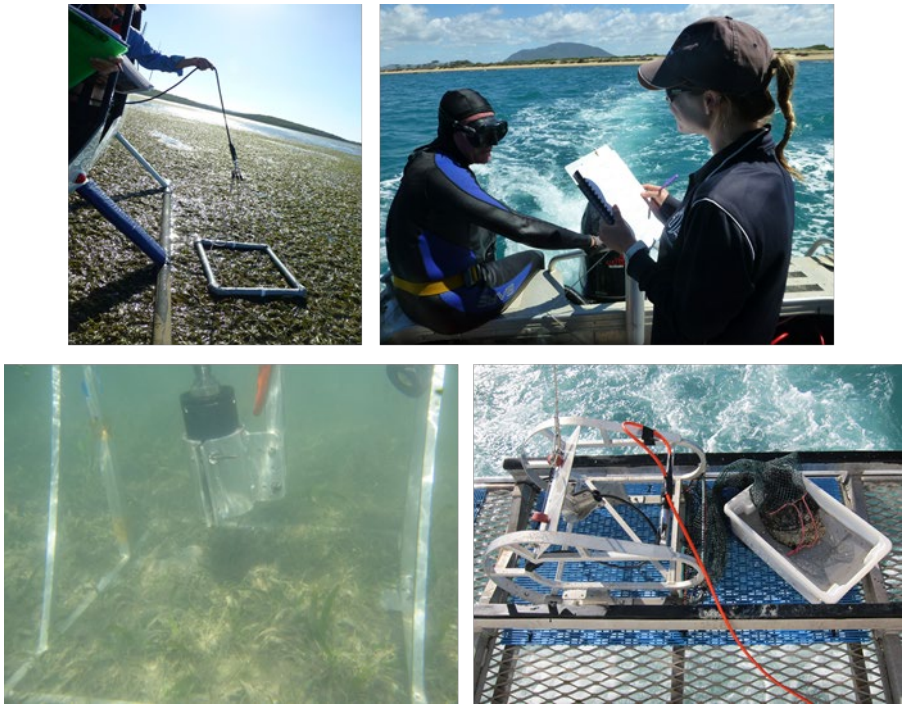


Figure 34. The different seagrass monitoring techniques and methods using helicopter aerial surveillance, boat based free divers and digital, live feed camera systems.

Seagrass above-ground biomass is determined using a "visual estimate of biomass" technique (see Kirkman, 1978; Mellors, 1991). A 0.25 m^{-2} quadrat is placed randomly three times at each site (3 replicates at each site). For each quadrat, an observer assigned a biomass rank made in reference to a series of quadrat photographs of similar seagrass habitats for which the above-ground biomass had previously been measured. Two separate ranges are used; low biomass and high biomass. The relative proportion of the above-ground biomass (i.e. percentage) of each seagrass species within each quadrat is also recorded. At the completion of ranking, the observer ranks a series of photos of calibration quadrats that represented the range of seagrass observed during the survey. These calibration quadrats had previously been harvested and the actual biomass determined in the laboratory. A separate regression of ranks and biomass from the calibration quadrats is generated for each observer and applied to the biomass ranks given in the field. Field biomass ranks are converted into above-ground biomass in grams dry weight per square metre (g DW m^{-2}).

Data Handling

Data from the surveys is entered into the Port of Townsville Geographic Information System (GIS) database. Three seagrass GIS layers for each survey are created in ArcGIS®:

- *Site Layer:* The site (point) layer contains data collected at each site, including:
    - Site number
    - Temporal details – Survey date and time.
    - Spatial details – Latitude, longitude, depth below mean sea level (dbMSL; metres) for subtidal sites.
    - Habitat information – Sediment type; seagrass information including presence/absence, aboveground biomass (total and for each species) and biomass standard error (SE); site benthic cover (percent cover of algae, seagrass, benthic macro-invertebrates, open substrate); dugong feeding trail (DFT) presence/absence.
    - Sampling method and any relevant comments.
- *Meadow layer:* The meadow (polygon) layer provides summary information for all sites within each meadow, including:
    - Meadow ID number – A unique number assigned to each meadow to allow comparisons among surveys
    - Temporal details – Survey date.
    - Habitat information – Mean meadow biomass + standard error (SE), meadow area (hectares) + reliability estimate (R), number of sites within the meadow, seagrass species present, meadow density and community type, meadow landscape category.
    - Sampling method and any relevant comments.
- *Interpolation layer*: The interpolation (raster) layer describes spatial variation in seagrass biomass across each meadow and was created using an inverse distance weighted (IDW) interpolation of seagrass site data within each meadow.

Seagrass meadow boundaries are determined from a combination of techniques. Exposed inshore boundaries are mapped directly from helicopter and guided by recent satellite imagery of the region (Source: ESRI; Google Earth). Subtidal boundaries are interpreted from a combination of subtidal survey sites and the distance between sites, field notes, depth contours and recent satellite imagery.

Statistical Analysis

The statistical design and analysis of data will follow the typical BACI design commonly used in impact assessments (before-during-after and control-impact). As a minimum, seagrass will be assessed as either a reference or impact location (noting meadows may change monitoring type (i.e. reference/impact/gradient) through the life of the Project).

We will also incorporate a finer-scale analysis with several impact levels (zones of influence, low impact, moderate impact and high impact – if applicable), and also analyse capital dredging effects along a gradient of impact for seagrass meadows that span several of zones, e.g. the Strand-Cape Pallarenda meadows to allow an evaluation of the potential changes to seagrass at increasing distance from the disturbance (dredge &/or plume). Seagrass data in tropical Queensland rarely meets the assumptions required to conduct standard statistical analysis used in BACI impact assessments, such as ANOVA. Advanced statistical techniques will be used on the data and options include; logistic regression, zero-inflated models and zero-altered gamma models. Other 'gradient from impact' tools that can be used to analyse data include proximity from impact and spatial interpolation tools.

Other information that will be required and feed into the data analysis include knowledge of where the dredge is operating at any given point in time, and integration with the network of water quality monitoring sites. Other environmental data (e.g. rainfall, river flow) will also be incorporated in to analysis.

With the change in dredge methodology (to back hoe only) and updated plume modelling, the Channel Upgrade Seagrass Program has shifted its' focus to the two meadows (meadow 12 and 14) that have sections inside and outside the "zone of influence" and run along a gradient from high to low/no exposure of some modelled plume scenarios (i.e. worst case scenario 95th percentile). The number of sampling sites (3 replicates at each site) has significantly increased throughout these meadows as of the May 2021 survey to reflect the shift in focus to detect change.

A power analysis for each meadow was completed to determine the appropriate number of sampling sites for each meadow in order to detect seagrass meadow change.

Quality Assurance Quality Control

The TropWATER seagrass group provide quality assurance and quality control within projects by ongoing internal review by the principal investigators and by project staff during all phases of the project. TropWATER staff adhere to uniform and documented methods, data entry, validation, and reporting. TropWATER publishes in international peer reviewed journals and reports to national and international

scientific panels and conferences on its approaches, methods and interpretations to invite review and feedback as part of continuous improvement.

The following aspects of QAQC are implemented by the TropWATER Seagrass Group:

- Standardised and published data collection methods - ensures the collection of sufficient data that is accurate and reliable;
- Data management and analysis - data validation and cross-check procedures are conducted during several stages of data entry and analysis;
- Standardised data processing methods - ensures consistency and reduced error in data entry, mapping, analysis and reporting;
- Internal and external (client) review of data, mapping and report files - for example some of our data is third party reviewed (i.e. Wet Tropics report card) through Independent Science/Technical Panels.
- Where appropriate formal publication of reports and independent review by independent science panels.

Pre-Dredge monitoring program results

Baseline conditions for seagrass biomass, species composition and meadow area have now been established for all Channel Upgrade Seagrass Program monitoring meadows. The baseline conditions/values for each indicator, for each meadow can be found in the latest monitoring report; McKenna et al. 2021 (and in figures 39-48 below).

Seagrasses in the Port of Townsville were in an overall good condition in 2020 (Figure 35; McKenna et al. 2021). The Channel Upgrade Seagrass Program meadows maintained an extensive footprint throughout the port with total Channel Upgrade Seagrass Program meadow area above the long-term (14 year) average (Figure 36). The biomass, area and species composition of all monitoring meadows was rated as satisfactory or better compared to their respective baseline conditions (Figure 35).

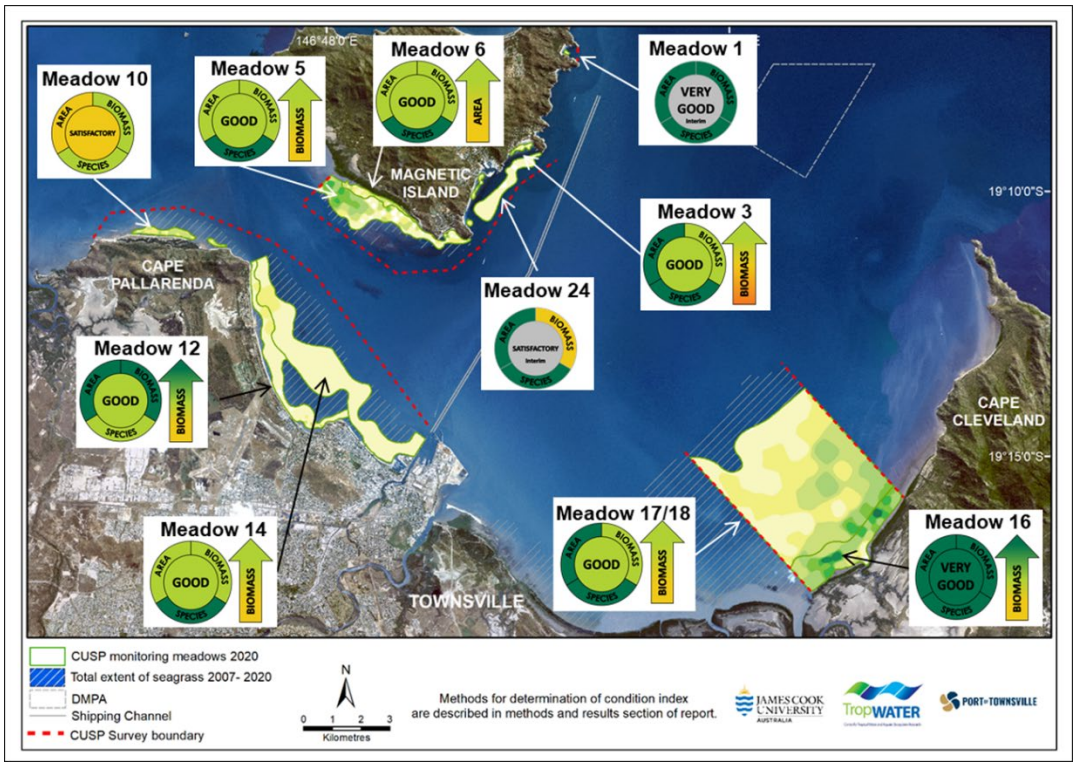


Figure 35. Seagrass condition for meadows monitored as part of the Channel Upgrade Seagrass Program (CUSP) in 2020. Directional arrows indicate a change (increase/decrease) from the previous year.

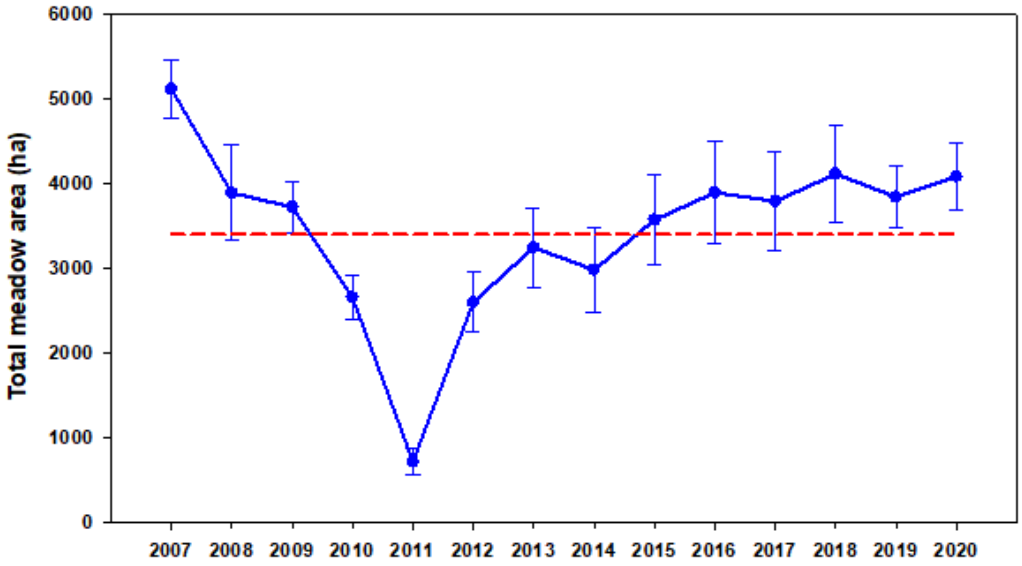


Figure 36. Total area of seagrass within Channel Upgrade Seagrass Monitoring Program (CUSP) coastal meadows from 2007-2020 (error bars = "R" reliability estimate), plus long-term average (red dashed line).

In 2020 two monitoring surveys were conducted in the Port of Townsville (Figure 37):

- April; post-wet season survey focusing on the coastal CUSP meadows only (Figure 37A):
    - A total of 639 sites were assessed for seagrass condition with seagrass present at 61% of sites;
    - The CUSP seagrass meadow footprint covered 3,420 ± 415
    - Deep water meadows (e.g. meadow 19) are not surveyed in the post-wet season survey.

- September-October; dry season. This survey was a whole-of-port survey that encompassed the CUSP seagrass meadows, as well as all seagrass within the extended broader port area (Figure 37B and 31):
    - A total of 1,351 sites were assessed for seagrass condition in this whole-of-port seagrass survey with seagrass present at 61% of sites.
    - The whole-of-port seagrass footprint covered 14,511 ± 1,895 ha of which CUSP meadows covered 4,075 ± 641 ha.
    - The deep water *Halophila* meadow made up 2,664 ± 561 of the total footprint.

Ten seagrass species have historically been identified within the Townsville region. All species were present in 2020.

Coastal CUSP meadows mostly consisted of aggregated patches or continuous cover of seagrass, with light to moderate cover. Species composition ranged from monospecific patches of seagrass to multi-specific (up to six species) meadows.

Seagrass biomass and area typically increase from May, when tropical Queensland seagrasses are at their minimum, to a peak in late spring (i.e. growing season). The seasonal differences tend to be more pronounced for deep-water seagrasses where they can be completely absent during the senescent season due to their life history strategy; germinating and flourishing for a brief period during the growing season (York et al. 2015). For the CUSP monitoring we only have two "low-season" surveys so it is difficult to make any strong conclusions on the degree of seasonality, especially as one of those surveys was strongly influenced by floods in 2019, and the other followed a particularly mild wet-season. However, these early results, and the original baseline surveys in 2007/2008 (Rasheed and Taylor 2008) suggest that the seasonal signal in biomass in Townsville may not be particularly strong or consistent compared with some other Queensland locations. There appears to be mixed results depending on meadow depth and type (seagrass community), with the clearest seasonal signal occurring in deeper meadows and those dominated by *Halophila* species. For seagrass area, the seasonal signal is stronger than biomass and is mainly driven by growth and expansion of colonising *Halophila* species in the dry-season surveys. Coastal CUSP meadow area increased by 19% from April to October in 2020 (Figure 37).

The overall good condition of seagrasses in Townsville in 2020 indicates they should be resilient to planned maintenance and capital dredging activities in 2021 assuming that there are no major seagrass losses associated with weather or anthropogenic events leading up to the 2021 dredging campaigns. The scheduled monitoring in April 2021 should capture any of these events if they were to occur prior to the commencement of dredging.

For full details of 2020 Channel Upgrade Seagrass Program results see McKenna et al. 2021.

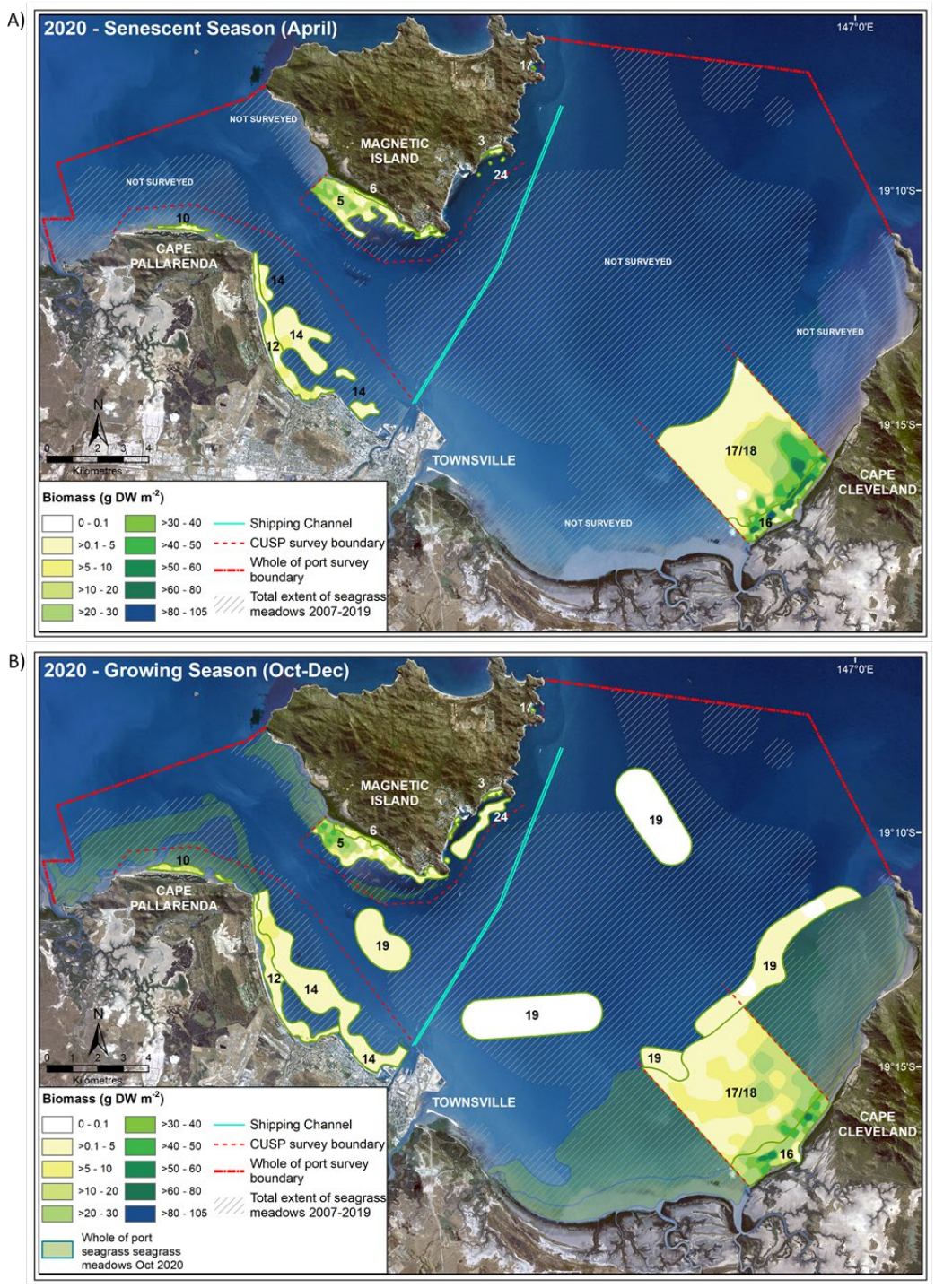


Figure 37. Seagrass density and distribution in the 2020 A) post wet-season and B) seagrass growing season Channel Upgrade Seagrass Program surveys

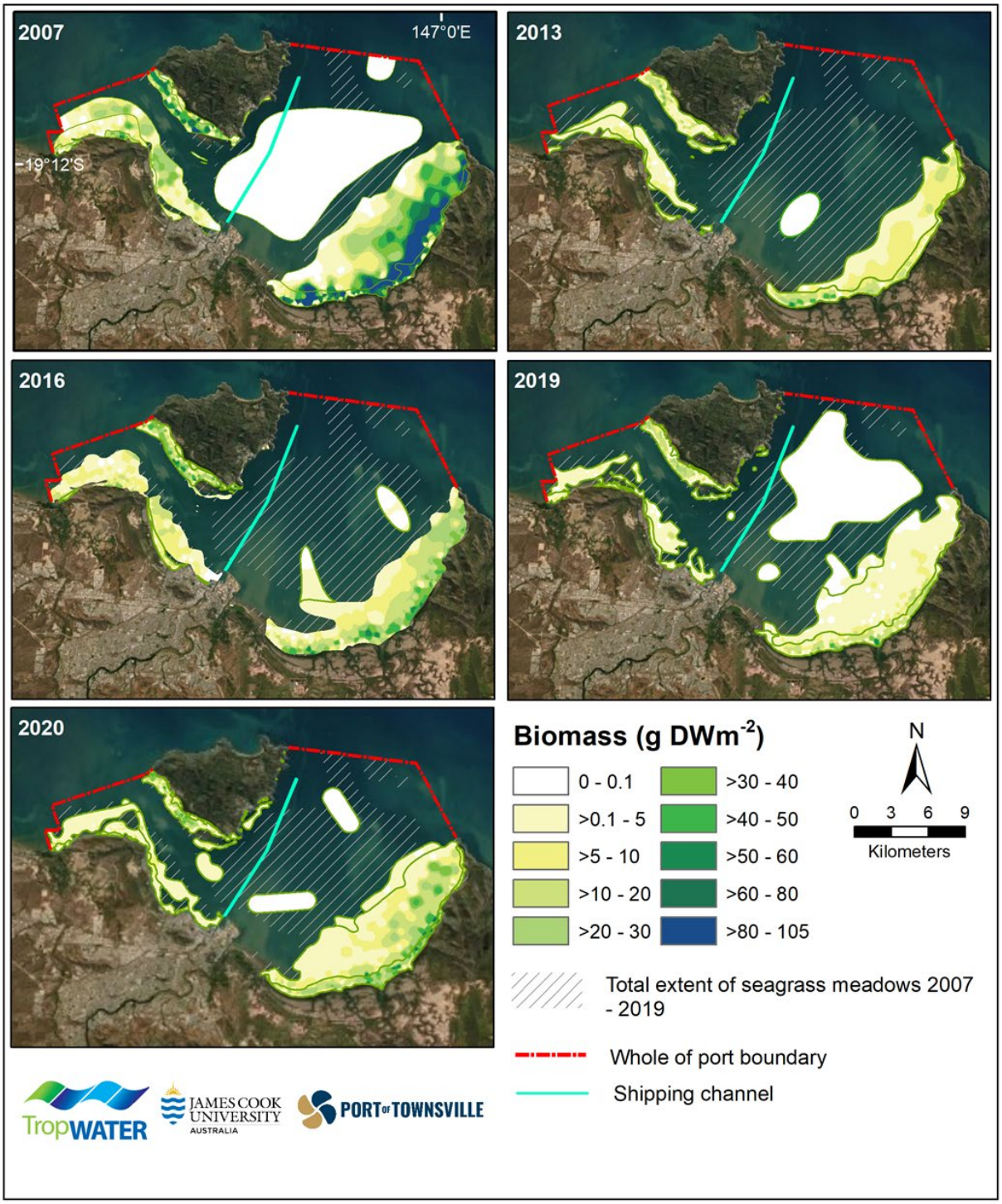


Figure 38. Comparison of whole-of-port growing season seagrass biomass (g DW m^{-2}) and meadow extent; 2007, 2013, 2016, 2019, 2020

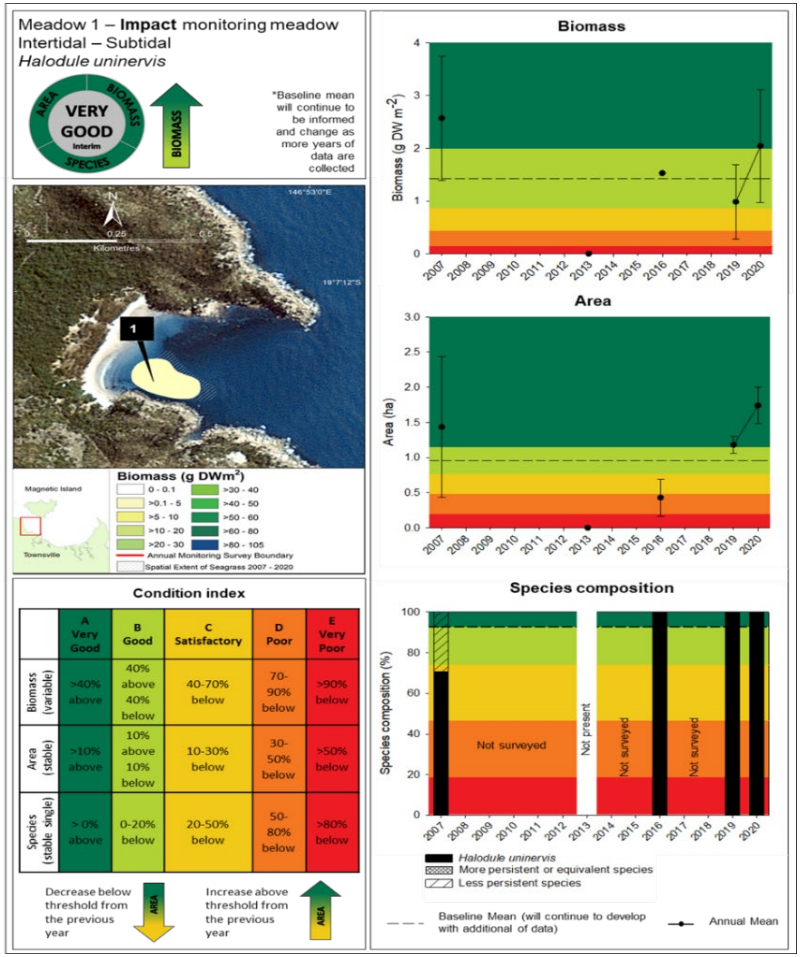


Figure 39. Changes in meadow area, biomass and species composition for seagrass Meadow 1 at Magnetic Island, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

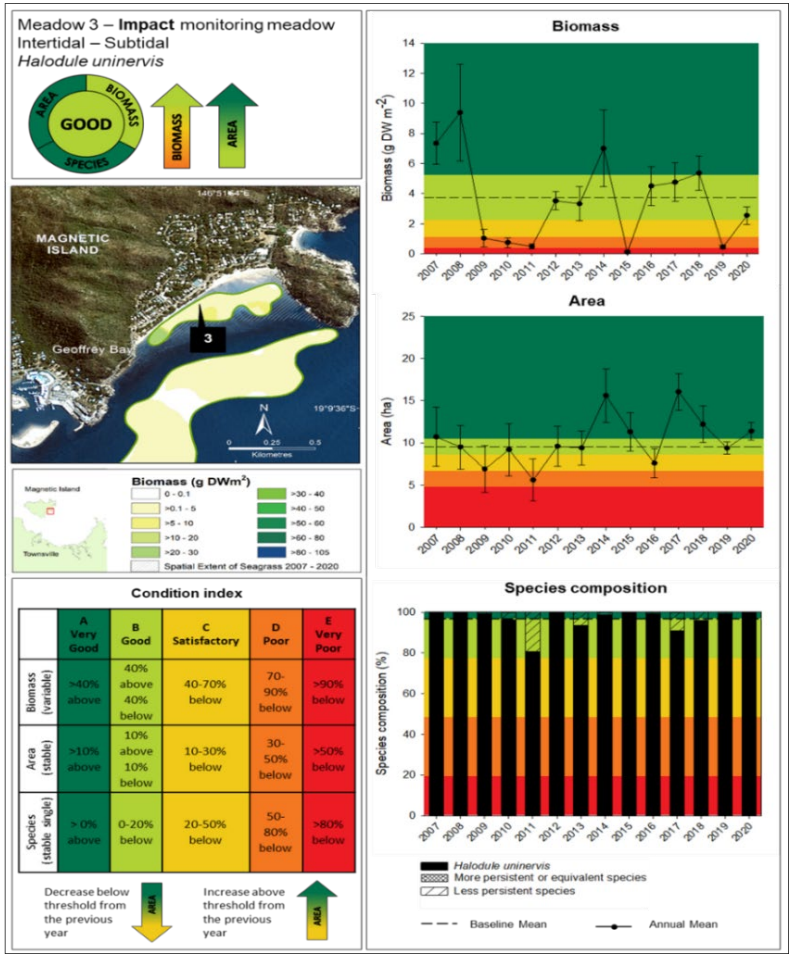


Figure 40. Changes in meadow area, biomass and species composition for seagrass Meadow 3 at Magnetic Island, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

Note: Monitoring location type (i.e. impact/control) based on original EIS & AEIS plume modelling and original tender scope. See Table 25 above.

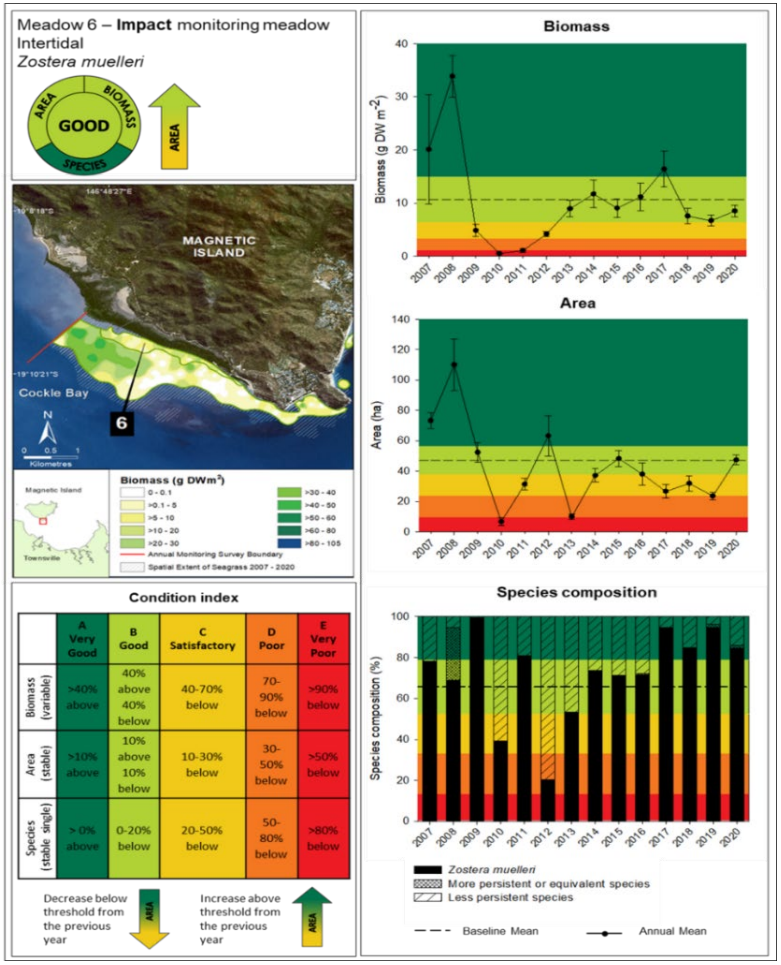


Figure 41. Changes in meadow area, biomass and species composition for seagrass Meadow 5 at Magnetic Island, 2007 – 2020.

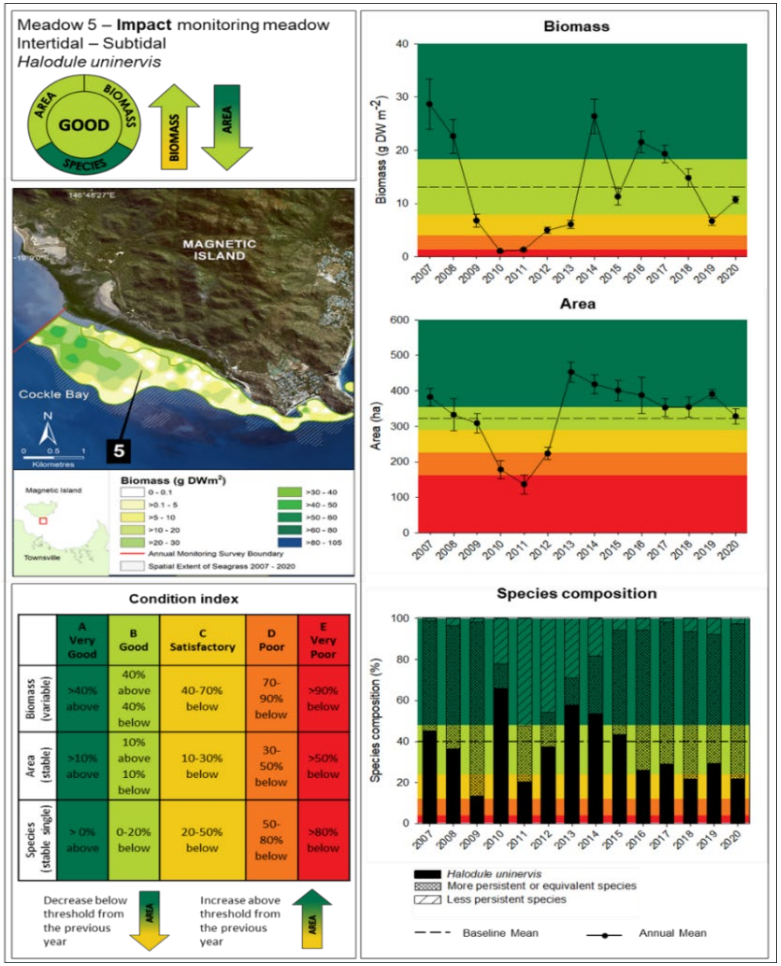


Figure 42. Changes in meadow area, biomass and species composition for seagrass Meadow 6 at Magnetic Island, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

Note: Monitoring location type (i.e. impact/control) based on original EIS & AEIS plume modelling and original tender scope. See Table 25 above.

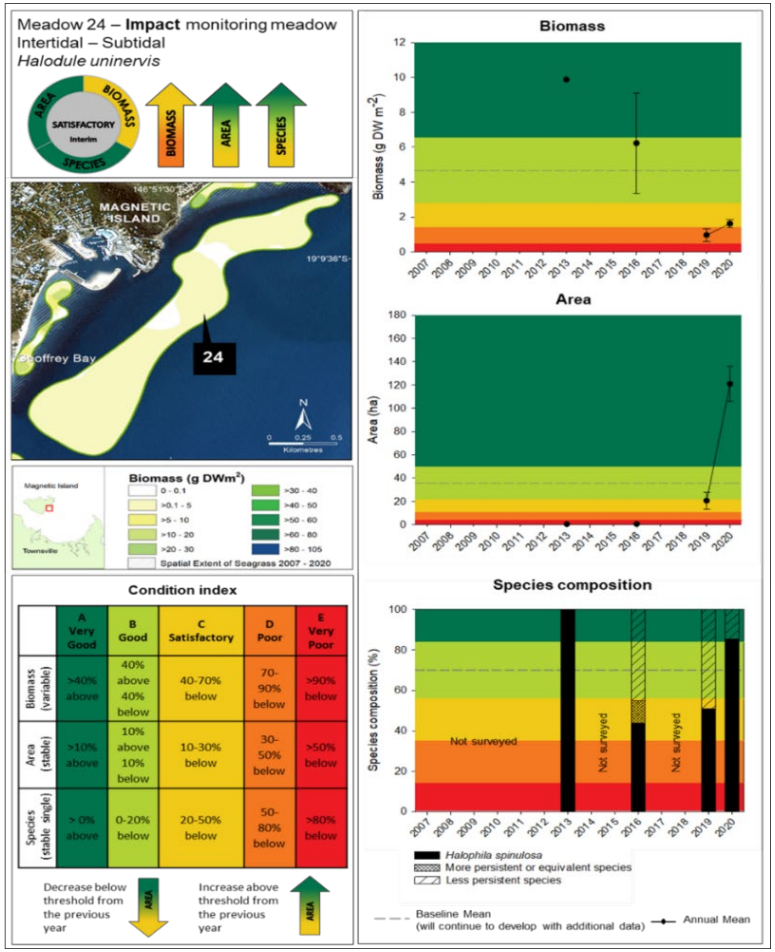


Figure 43. Changes in meadow area, biomass and species composition for seagrass Meadow 24 at Magnetic Island, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

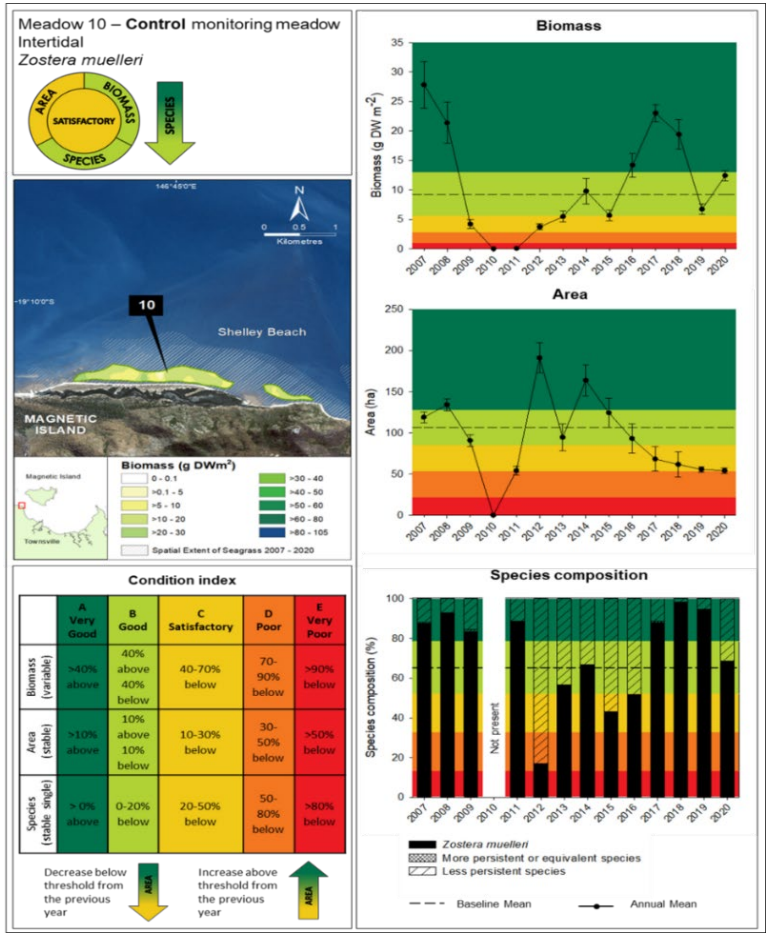


Figure 44. Changes in meadow area, biomass and species composition for seagrass Meadow 10 at Shelly Beach, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

Note: Monitoring location type (i.e. impact/control) based on original EIS & AEIS plume modelling and original tender scope. See Table 25 above.

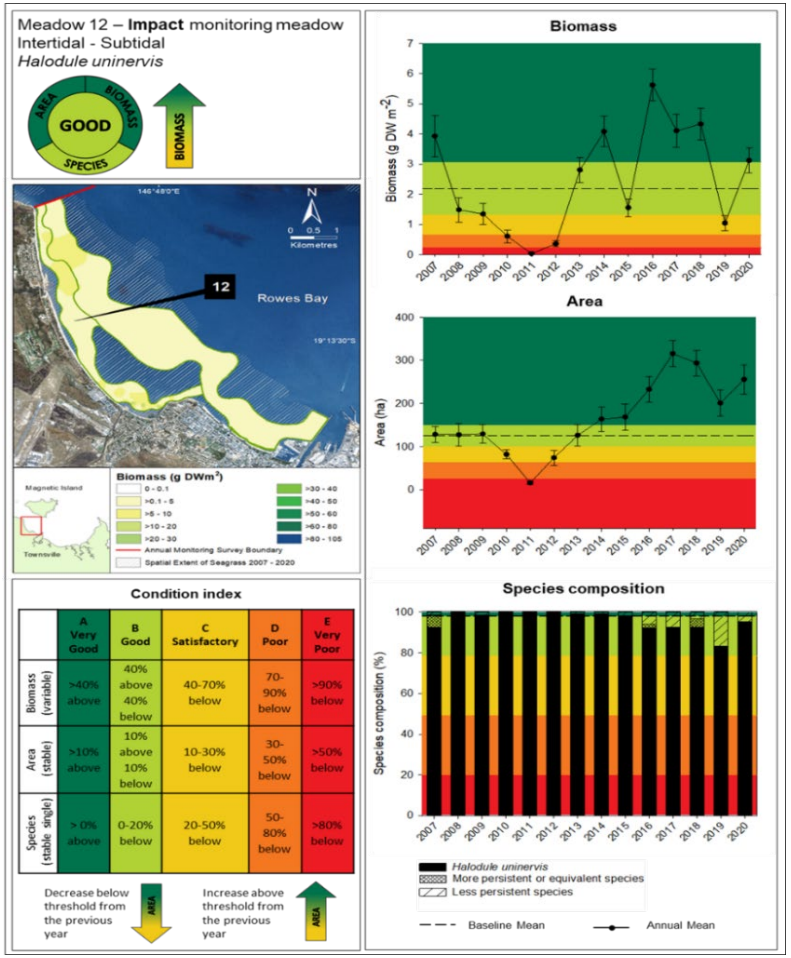


Figure 45. Changes in meadow area, biomass and species composition for seagrass Meadow 12 at Cape Pallarenda to Rowes Bay, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

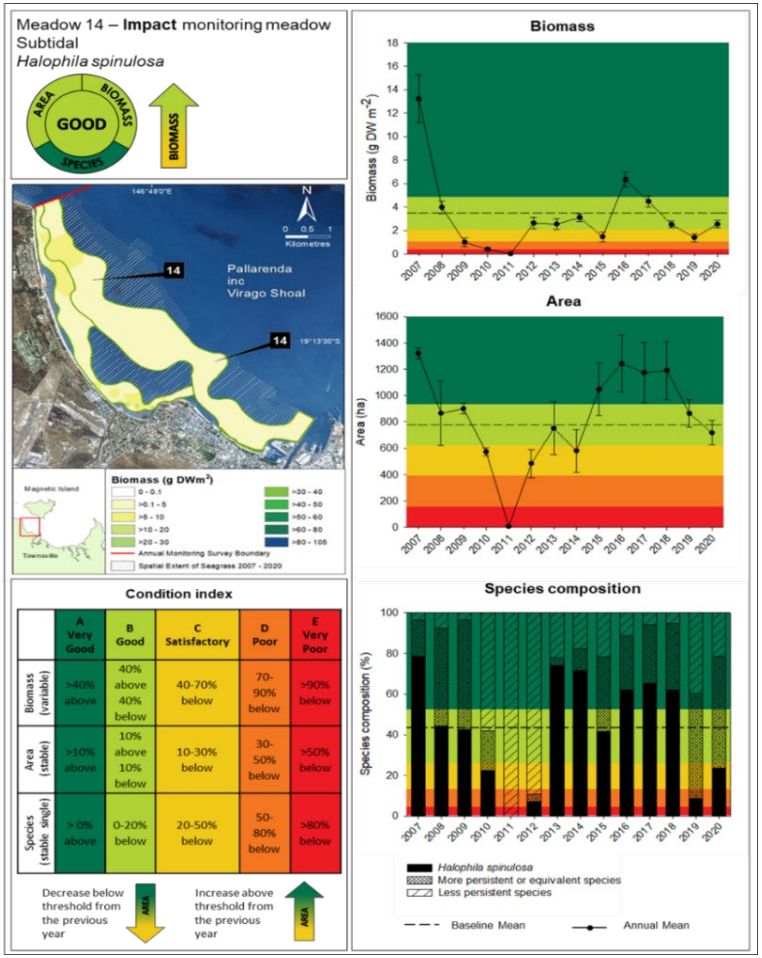


Figure 46. Changes in meadow area, biomass and species composition for seagrass Meadow 14 at Cape Pallarenda to Strand, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

Note: Monitoring location type (i.e. impact/control) based on original EIS & AEIS plume modelling and original tender scope. See Table 25 above.

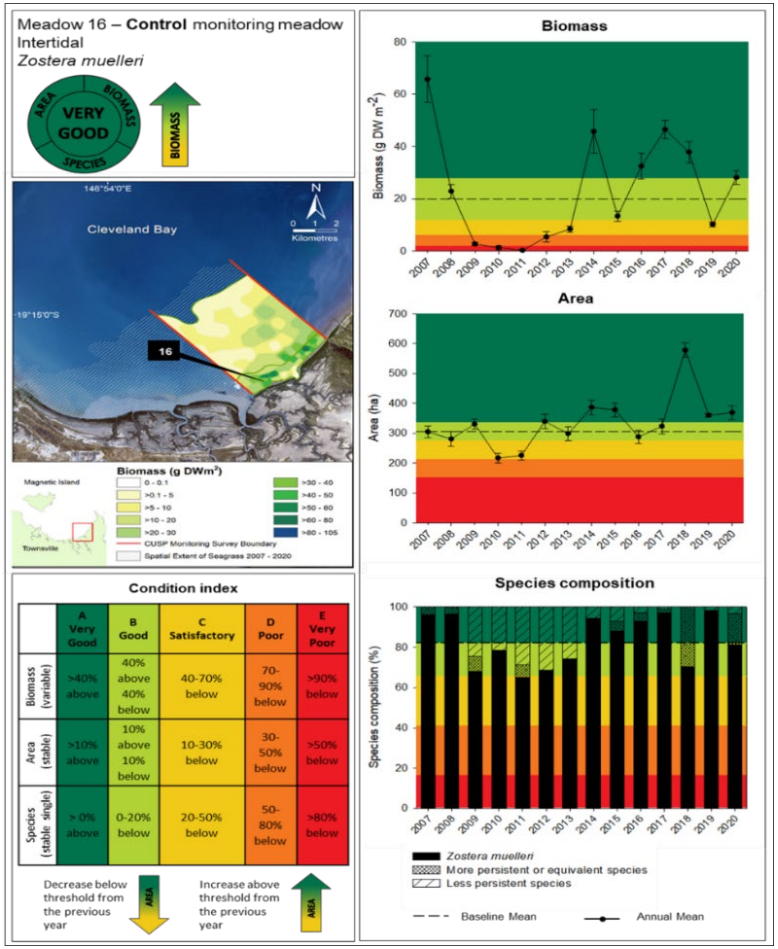


Figure 47. Changes in meadow area, biomass and species composition for seagrass Meadow 16 at Cleveland Bay, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

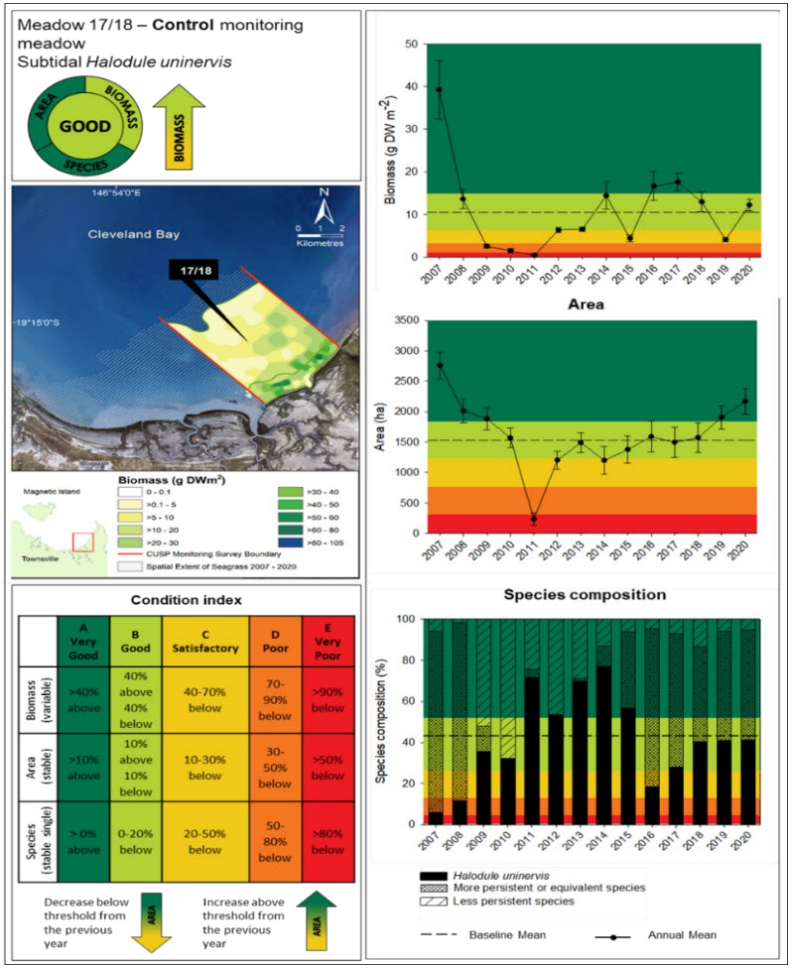


Figure 48. Changes in meadow area, biomass and species composition for seagrass Meadow 17/18 at Cleveland Bay, 2007 – 2020. (Biomass error bars = SE; area error bars = "R" reliability estimate).

Note: Monitoring location type (i.e. impact/control) based on original EIS & AEIS plume modelling and original tender scope. See Table 25 above.

12.1.4 Dredge Footprint Seagrass Survey

EPBC Condition 3 states: *The person taking the action must ensure that field surveys of the dredge footprint in Appendix A and surrounding areas are likely to be affected by dredging, are undertaken before each stage of the action (stages 1-3) to determine the presence and density of seagrass within the footprint to be dredged and surrounding areas for the relevant stage.*

The capital dredge footprint was surveyed in September/October 2020 (Figure 49). A small section of seagrass was found in the Platypus Channel directly adjacent the Western Breakwater, and within the Diagonal Breakwater construction footprint (Figure 50a). The final dredge footprint for the Temporary Unloading Facility (TUF) was not finalised at the time of the September/October 2020 Survey as such an additional survey was undertaken on the 7 May 2021 with no seagrass found in the TUF dredge footprint.

As the result of the change from the proposed diagonal breakwater to the eastern breakwater, the proposed dredge area in proximity to the Diagonal Breakwater construction footprint was reduced. As such the dredge footprint was adjusted in the GIS layer and remapped, based on this mapping up to 0.8ha of seagrass was present in the footprint (McKenna report 23/49 August 2023). This remapping was against the two most recent surveys (October 2022 and May 2023) with the larger footprint used to calculate the area (Figure 50c).

With the introduction of the new dredge area for the Eastern Entrance Widening, an additional seagrass survey was undertaken for this dredge footprint in October 2022 with no seagrass present (Figure 50b).

Based on the mapping of all areas, up to 0.8ha of seagrass needs to be offset which is a slight reduction from the 1.46ha that was required to be offset with diagonal breakwater work. The OMS POT 2094 provides for the compensation methodology for the loss in line with EPBC Condition 27d.

Figure 49. Dredge footprint Seagrass Survey

Figure 50a. Diagonal Breakwater Seagrass Survey

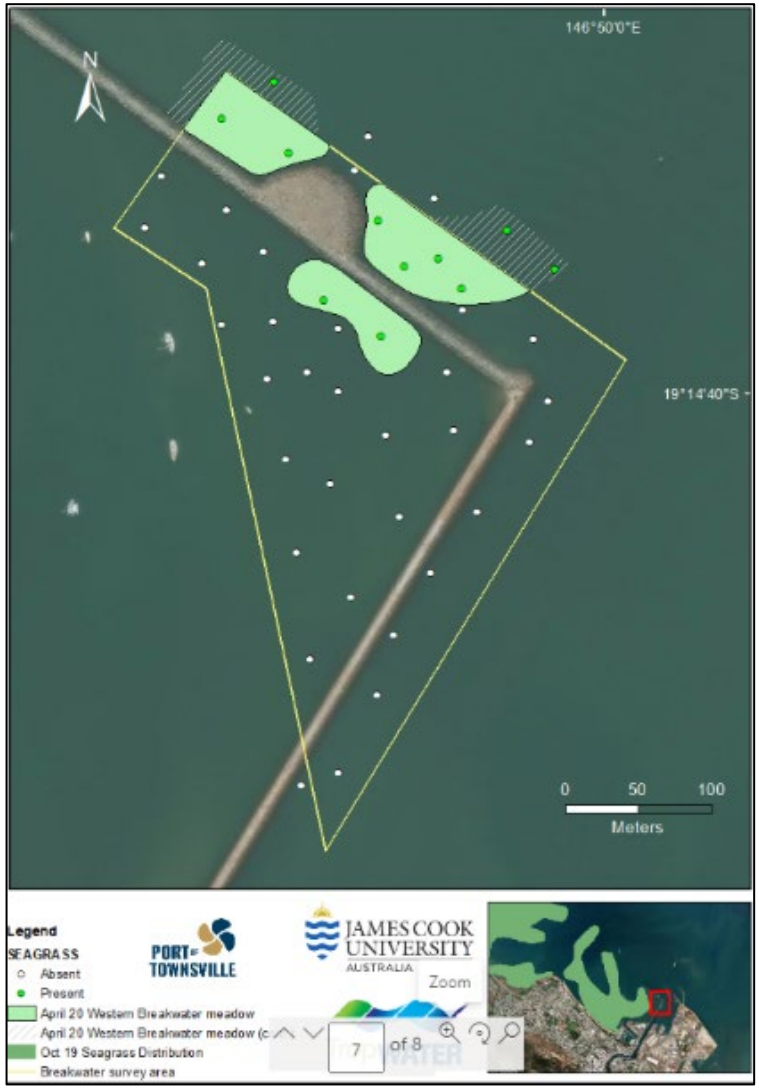
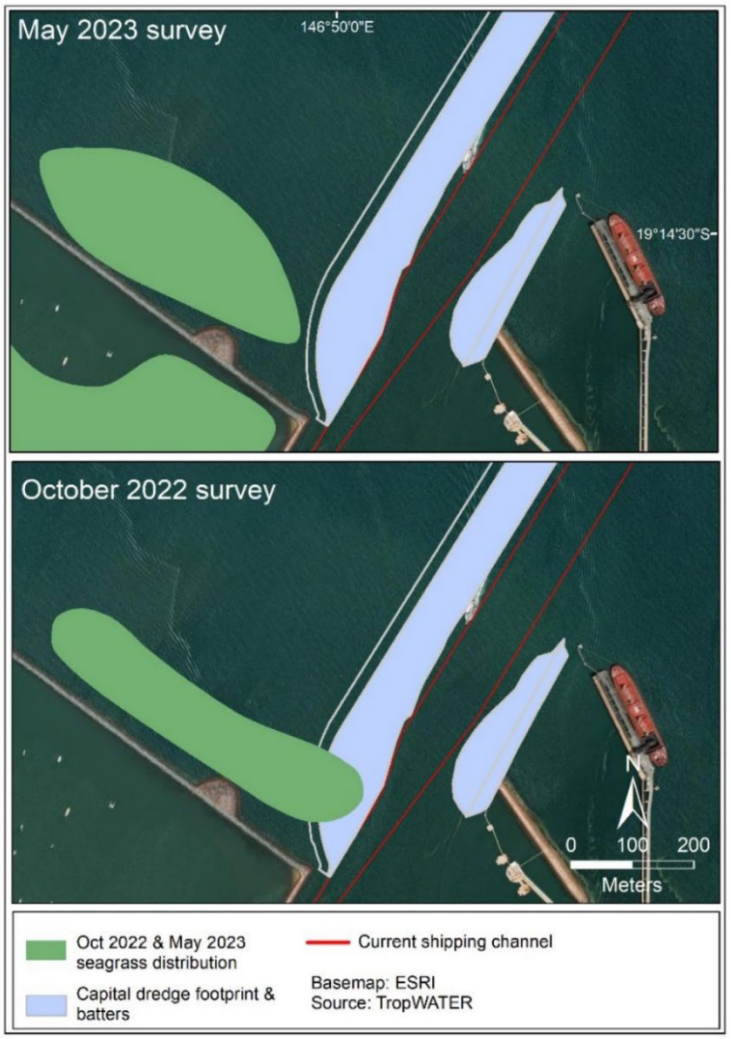


Figure 50b. Eastern Breakwater Widening Seagrass Survey

Figure 50c. Updated Dredge footprint Seagrass Survey



12.1.5 Sediment Sampling and Analysis – Methodology and Results

A number of SAPs were undertaken for the project all are presented below. The Channel and the TUF was surveyed with vibrocore. Following an operational change to the proposed location of the TUF

further sampling was undertaken to fully capture the "new" TUF dredge footprint. Additional "at depth" sampling was undertaken to characterise the at depth sediment (jack up barge) and the Eastern Breakwater dredge area was sampled (vibrocore sampling).

Channel and the TUF

Ports and Coastal Environmental (PaCE) was commissioned by the Port to conduct sediment quality survey within the dredge areas forming part of the CU Project. A sampling and analysis plan (SAP) was prepared in accordance with the following guidelines:

- National Assessment Guidelines for Dredging (NAGD);
- Queensland Acid Sulfate Soil Technical Manual (QASSTM); and
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM).

The SAP has been reviewed by the Department of Environment and Science (DES) and DCCEEW, with comments from DES incorporated into the final SAP.

This SAP identified four dredge areas, Platypus Channel, Sea Channel, the Temporary Unloading Facility and the Western breakwater (area within the duck pond that will be dredged as part of the diagonal breakwater realignment works) (See figures 51 - 53). Utilising a risk-based approach, the SAP focused on sampling and analysis of surficial sediment within the channel widening footprint and the dredging areas associated with the Temporary Unloading Facility and Diagonal Breakwater.

Dredge Area	Dredge Volume (m^3)	Area (m2)	Number of samples
Sea Channel	353,031	209,873	25
Platypus Channel	3,271,329	535,183	42
Western Breakwater	60,000	25,180	17
Temporary Unloading Facility*	100,000	92,056	18

*The location and the design of the Temporary unloading facility was slightly modified following this SAP sampling work. Whilst still located on the Western wall of the new reclamation area, this was shifted seaward by the Dredge and Reclamation Contractor to improve operability of this facility and to provide better all weather access. The "new" dredge area for the Temporary Unloading Facility is immediately adjacent (to the north) to the Temporary Unloading Facility that was sampled through the initial SAP. Additional details and results for the "new" Temporary Unloading Facility are presented separately below. The "new" Temporary Unloading Facility dredge area has a smaller footprint and lower dredge volume.

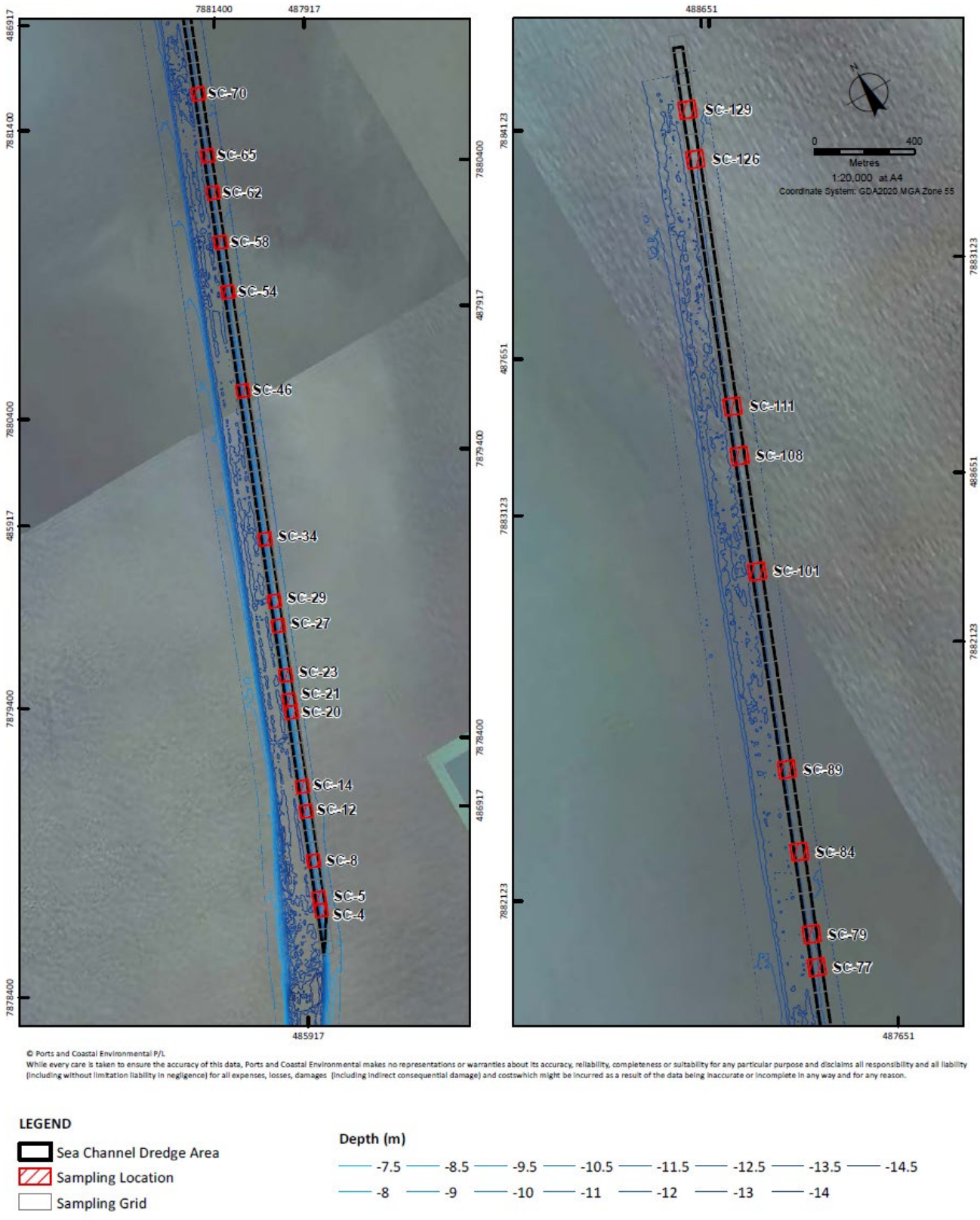


Figure 51: Sampling locations Sea Channel

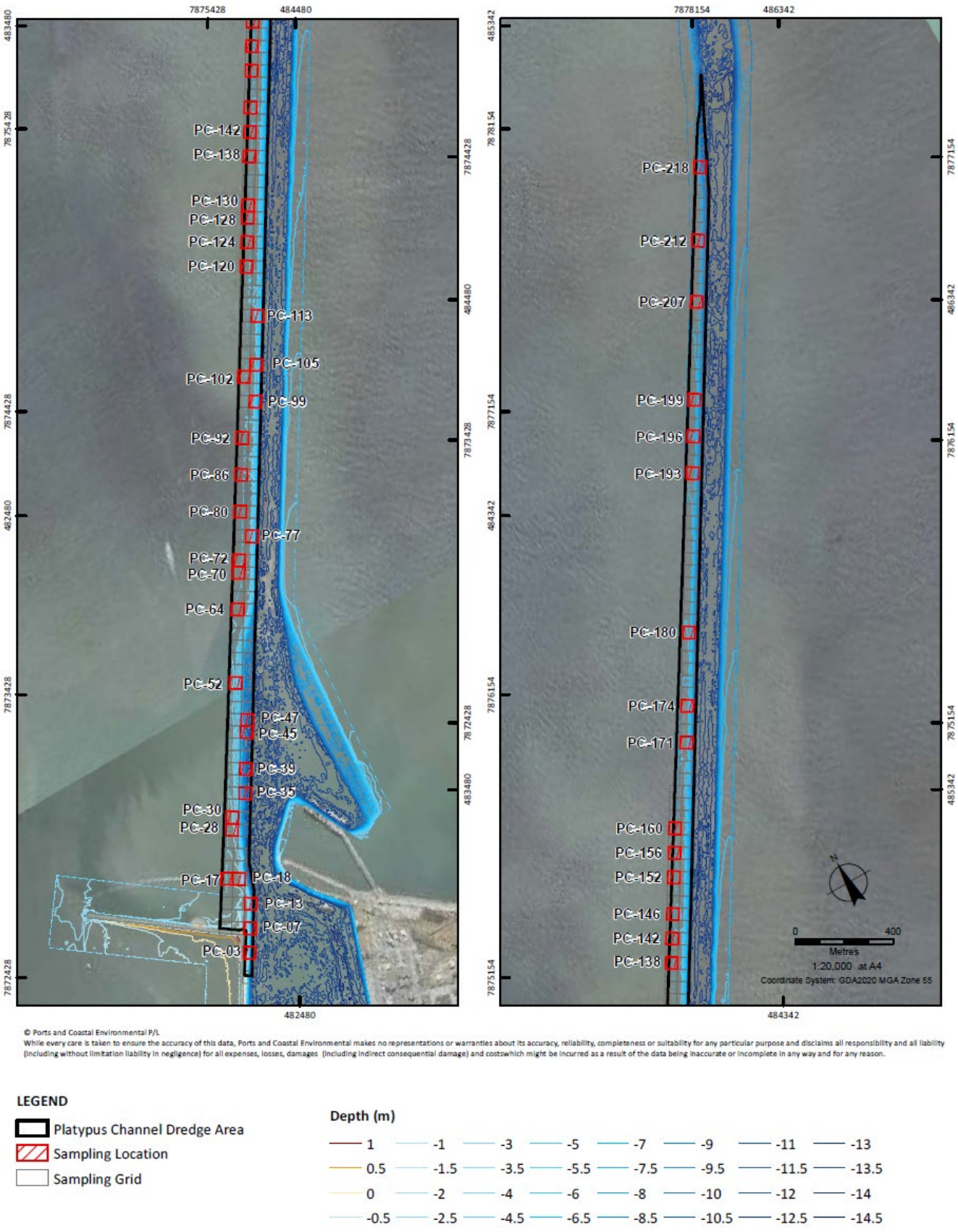


Figure 52: Sampling locations Platypus Channel

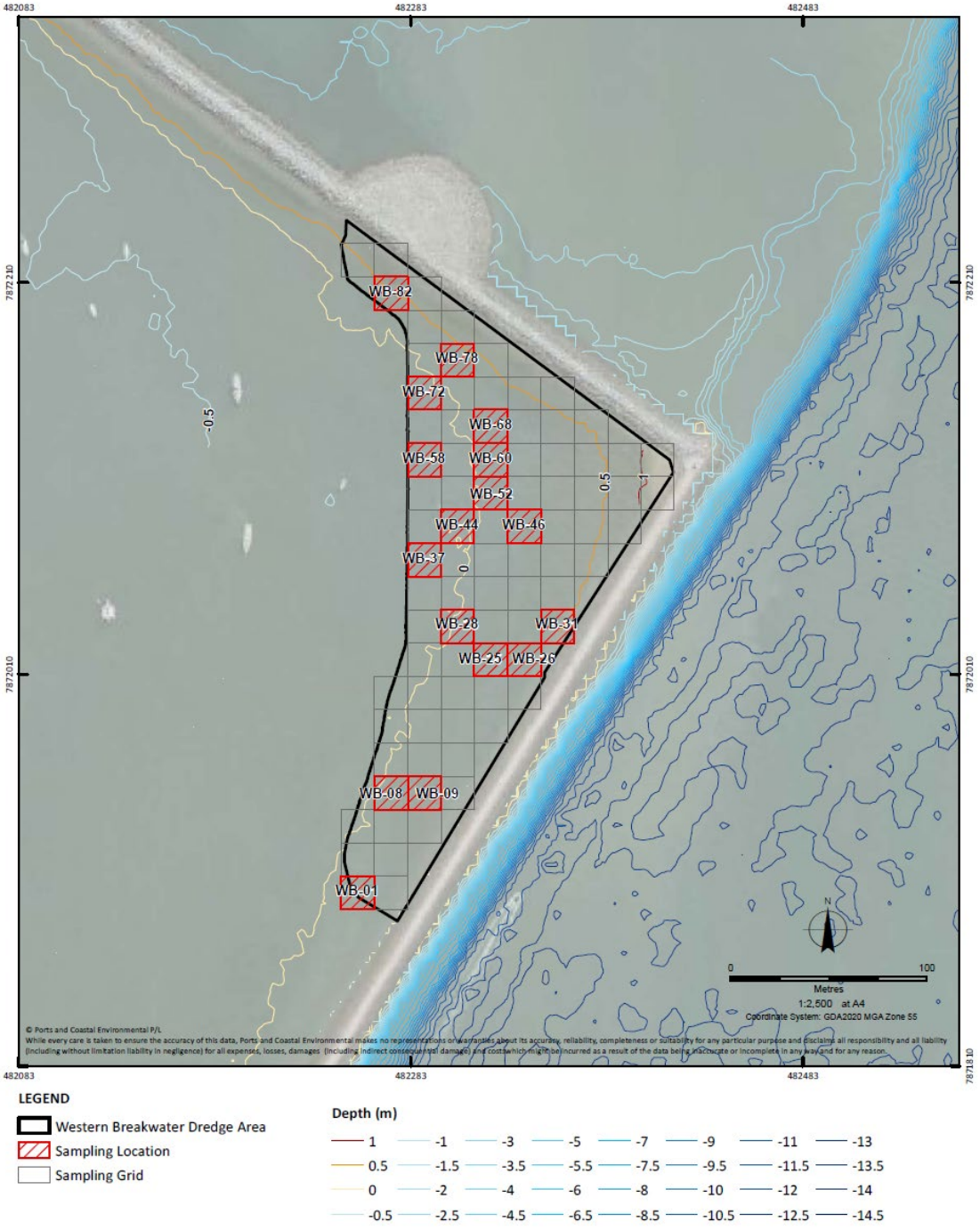


Figure 53: Sampling locations Western breakwater

Sampling was undertaken between January 7th and January 29th, 2021. The field survey team worked within limited weather windows, including the passage of Cyclone Kimi. The number of sampling locations established within each dredge area follows the requirements detailed within Appendix D of the NAGD and SAP design. Sample locations were randomly assigned to each dredge area following the methods outlined within the NAGD.

Samples were collected using a vibrocoring method designed to retrieve continuous, undisturbed core samples from unconsolidated and semi-consolidated sediments. This method retains the integrity of sediment samples, preserving sediment strata with minimal disturbance. Stainless steel core barrels (ranging 3m to 6m) were deployed as stand-up pipes in shallow water or by using the weighted barrel method in deeper water, which ensures vertical penetration of the sediment.

Dredging for the CU Project ranges between 0.5m and ~12m over the four areas. The sediment removal depth required to meet channel design has been reviewed from bathymetric data. As defined in the SAP, sampling using the vibrocore system would encounter refusal within the underlying Pleistocene clays with predicted penetration of <0.5m to 3.0m. Actual survey penetration followed this assessment closely, with samples ranging between 0.25m to 3.4m.

Depending on penetration, each sampling location targeted sample horizons as follows:

- 0.0m to 0.5m;
- 0.5m to 1.0m; and
- 1.0m to end.

QA/QC

The quality assurance protocols were implemented as per the SAP and followed the recommendations of the NAGD. This included field protocols to ensure sample integrity, field replication, interlaboratory analysis and laboratory quality protocols.

Analytical parameters

Sediments were assessed for physical parameters including:

- Total moisture (%);
- Particle size (PSD) (sieve / hydrometer); and
- Total organic carbon (% TOC).

Physical analytes were screened from 30% of locations within each dredge area. Moisture is reported by the laboratory for internal calculations from 100% of samples.

The following chemical suites were analysed:

- Metals - (Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Silver, Zinc)
- Organotins – (TBT);
- Hydrocarbons (TPH, TRH, BETXN);
- Pesticides (OC Pesticides); and
- Polyaromatic Hydrocarbons (PAH).

Metals were analysed from 100% of samples. TBT, hydrocarbons, pesticides and PAH were analysed from 30% of locations within each dredge area. Sediments were also analysed for potential acid sulphate soils from all locations. PASS results are reported separately to the SAP implementation report.

Total contaminant concentrations are compared against the Screening Levels listed in Table 2 of Appendix A of the NAGD to assess whether the material is suitable for unconfined placement at sea, or if further testing is required. This assessment specifically compares guideline levels against the upper 95% confidence level (95%UCL) of the mean for an identified dredge area.

Under the NAGD, if the 95% UCL values for all substances are below relevant screening levels, it is considered unlikely that sediment contaminants will have adverse effects on organisms living in or on that sediment. The sediment is therefore considered non-toxic and there are no chemical obstacles associated with the placement of these materials.

Results

The SAP (based on the results of the vibro-core program) provided assessment according to the NAGD (2009) and identified the following:

1. Several individual samples exceeding the NAGD screening criteria for metals (lead and zinc). The surface interval within the Western Breakwater (0.0-0.5m) exceeded the 95%UCL for lead. Although several samples exceeding the NAGD metals criteria remaining dredge areas and horizons remained below the 95%UCL.

2. Sediments were screened for PAHs, TPH, OC Pesticides and TBT. Most samples remained non-detect for these analytes, however where identified above detection, concentrations remained below the NAGD screening criteria, with all dredge areas and horizons remaining compliant to the 95%UCL.

3. Potential Acid Sulfate Soils (PASS) was assessed via pHFox analysis as proposed within the SAP. These analyses identified the presence of suspected PASS materials from the upper unconsolidated and semi consolidated Holocene sediments. Progress to additional assessment by way of the Chromium Suite identified PASS materials ranging from low level acidity with high ambient neutralising potential to materials with moderate acidity and low ambient neutralising potential. Refusal during the vibro-core program occurred within stiff Holocene clays, precluding sampling and analysis of materials from the full depth of dredging. The presence of PASS triggered the requirement to assess for this parameter to the full depth of dredging.

4. Evidence collected to-date indicates that the underlying clays and clayey sands (Pleistocene sediments) are unlikely to present a chemical risk to dredging (metals, hydrocarbons, OC Pesticides etc.) nor contain problematic PASS materials. However, as the full dredge depth had not been reached during the initial vibro-core program, the physical nature of the underlying sediments, including the distribution of PASS at depth, was not sufficiently described to address project approvals and regulatory guidelines. Review of available geophysical survey data and the depth to predicted Pleistocene sediments (SMEC, 2019) suggested that PASS continued ~1.0m to 3.0m below the collected cores. Review of geophysical data also indicated that Holocene sediments within paleochannels (ancient creeks and drainage lines) exceeded the proposed dredge depth in several locations.

The Platypus Channel, Sea Channel and Temporary Unloading Jetty areas are considered uncontaminated according to the NAGD. These materials are not expected to generate imposts to chemical water quality during dredging or placement, or impact organisms living in or on the seabed surrounding the dredge footprint. In accordance with the NAGD, the sediments to be dredged from these areas are considered non-toxic, with no chemical obstacles associated with the proposed dredging and disposal of these sediments at the reclamation area.

Elevated results were identified within the 0.0-0.5m horizon at the Western Breakwater dredge area, so additional analysis was conducted using dilute acid extraction (DAE) and elutriation. The weak acid extraction process used during DAE analysis continued to return elevated concentrations for lead (95% UCL 53.67 mg/kg). Progress to elutriation testing resulted in a low-level release of lead from the sediment water matrix. Raw elutriate results (2.7 mg/l) remained below the ANZECC screening criteria for lead (4.4 mg/l 95% Species Protection). As the specific dredging process is still to be informed by the demolition staging and methodology for the Diagonal breakwater dilution factors and controls were not able to be incorporated into this assessment as per NAGD for the sediments within the Western Breakwater. Regardless the placement of sediments within a dedicated reclamation facility will remove the physical interaction pathways between benthic and epibenthic fauna and the dredged sediments.

The tender for removal and realignment of the breakwater has not been released, as such this poses challenges to resolve a number of key aspects for dredging the western breakwater dredge area.

Screening undertaken using elutriation tests indicated some potential for the release of metals exceeding ANZECC guideline criteria at 95% Species Protection. Further consideration of dredging and placement processes, including estimates of dilution will need to be considered when the demolition staging and methodology are resolved. Additional dredging controls or management techniques will need to be considered prior to the dredging of the Western Breakwater, as it is deemed a contaminant hot spot. As such it is proposed that further review and consideration is needed for the western breakwater dredge area once the contractor and construction methodology for the realignment of the breakwater is known.

Further consultation and discussion will occur with the ITAC on the proposed mitigation strategies to be implemented for this hot spot once the scheduling and programming is understood for this works. Following this work the DMP will be updated and approved as relevant prior to dredging being undertaken in this area.

As the material is being placed within the reclamation area, there is no concern for placement of the material with this low level of contamination.

"New" Temporary Unloading Facility

As outlined above, the location and the design of the Temporary unloading facility was changed by the Dredge and Reclamation Contractor following this SAP sampling work to improve operability of this facility and to provide better all weather access. The new location and sampling sites for this "new" Temporary Unloading Facility is shown in Figure 54, with some locations (shown in green) from the initial sampling able to be retained given they were within the new footprint area.

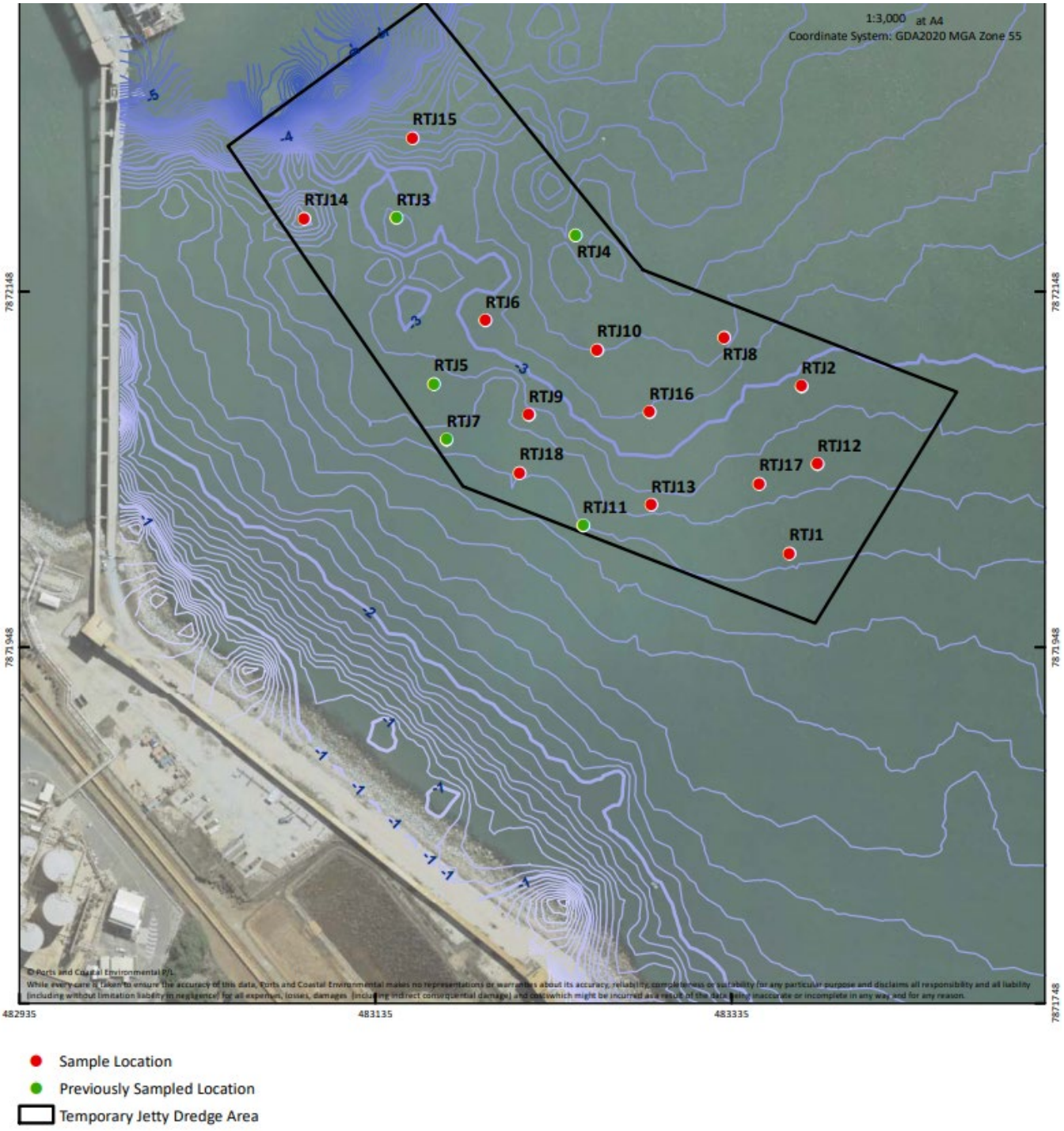


Figure 54: Sampling locations "new" Temporary Unloading Facility

The "new" Temporary Unloading Jetty areas are considered uncontaminated according to the NAGD. These materials are not expected to generate imposts to chemical water quality during dredging or placement, or impact organisms living in or on the seabed surrounding the dredge footprint. In accordance with the NAGD, the sediments to be dredged from these areas are considered non-toxic, with no chemical obstacles associated with the proposed dredging and placement of these sediments at the reclamation area.

These results indicate material is suitable for placement within the reclamation area without further treatment. However, actions to minimise the creation of a dredge plume are necessary to minimise the impact from zinc and copper mobilisation.

At Depth

The upper unconsolidated materials within the capital dredging footprint have been sampled using a vibrocore system (PaCE, 2021). This method generally met refusal within stiffer Holocene clays and did not reach the full depth of dredging. To achieve the objectives of a full dredge depth sampling program an over-water drilling program was undertaken.

The full depth program provides additional data to address the Ports regulatory requirements and assist in the management of acid sulphate soils to minimise environmental risks.

The full depth sampling program objectives are as follows:

- Provide at depth data to address the National ASS Guidelines and QASSIT guidelines which require characterisation of the materials over the full depth of dredging.
- Address requirements within the NAGD describing physical sampling to the full depth of dredging.
- Facilitate a value-added interpretation of the existing geophysical data (SMEC, 2019) collected along the channel alignment for the predictive mapping of PASS material distribution and volume estimation.
- Support dredging and material placement requirements as detailed within the Acid Sulfate Soils Management Plan (ASSMP).

The chemical and physical sampling and analysis of sediments follows the requirements outlined within the NAGD (Commonwealth, 2009) and should be read in conjunction with the detailed surface chemical and physical analysis completed in January and May 2021 (PaCE, 2021). This program also assesses acid sulfate soils in accordance with relevant guidelines.

In 2019 SMEC undertook detailed geophysical survey from the Platypus Channel and Sea Channel alignments. Findings presented a complex subsurface stratigraphy over the CU Project footprint. PaCE applied this detailed spatial knowledge with sample results from the upper horizons to support a reduced number of targeted full depth coring locations as undertaken during this study.

Thirteen locations were sampled during this program following the requirements of the SAP. The number of sampling sites and their distribution is proportional to their respective volumes and geophysical complexity (see figure 55, and table 26).

Figure 55: Sampling locations for at depth SAP sampling

Table 26 Sample Location numbers for sediment characterisation

Dredge Area	Total dredge volume (m3)	Representative % of dredge program	No of Cores	Description
Sea Channel	292,847	8%	2	Two shallow cores (~4m) have been located within the thickest sediment profiles for this program based on the SMEC geophysical survey data. SC1 – CH 7865 (4.0m) SC2 – CH 8050 (4.5m) Note: The mid to outer Sea Channel attained the full depth of dredging during January vibrocore surveys.
Platypus Channel	3,280,809	88%	11	The Platypus Channel presents a complexity in geophysical conditions which have been assessed from 11 core locations and 13 cores (*note additional 2 QAQC Cores at PC1). The thickness of sediments to design depth ranged between ~10m to 6m, with an estimated average depth to the Pleistocene surface of 3m. Cores were located to assess potential Paleochannels, thicker Holocene sediments,

Dredge Area	Total dredge volume (m3)	Representative % of dredge program	No of Cores	Description
				near surface Pleistocene sediments and predicted hard strata. PC1 – CH 960 (9.1m) PC1B* – CH955 (9.1m) PC1C* - CH950 (9.1m) PC2 – CH 2310 (10.0 m) PC3 – CH 2660 (9.6m) PC4 – CH 3100 (9.1m) PC5 – CH 3555 (8.5m) PC6 – CH 4360 (7.6m) PC7 – CH 5010 (7.0m) PC8 – CH 5590 (6.5m) PC9 – CH 6265 (6.6m) PC10 – CH 6525 (6.1m) PC11 – CH5080 (8.0m)
Temporary Unloading Facility	100,000	3%	0	A separate chemical and ASS assessment, including ASSMP has been prepared to facilitate the construction of access infrastructure to enable the CU Project to proceed.
Western Breakwater	60,000	2%	0	The site planned for the Western Basin was moved during survey given access safety factors. The findings from nearshore conditions (PC1) are thought to be representative of the at depth profiles to be expected from this location. Surface samples to ~3m have been obtained during the January vibrocore survey program.
Total	**3,733,656**	**100%**	**13**	

To reach a design depth of -12.5 mLAT, sampling locations provided a range of core depths ranging between 4.0 and 10.0m. Samples were obtained using a combination of push-tube and split spoon sampler methods. The Push-tube methods were utilised in the upper sediment horizons until consolidated sediments/clays prevented efficient penetration. The split spoon sampler was then used to obtain a continuous sample to the targeted dredge depth. The following analytical horizons were established for geochemical assessments:

- 0-0.5m
- 0.5-1.0m
- 1.0-2.0m
- 2.0-4.0m
- 4.0-6.0m
- 6.0-8.0m
- 8.0-10.0m

Note: Sampling for acid sulfate soils were taken every 0.25m.

The analytes assessed for the full depth dredge program included metals, PASS, PSD, moisture, bulk density and TOC. A single location (PC5) has been screened throughout the full depth profile for an extended organic contaminant suite (TPH, TRH, PAH, OC pesticides and TBT).

The findings from this study confirmed an absence of problematic chemical contamination, with all samples being compliant to the adopted NAGD screening criteria. However, potential acid sulfate soils (PASS) have been identified.

The dredge footprint of the CU Project intersects both Holocene and Pleistocene sediments. The Holocene represents unconsolidated to semi consolidated grey marine sediments and the Pleistocene, consolidated lighter orange/brown sediment of terrestrial origins. In combination these materials are dominated by the silt and clay fractions (~75%) with sands making the bulk of the remainder (~22%).

The full depth program identified the presence of PASS throughout the Holocene sediments and confirmed that PASS is not present within the Pleistocene, this is discussed further below.

Eastern Breakwater

GHD was commissioned by the Port to conduct sediment quality survey within the dredge area for Eastern Breakwater which forms part of the CU Project. A sampling and analysis plan (SAP) was prepared in accordance with the following guidelines:

- National Assessment Guidelines for Dredging (NAGD);
- Queensland Acid Sulfate Soil Technical Manual (QASSTM); and
- National Environment Protection (Assessment of Site Contamination) Measure (NEPM).

The SAP has been reviewed by the Department of Environment and Science (DES), with comments from DES incorporated into the final SAP. The SAP consisted of 12 sample locations as outlined in figure 56, and the analysis of contaminant testing results demonstrate that the sediments within the Eastern Breakwater proposed dredge area meets the NAGD, NEMP PFAS and NEPM adopted requirements; therefore, the material to be targeted for capital dredging is suitable to for unconfined ocean placement or land use (land-based placement). The dredge material is designated for land-based placement via mechanical dredge within the Port's onshore reclamation area.

Results indicated a lack of contaminants of potential concern with no exceedances of the NAGD screening levels (SL), NEPM PFAS and conservative NEPM 2013 adopted assessment criteria.

TBT (normalised to 1% TOC) was detected within one sample, across the twelve locations. While the one individual sample concentration of TBT was above the assessment criteria (NAGD SL), overall the 95%UCL of the mean TBT concentration was below the assessment criteria. The TBT content of the dredge material therefore meets the criteria for unconfined ocean placement or dredging, and does not require any further analysis.

All OCPs were below laboratory LORs and therefore these concentrations were below the assessment criteria (NAGD SL and NEPM HILs).

Nine samples recorded minor detects of PAHs. Individual sample concentrations of total sum of PAHs were all below the assessment criteria (NAGD SL and NEPM HILs). Similarly, the 95%UCL of the mean concentration was below the assessment criteria.

All metal and metalloid results, including 95%UCL concentrations were reported below NAGD SL. Individual concentrations were below adopted NEPM EILs and HILs criteria.

PFAS and PFAS TOPA were all reported below LOR across all samples and locations.

No Phase III investigation is required for assessment.

The acid sulfate soils analysis indicated the presence of self-neutralising soil within all samples analysed across the full Holocene profile.

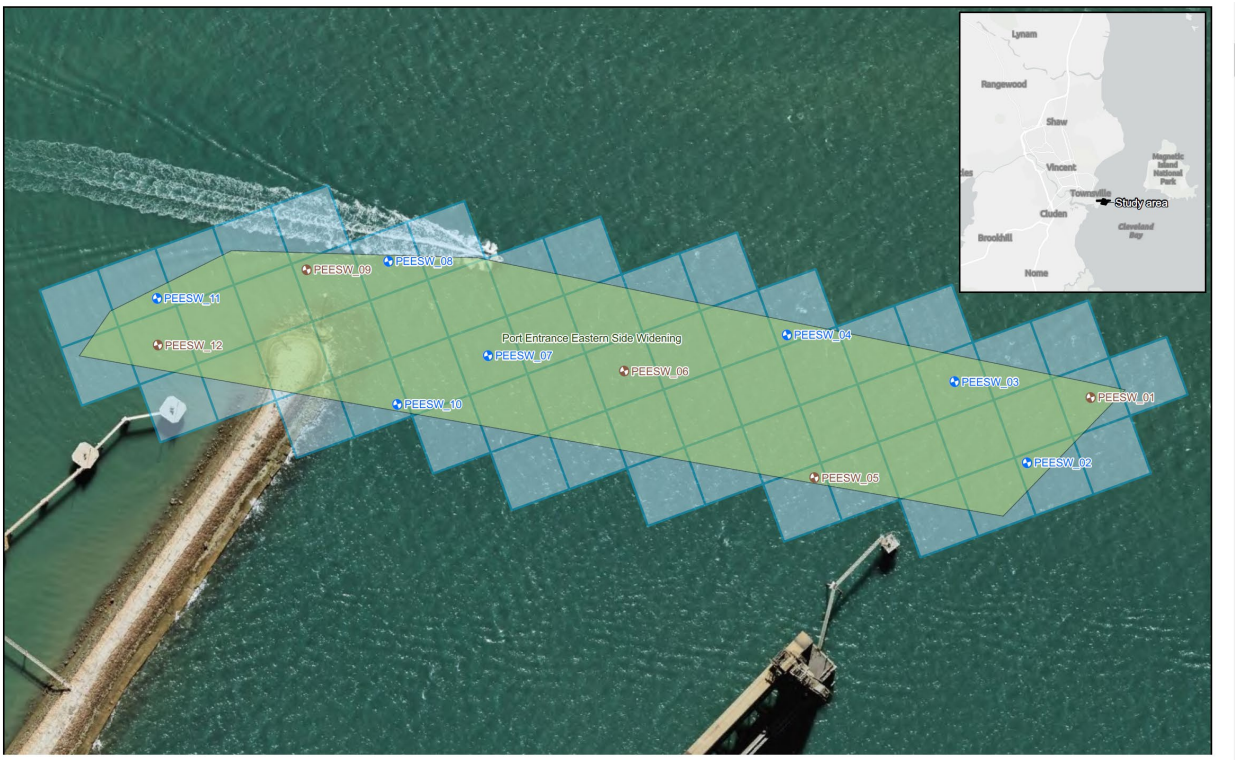


Figure 56: Sampling locations the Port Entrance Eastern Widening

Potential Acid Sulfate Soil

Sediments and Geology

The regional geology is mapped in Queensland Globe as comprising Quaternary aged alluvium and colluvium sediments underlain by Late-Palaeozoic age granite. Previous investigations have described the sediments in Cleveland Bay as typically comprising gravelly, muddy sands, but locally can have a high content of fine fraction (silts and clay) material. These surface sediments are variable in nature but are generally relatively thin and are thought to arise from tidal and seasonal movement of the seabed sediments. Hard clayey sands and silty clays underlie unconsolidated materials throughout Cleveland Bay.

As outlined in the Golder 2012 Geotechnical Review report, marine sediments in the Reclamation Area, Outer Harbour, Platypus Channel and Sea Channel were described as comprising two distinct layers:

- The surface layer of seabed sediment material is comprised of recent marine sediments generally consisting of a mixture of very soft to soft silty clay to clayey silt with very loose and loose sand to silty sand to clayey sand. Shell fragments and organic materials commonly occur within this layer. The seabed sediments are easily identified by their dark hue and “very soft” and “very loose” nature. The fine fraction of these materials is generally 45-50% clay, 45-55% silt and 0-10% sand.

- A subsurface layer comprised of lighter coloured, denser sandy clays, clays and sands. These materials are much lighter in colour than the seabed sediments.

The typical depth to underlying Pleistocene clays varies from <1m to ~ 4m within the proposed dredge footprint. Infrequent channels (Paleo Channels) incised within the underlying Pleistocene clays may present deeper pockets of soft unconsolidated silts, clays, sands and gravels. These may be associated with mangrove muds containing roots and organic debris.

The upper unconsolidated materials within the proposed capital dredging footprint have been sampled using a vibrocore system. This method typically ended within stiff underlying clays.

Acid Sulfate soil assessment

Surface chemical and physical analysis (January and May 2021, PaCE, 2021)

All core samples collected in the SAP were screened for Potential Acid Sulfate Soils (PASS) via field pH peroxide test pHFox analysis as proposed within the SAP. This is used as an indicator of oxidation potential and inferred presence of Reduced Inorganic Sulfur (RIS) and hence PASS. This test for PASS uses concentrated (30 %) hydrogen peroxide to rapidly oxidise RIS within a sample of soil, resulting in the production of acidity and a corresponding drop in pH. Depending upon the findings, samples will be classified as either actual acid sulfate soils or potential acid sulfate soils. These analyses identified the presence of PASS from the upper unconsolidated and semi consolidated sediments.

Further testing was undertaken by way of the Chromium Suite, and identified PASS materials ranging from low-level acidity with high ambient neutralising potential to materials with moderate acidity and low ambient neutralising potential. Core refusal due to the occurrence of hard/stiff clays precluded sampling and analysis of materials from the full depth of dredging. The sampling undertaken for PASS to-date (PaCE, 2021) has identified the presence of a combination of low to moderate acidity sediments with a variable acid neutralising capacity.

The National ASS Guidelines, QASSIT Guidelines requires sampling from the full depth of dredging. While this has been achieved from the current sampling program at the Temporary Unloading facility and approximately half of the Sea Channel, the remaining dredge footprint has not been assessed for PASS to the full depth of dredging. To achieve the objectives of a full dredge depth sampling program, a Jack-up barge with over-water drilling equipment was undertaken. This full depth sampling program fieldwork was conducted in June 2021.

At Depth

All samples have been submitted for pHF and pHFOX analysis. PaCE has screened samples as either actual acid sulfate soils (AASS), potential acid sulfate soils (PASS) or Non-PASS (does not exhibit pH reductions following oxidation). All samples were progressed to Chromium suite analysis. This provides assessment of actual acidity and acid neutralising capacity (ANC) for the consideration of self-neutralisation. Acid base accounting has also been provided so that an estimate of neutralisation required from agricultural lime can be ascertained by either including or excluding the sediments natural buffering potential (ANC).

PASS samples have also been analysed to define if the sediments can be classed as self-neutralising PASS (SNP). This assessment considers available ANC and applies a fineness factor of 3. To provide an improved understanding, a split from each sample has also been analysed for sieved ANC (<500µm). This enables an improved consideration of the available fine fraction carbonates and helps define if the fineness factor of 3 is suitably conservative. Samples have been classified as:

- Non-PASS
- PASS and
- SNP

The dredge footprint of the CU Project intersects both Holocene and Pleistocene sediments. The Holocene represents unconsolidated to semi consolidated grey marine sediments and the Pleistocene, consolidated lighter orange/brown sediment of terrestrial origins. In combination these materials are dominated by the silt and clay fractions (~75%) with sands making the bulk of the remainder (~22%).

The findings from this study confirmed an absence of problematic chemical contamination, with all samples being compliant to the adopted NAGD screening criteria. However, potential acid sulfate soils (PASS) have been identified.

PASS materials are located wholly within the Holocene sediments, with the underlying Pleistocene materials being identified as Non-PASS. Following a rising sea level over the last 40,000 to 60,000 years, intertidal shorelines, including wetland and mangroves, have retreated through Cleveland Bay from the outer extent of Magnetic Island to their present-day location. These ancient marine sediments are considered the origin of the PASS. Where PASS materials contain a substantial carbonate (shell) component these sediments may provide a high acid neutralising capacity (ANC). If sufficient ANC is present the sediments may be considered self-neutralising PASS (SNP). However, where ANC is insufficient to neutralise the sediment PASS may remain. The CU Project presents a combination of these conditions.

The full CU Project footprint presents an estimated 68% Non-PASS, 13% PASS and 19% SNP. When considering just the Holocene sediments these can be refined as 15% Non-PASS, 38% PASS and 46% SNP.

The typical occurrence of PASS within the profile includes SNP within the upper Holocene sediment, with peak PASS located over the 1.0 to 2.0m horizon, extending to ~ 4.0m. The Non- PASS of the Pleistocene sediment then continues to the depth of dredging. This distribution varies in paleochannels, channels which were formed within the Pleistocene sediments. Holocene sediments have filled these features and present an increased occurrence of post neutralised PASS (the Platypus Channel presents five such zones).

Presently available data indicates a greater PASS concentration within the outer platypus Channel and Sea Channel, though additional sampling is required to confirm these distributions.
The available survey data and SMEC geophysical data has allowed PaCE to define the depth, volume and distribution of the Holocene, paleochannel and Pleistocene sediments. The classification and contribution of PASS, SNP and Non-PASS materials to the dredge profile has also been estimated.

The full depth program identified the presence of PASS throughout the Holocene sediments and confirmed that PASS is not present within the Pleistocene. The total dredge volume of the CU Project is estimated to be evenly shared between the Holocene and Pleistocene. Following the consideration of ANC this results in an estimated 536,059m3 of post neutralised PASS and 607,534m3 of SNP. The dredging approach for this material can significantly alter the management options and this information has informed the Acid Management Plan.

Eastern Breakwater

The acid sulfate soils analysis indicated the presence of self-neutralising soil within all samples analysed across the full Holocene profile. WSP Golder note that the sediment to be dredged from the PEESW proposed dredge area do not require neutralisation and their placement within the CU project reclamation area can be managed under the existing ASS Management Plan developed for the CU project.

12.2 Receiving Environment Monitoring Program (REMP)

This section of the DMP outlines Receiving Environment Monitoring Program (REMP) and corrective actions that will be undertaken during the dredge campaign. It responds to the following approval requirements:

- Environmental Authority EA0002890 - Condition G16(6) to provide a detailed description of the receiving environment monitoring program (REMP)
- Environmental Authority EA0002890- Condition G15 and G16(4) to outline the sediment plume associated monitoring (SPAM) that will be undertaken if a sediment plume associated impact is detected.
- EPBC Controlled Action – Conditions 5(h)-(k) setting out the program to monitor water quality before, during and after dredging to validate risk assumptions, modelling results, and predicted effects from BHD dredging including measures to monitor turbidity and suspended sediment concentrations at sensitive habitat sites, including seagrass and coral habitat.

Aim

The overall aim of the REMP is to avoid or otherwise minimise impacts to sensitive marine environments that could be affected by capital dredging activities.

The design of the program is benchmarked and generally consistent with guidance provided in *Water Quality Review and Monitoring* (SKM 2012) developed as part of the GBRMPA's Strategic Assessment. This monitoring program is overseen by the ITAC that has been formed to guide the project.

The REMP is focussed on setting trigger levels for early detection of water quality impacts and corrective action based on benthic PAR monitoring program for coral and seagrass sensitive receptor sites but will also utilise collected turbidity data and data from the various reference locations as secondary lines of evidence for management.

Optimisation of Water Quality Monitoring Program for CU Project

Following the review of the revised modelling for CU project in 2021, the majority of the established water quality monitoring locations were found to be located outside of the predicted zone of influence now that the dredging methodology includes Backhoe dredging (BHD) only. As a result, some additional decisions about the monitoring locations and program for the CU Project have been made as follows:

1. The Strand (Deep) existing site does not have a sensitive receptor (seagrass community) co-located at this sampling location. However, as it is one of the few monitoring locations that is within the predicted zone of influence, this site remains a sentinel water quality site and is telemetered.

2. The Strand (Shallow) is a new monitoring site within the *Halophila spinulosa* seagrass bed, that is a test/compliance site for PAR and is telemetered. The Strand (Shallow) location is in the middle of the *Halophila spinulosa* bed. This site has been advised by TropWATER as the most relevant site along the Strand area on the basis of more permanent seagrass cover across seasons.

3. Virago Shoal and Middle Reef are on the edge of the predicted zone of influence and closest coral sites, and as such are test/compliance sites for PAR, both are telemetered.

4. The control sites for offshore areas were Herald Island, Rattlesnake Island and Bay Rock. Whilst these locations provide indication of regional scale influences to be detected (e.g. coral bleaching, freshwater inflow, etc.), Paluma Shoals is a more critical and comparable control for the proposed near shore compliance locations. As such:
   - Herald Island has been discontinued as a control site both for water quality and coral monitoring;
   - Bay Rock continues to operate as a control site both for water quality and coral however is not telemetered[1];
   - Paluma Shoal is telemetered (using redirected telemetry equipment from Bay Rock); and
   - Rattlesnake Island continues to operate as a control site both for water quality and coral (and is telemetered).

5. An intertidal PAR monitoring location within the seagrass meadow has been installed at Cockle Bay as the existing Cockle Bay water monitoring location is too deep to be of relevance for that seagrass bed. The existing Cockle Bay water monitoring location is in close proximity to Middle Reef with the Picnic Bay site between this and the channel. As such this water quality location adds very little additional information to the program. As such:
   - the existing Cockle Bay water monitoring location is discontinued as a sentinel site and removed.
   - the Cockle Bay intertidal site has been established and telemetered within the seagrass meadow using similar equipment as the other monitoring locations (this will continue to serve as a sentinel site as it is outside the predicted zone of influence). Note there is an existing baseline for this site with PAR having been collected for the entire baseline period to inform the seagrass monitoring program.

6. The remaining four (4) locations along Magnetic Island (Picnic, Cockle, Geoffrey and Florence Bays) are no longer sensitive receptor sites as they lie outside any zone of influence under expected or worst case scenario modelling. As such they have the potential to act as sentinel sites (a location situated between the disturbance source and the sensitive receptor providing an early warning).

The results of this rationalisation are summarised in the Table below.

Test/Compliance Sites	Sentinel Sites	Reference/Control Sites
The Strand (Shallow)	Picnic Bay	Rattlesnake Island
Virago Shoal*	Geoffrey Bay	Paluma Shoal
Middle Reef*	Florence Bay	Bay Rock
	The Stand (deep)	Cape Cleveland
	Cockle Bay (intertidal)	Cleveland Bay

* Worst case modelled scenario only

In accordance with Condition WT5 of Environmental Authority EA0002890, the following water quality parameters will continue to be collected at each site: pH, Dissolved Oxygen, Turbidity (NTU), Total Suspended Solids (TSS), Photosynthetic Active Radiation (PAR), and Sediment Settling Rate. However, to remove any doubt, a description of the function of each monitoring site in accordance with the above is summarised below.

Test/Compliance Sites

Based on the predicted zones of influence in the revised CU modelling the following locations are within the modelled zones of influence:

Expected case	Worst case
The Strand (Shallow) Virago Shoal (located near the leading edge of the zone of influence)	The Strand (Shallow) Virago Shoal Middle Reef

These sites are considered 'test/compliance sites' within the meaning of the EA Conditions which is defined as follows –

[Test sites are] – 'a concern site that functions as a test point for compliance, is a monitoring site situated in an area where the sensitive receptor occurs and where environmental monitoring-related assessment criteria (e.g. trigger values) apply.

As outlined above, there were no zones of low, medium or high impact for water quality from the model outputs. So the placement of the test/compliance sites within the zones of influence recognises that these areas have the *possibility* for impact as they will experience detectable plumes (but are not expected to result in any ecologically relevant impacts on these habitats based on the impact prediction). All of these sites will be telemetered.

A traffic light approach to assuring compliance is active for these test/compliance sites with imbedded early warning trigger levels (green, yellow, red) and corrective actions. While data on all parameters will be collected, as outlined earlier, and as recommended by ITAC, PAR is the primary parameter for assessing compliance.

Sentinel Sites

The sentinel sites include: Picnic Bay, Geoffrey Bay, Florence Bay, The Stand (deep) and Cockle Bay (intertidal seagrass).

Sentinel sites are defined in the EA as the following –

'Is a test site that is situated between the disturbance source and the sensitive receptor and serves to provide earlier warning of developing adverse conditions than does a test site.'

These sites have been selected as sentinel sites on the basis that they are:

(a) in generally deeper water (PAR measurements not relevant to the sensitive receptors),

(b) are not co-located within a sensitive receptor habitat, or

(c) are not expected to be affected by the dredging based on the revised modelling with most of these areas (except the Strand) outside the mapped zone of influence.

The exception to this is the intertidal site at Cockle Bay which will be an additional/supplementary sentinel site for seagrass (using PAR). This is classed as a sentinel site as it is located outside the expected zone of influence of dredging.

By their definition, the sentinel sites are not compliance points but represent an early warning approach, measuring changes in water quality that may lead to an impact on adjacent or nearby sensitive receptors. On this basis, they are telemetered and subject to real time monitoring and any exceedance of the stated limit will trigger an operational review by the port to understand the potential cause of the exceedance.

While all water quality parameters are being collected at sentinel sites, turbidity (NTU) (as opposed to PAR) is the primary parameter used for triggering an operational review against the control/reference sites and to review dredging practices. The only exception to this is the cockle bay intertidal site, which will measure PAR.

Reference (or control) sites

Reference (or control) sites are defined in the EA as the following –

'refers to a monitoring site located beyond the anticipated zone of influence of sediment plumes and has site pairing with one or more test sites or sentinel sites. In monitoring programs, control sites serve the same role as do reference sites but only for a defined subset of indicators.

In considering the two reference sites to the east of the channel, no zones of influence approach the Cape Cleveland or Cleveland Bay reference monitoring sites. However, these two sites are located in the most significant seagrass beds in the Bay which are known critical habitat for marine megafauna in Cleveland Bay. It had been discussed with ITAC that there was potential for these locations to be removed from the program, however the Port considers it prudent to retain these sites at least until the validation period has been undertaken and multiple lines of evidence are in hand to confirm that these locations are not required.

As the reference sites are used for comparison against test/compliance sites and sentinel sites, all of the reference/ control sites are telemetered except for the Bay Rock site as outlined previously.

Monitoring Equipment and Parameters

The monitoring equipment deployed at each location and additional physical sampling to be undertaken during the dredging campaign is detailed in Table 27. Sampling is collecting continuous data on the following parameters every 10 minutes:

- Turbidity (NTU)
- Multi-spectral light (including PAR)
- Dissolved Oxygen
- pH
- Conductivity
- Temperature
- Depth

Sedimentation data is collected at sites every 2 hours. Monthly grab samples are also being collected for TSS, nutrients and a suite of metals and prospective toxicants at a subset of the monitoring locations.

Table 27. Marine Water monitoring parameters

Parameter Name	Parameter Symbol	Sampling Approach	Frequency
Subtidal Monitoring			
Turbidity (NTU)	NTU	Telemetered seabed logger	Every 10 minutes
TSS	mg/L	Estimations of TSS will be calculated based on site specific correlations to recorded turbidity values.	n/a – see below
Multi-spectral light (including PAR)	µW cm^2 nm^{-1}	Telemetered seabed logger	Every 10 minutes
Dissolved Oxygen	mg/L	Telemetered seabed logger	Every 10 minutes
pH	pH units	Telemetered seabed logger	Every 10 minutes
Conductivity	µS/cm	Telemetered seabed logger	Every 10 minutes
Temperature	°C	Telemetered seabed logger	Every 10 minutes
Depth	m	Telemetered seabed logger	Every 10 minutes
Sedimentation	mg/cm^2	Telemetered seabed logger	Every 2 hours
Intertidal Monitoring			
Intertidal PAR	mol m^{-2} day^{-1}	Intertidal sentinel logger	Every 15 minutes
Intertidal temperature	°C	Intertidal sentinel logger	Every 15 minutes
Physical sampling			
Trace metals	µg/L	Physical sample collection	Monthly
Nutrients	µg/L	Physical sample collection	Monthly
TSS	mg/L	Physical sample collection	Monthly
Secchi disk	m	Physical sample collection	Monthly

Subtidal monitoring sites

Subtidal monitoring equipment is attached to an instrument frame that is deployed on the seabed. The instruments are connected to a surface telemetry buoy via an armoured data cable, with collected data being uploaded to an online DVSP. Equipment is serviced on a monthly basis to manage biofouling, calibration requirements, and general maintenance needs. Upon deployment, equipment is checked to ensure sensors are on a level surface and avoid instrument tilt.

Physical samples are collected from the surface, middle and bottom of the water column during monthly servicing events. Samples are sent to a NATA accredited laboratory for analysis.

Intertidal monitoring sites

Intertidal monitoring equipment is attached to an instrument frame, based on the seabed in the intertidal zone. Data is recorded and stored on the equipment, with data downloads occurring during monthly servicing events.

Intertidal data is downloaded on a monthly basis. Cockle Bay intertidal has been transitioned to a telemetry system prior to dredging as this is a sentinel site. The data handling workflow applied is similar to that described for the subtidal loggers, however the intertidal data also has a correction factor applied to PAR measurements to take into account difference when the sensors are submerged or exposed. This correction factor follows the recommendations of Kirk (1994), to account for the additional backscatter of light that occurs underwater.

Laboratory supplied data

Physical samples are collected in accordance with the requirements outlined in the DES Monitoring and Sampling Manual. Samples are analysed by a NATA accredited laboratory in accordance with their certified QA/QC practices, and reports are provided each month. Results are uploaded to an ESDAT database to assist in managing QA/QC and data outputs.

Equipment Failure at TEST/Compliance Sites

In the event of failure of the monitoring equipment at a compliance site during dredging, the following is undertaken:

- A spare monitoring buoy will be available for rapid deployment (within 48 hours in case of equipment failure of deployed equipment – weather dependent).
- If spare equipment is not available, then equipment from one of the reference sites will be relocated to the compliance site temporarily while replacement equipment is sourced.
- At PAR sites, if equipment fails or needs to be relocated to another site, non-telemetered PAR loggers will be deployed to continue to collect data.
- Telemetered equipment is fitted with a GPS tracker, and the moment the instruments cease recording or the GPS tracker indicates a buoy has moved from the fixed location, an automatic notification will be issued to the Monitoring Consultant , which is then communicated to the Port. Instruments will either be recovered or spare monitoring equipment deployed, as per the timeframes above (pending safe weather conditions). Reporting of remedial measures undertaken will be provided to Regulators by the Port as required.
- If the Daily Light Integral (DLI – the PAR statistic used for compliance assessment) is unable to be calculated due to data being unavailable (e.g. due to logger communication failure) or unreliable (i.e. no data passes QAQC checks during daylight hours), the value of the DLI for that particular day will be set to zero as agreed with the ITAC. The DLI running mean intervals displayed on the DVSP and linked to trigger alerts will be calculated including the zero DLI days.

  This provides a conservative approach to track the environmental performance at these locations, where the management criteria are linked to DLI. If missing data is associated with transmission issues (i.e. data is still being recorded on the logger but not being transmitted to the DVSP), missing data will be downloaded directly from the logger following field works. This data would be incorporated into a manual DLI calculation outside of the DVSP.
- If there is an exceedance of a compliance limit that is attributable to dredging at the time of equipment failure, then the dredge mitigation measures would continue to be implemented as a precautionary approach until the equipment is fixed.

Data Handling

Real-time monitoring data is automatically downloaded (every 10 mins where reception is available) from each site remotely via telemetry. This data is stored and processed using a web-based platform that will allow:

- Manual and automatic data processing – including QA/QC data checking and flags. The QAQC measures in place have been thoroughly tested and agreed with the ITAC. Any amendments to these processes are discussed and approved by ITAC prior to implementation.
- Display of real-time data in graphs and tables.
- Sending of alerts (email and text message) when trigger levels are exceeded.
- Storage and export of historical data.
- The raw data will be processed and, following a QA/QC process, the following will be calculated:
- For turbidity: burst recorded every 10 minutes, with the burst median calculated to give one value every 10 mins. Daily average turbidity (midnight to midnight) is calculated from the 10 minute values.
- At PAR sites, the total daily PAR (DLI statistic) will be calculated by: burst recorded every 10 minutes with the burst mean calculated to give one value every 10 minutes. Total daily PAR (during daylight hours[3]) is calculated as the daily sum of the 10-minute integrated PAR measurements (per industry standard) Following this, the relevant (7 or 14) day rolling average will be calculated daily using the previous relevant (7 or 14) days of total daily PAR data.

If for any reason the web-based platform rolling averages are not capturing and reflecting the relevant averaging period (e.g. following logger software reset), the running means are automatically calculated external to the DVSP, following the same approach as the web-based platform implements. The automatic external calculations are performed in a live spreadsheet that houses all historical data required for the running mean calculations. The results from the spreadsheet are then automatically read back into the DVSP on a daily basis and reported in 'external' dashboards that replicate the information seen on the primary DVSP dashboards. This ensures that the dashboard displays accurate data at all times to inform management decisions.

Data QA/QC

The following is undertaken to ensure data quality and to minimise any data loss from the real-time monitoring equipment:

- Sensors and equipment are cleaned and maintained regularly (approximately monthly, depending on weather conditions).
- Equipment is serviced and calibrated in accordance with manufacturer specifications. Depending on the equipment this ranges from bi-monthly to annual servicing by equipment providers.
- Some equipment also requires additional calibration prior to each deployment. For these instruments, all sensors are calibrated as recommended by the manufacturer using standard solutions prepared from National Institute of Standards and Technology (NIST) traceable reagents.
- Accuracy and precision checks are undertaken in accordance with manufacturer instructions. Re-calibration of instruments are undertaken if accuracy and precision tests fail to meet data quality objectives.
- When sensors are retrieved from the field a report on their condition and appearance will be completed. This identifies if a sensor has been biofouled or has any other noticeable issues. This data

[3] Daylight hours are defined as 5:00am to 7:20pm

will be used to assist in the post-processing assessment of the data , and to determine if additional servicing is required.

- During deployment, equipment is checked to ensure sensors are on a level surface and avoid instrument tilt. Tilt is monitored continuously, and alarms are set to alert the Consultant Environment Representative if instruments experience tilt.
- A calibration log is kept and made available upon request – the log contains all calibration details including before and after calibration (should any back calculation be necessary) and details of standards used during calibration

Data Quality Control Procedures

As real-time data is automatically uploaded by the web-based platform, programming has been incorporated to screen incoming data using a set of QAQC rules. These rules have been agreed with ITAC, and any changes to the rules are discussed and approved by ITAC prior to implementation. QAQC rules include:

- Upper and lower bounds of typical readings for all parameters. These bounds have been determined based on baseline collected for the CU Project, and knowledge gained from works in similar environments.
- For some parameters, changes of >100% of previous results are screened (e.g. a brief spike in turbidity).
- Samples for laboratory analysis of TSS are also taken during servicing trips to provide additional evidence that sensors are reading correctly. A handheld NTU meter is also deployed during each servicing trip to confirm readings. Should data not be reading correctly, an appropriate calibration can be placed on the data on the monitoring website to ensure data displayed is correct.

Setting Trigger Levels

Water quality thresholds for corals and seagrass have been set based on published scientific literature and cross checked against prevailing baseline conditions within Cleveland Bay. This has included at least 12 months of continuous and contemporary water quality data obtained from each monitoring location as described earlier in Table 15, with up to 16 months of data available at many sites. This is in addition to previous water quality monitoring programmes undertaken as part of the EIS/AEIS and subsequent studies. The Stand Shallow (seagrass) site is the only exception as this was added late in the program due to the reduced area of the zone of influence as a result of Mechanical dredging only.

The water quality trigger levels have been set using an approach similar to that used to determine impact assessment threshold values in the EIS and AEIS that was approved by regulatory agencies. A range of temporal scales have been considered in order to provide a metric for both potential lethal and sub lethal impacts. This was undertaken in consultation with the ITAC who provided expert opinion on the resilience of local benthic species and communities to water quality impacts. Reference has also been made to other recently approved capital dredging projects and their approved regulatory conditions and plans.

Some key determinations from the project ITAC relevant to setting trigger levels are outlined below.

Use of PAR for test/compliance limits

As per the EPBC Controlled Action approval requirements,

"trigger levels must be ecologically relevant, and determined based on the assessment of the condition of seagrass and coral communities in areas likely to be affected by dredging as required by Condition 4, and suitable for preventing sub-lethal and lethal impacts to seagrasses and corals from dredging".

Whilst background monitoring data is available for a range of parameters across the network of water quality monitoring sites, PAR has been resolved by ITAC to be the most ecologically relevant parameter for the establishment of limits/trigger values in Cleveland Bay.

It is also recognised in discussions with ITAC that reliable measurements of PAR depend on the water quality instruments being situated in or very close to the sensitive receptor habitat and at a similar depth to the sensitive receptor. The test/compliance sites selected for the CU Project have taken this into account including where required, identification of an additional subtidal monitoring site as identified for the Strand. This information has been incorporated into the DMP and EA.

Use of Turbidity Limits for Sentinel Sites

Whilst the test/compliance trigger levels are based on PAR/DLI (as per above), the full range of other identified water quality parameters are required to be monitored at all the designated monitoring locations. These parameters are used as part of any inference assessment for compliance as described in the REMP procedure outlined below.

Turbidity (NTU) performance criteria are set for nominated 'sentinel' water quality monitoring sites. At these sites, the water quality instruments are generally in deeper water and are situated between the proposed dredging footprint and the sensitive receptor, as opposed to being co-located with the sensitive receptor habitat. As such turbidity is considered a better measure than PAR at these sites as an early warning of potential water quality impacts (which is the function of sentinel sites compared to test/compliance sites).

The performance criteria for NTU at sentinel sites is based on the 80th percentile and 95th percentile of existing water quality collected over a period of at least 12 months at each monitoring location (this approach is consistent with water quality guidelines and regulatory approaches taken for other major dredging projects in Queensland). It is envisaged that throughout the program a more refined, tailored trigger system may evolve for the sentinel locations as additional data is captured during capital dredging. Any change in this approach / sentinel triggers will be developed in consultation with ITAC and relevant regulatory bodies with the DMP updated accordingly.

The turbidity performance criteria and real time monitoring data from the sentinel sites is used by the Port and its dredge contractor to avoid or minimise exceedance of water quality limits. The dredge contractor is responsible for observing this turbidity data during dredging with notification and corrective action requirements to the Port if turbidity limits are approaching the trigger levels.

Seasonal Data

Whilst background monitoring data is available for a range of parameters across seasons, it has been advised by seagrass and coral experts on ITAC that the PAR trigger adopted should be based on a minimum light (threshold) over a specified number of days based on best available scientific knowledge for relevant corals and seagrass species, irrespective of the season.

The ITAC seagrass expert has also indicated that in reviewing successive seagrass surveys over time in the region, that the key seagrass species within Cleveland Bay displays strong seasonality in subtidal seagrass distribution and abundance with some *Halophila* species and seasonal reductions of biomass of other species. As many of the local seagrass species are likely to be actively growing throughout the year, as such the minimum light requirement to support seagrass growth is likely to be similar between seasons. However it is important to note that in some locations for times during the year the minimum light requirement for seagrass species in Cleveland Bay is not met as part of the natural processes (independent of any dredging influence) which contributes to the cycle of declines and recovery.

Based on these points, ITAC have advised that this minimum (PAR) light value is considered the most appropriate trigger level for the proposed test/compliance sites and does not need to vary across seasons over the expected CU dredge campaign (2+ years). However as outlined above, it is important to consider that PAR fluctuates below the minimum light threshold naturally occur and this needs to be incorporated into the inference assessment to identify non-project vs project related impacts to PAR at some locations.

While not relevant to PAR, consideration of seasonal differences (wet and dry) has been undertaken for the other water quality parameters including the turbidity trigger values set for the sentinel sites. For the purpose of setting turbidity triggers based on collected data, wet season has been defined as November – April, and dry season from May – October. However, the ITAC has previously noted that the change of seasons in the region is not defined by a specific date and in some years wet season may extend into the dry season period and dry season into wet. This will also be considered in any high level review / inference assessments.

Threshold Determination for PAR

Corals and seagrasses are unable to distinguish between natural and dredging turbidity related events (Jones et al., 2017). As such the determination of threshold values to manage sub-lethal and lethal impacts to these sensitive receptors must consider cumulative pressure, encompassing intensity and duration. The use of running mean intervals over a number of telescoping timeframes enables this such that the influence of short-term acute events as well as longer-term chronic events are captured (Jones et al., 2015). Running mean interval timeframes must be ecologically relevant, covering periods where sub-lethal responses are likely to commence, enabling management intervention in a timely manner. Further, they must also be relevant to the sensitive receptors present on site. Information presented following for CU Project threshold determination has therefore been informed by results of coral and seagrass baseline monitoring activities. As light is considered to be a key limiting factor for the growth and health of both corals and seagrasses it is the focus parameter for threshold determination.

Fisher et al. (2019) note that when using the running mean approach total pressure on the system must be accounted for. Therefore, in the application of running mean intervals to the CU Project the following will be undertaken (per Fisher et al., 2019, p36):

- Pressure experienced at each site will be calculated using the parameter of light; it will be calculated in absolute terms (i.e. a running mean of ***x*** DLI (mol/m^2/day) over a period of ***y*** days)
- Pressure experienced at each site will not be calculated as a change in light conditions at sensitive receptor sites relative to reference sites
- Specified running mean time intervals will be used to track changes in light conditions at each site rather than coarser time averaging approaches.

For the management of sub-lethal and lethal responses of corals to turbidity and light stress, Fisher et al. (2019) notes that there are multiple lines of evidence that indicate that a 14-day running mean period is an appropriate time scale. This research encompasses both laboratory and field studies and includes species or morphologies

similar to those present in Cleveland Bay. This approach is further supported via the NESP research which derived thresholds in Cleveland Bay (Jones et al., 2020).

Collier et al. (2016) have identified minimum light requirements for maintaining seagrass abundance (biomass, density, percent cover) for species that occur in the Great Barrier Reef World Heritage Area. Running mean intervals range from 1-14 days depending on the sensitivity and resilience of each species.

Trigger Levels

Based on the above, the following PAR triggers are applied as outlined in Table 28 and Table 29. These sites and values are reflected in the Environmental Authority for the Project.

Table 28 - Sensitive Receptor Water Quality Limits – Test/Compliance Sites[1]

Monitoring Location Name / Type	Coordinates (GDA 94 decimal degrees)		Sensitive Receptor Type	Parameter	Compliance Threshold	Limit Type
	Latitude	Longitude				
The Strand (Shallow)	-19.246103	146.814586	Seagrass (*Halophila spinulosa)*	PAR	**2.5 mol/m²/day**	7 day rolling average (28 consecutive days below threshold)
Virago Shoal	-19.21307296	146.792598	Seagrass (*Halophila spinulosa*)	PAR	**2.5 mol/m²/day**	7 day rolling average (28 consecutive days below threshold)
			Coral	PAR	**2.5 mol/m²/day**	14 day rolling average (40 consecutive days below threshold)
Middle Reef	-19.19682699	146.817747	Coral	PAR	**2.5 mol/m²/day**	14 day rolling average (40 consecutive days below threshold)

[1] Also termed a 'concern site' using the terminology from the draft EA conditions in the CGER

The Strand (Shallow) monitoring location in the seagrass meadow has limited baseline information to confirm how often PAR naturally meets or doesn't meet the minimum light requirement threshold for positive seagrass

growth. The ITAC involvement in the inference assessment, to be informed by the compliance and sentinel sites, is essential to understand natural fluctuations of this location.

Table 29 – Associated monitoring requirements – Sentinel Sites

Monitoring Location Name / Type	Coordinates (GDA 94 decimal degrees)		Sensitive Receptor Type	Parameter	Sentinel Threshold and Limit Type (*)	
	Latitude	Longitude				
Florence Bay	-19.12229997	146.882036	Water Quality	NTU	Wet Season **11.63**	95th percentile NTU – measured as a 7 day rolling average
					Wet Season **3.10**	80th percentile NTU – measured as a 14 day rolling average
					Dry Season **9.17**	95th percentile NTU – measured as a 7 day rolling average
					Dry Season **4.83**	80th percentile NTU – measured as a 14 day rolling average
Geoffrey Bay	-19.15531503	146.868214	Water Quality	NTU	Wet Season **4.60**	95th percentile NTU – measured as a 7 day rolling average
					Wet Season **2.46**	80th percentile NTU – measured as a 14 day rolling average
					Dry Season **6.29**	95th percentile NTU – measured as a 7

						day rolling average
					Dry Season **3.51**	80th percentile NTU – measured as a 14 day rolling average
Picnic Bay	-19.18670198	146.8389690	Water Quality	NTU	Wet Season **2.90**	95th percentile NTU – measured as a 7 day rolling average
					Wet Season **1.78**	80th percentile NTU – measured as a 14 day rolling average
					Dry Season **7.24**	95th percentile NTU – measured as a 7 day rolling average
					Dry Season **3.82**	80th percentile NTU – measured as a 14 day rolling average
Cockle Bay (intertidal)	-19.17045903	146.815239004	Seagrass (*Zostera muelleri*)	PAR	**6 mol/m^2/day** – measured as a 14 day rolling average (28 consecutive days below threshold)	
The Strand (deep)	19.23415697	146.824849	Water Quality	NTU	Wet Season **19.94**	95th percentile NTU – measured as a 7 day rolling average
					Wet Season **12.66**	80th percentile NTU – measured as a

						14 day rolling average
					Dry Season **23.04**	95th percentile NTU – measured as a 7 day rolling average
					Dry Season **13.05**	80th percentile NTU – measured as a 14 day rolling average

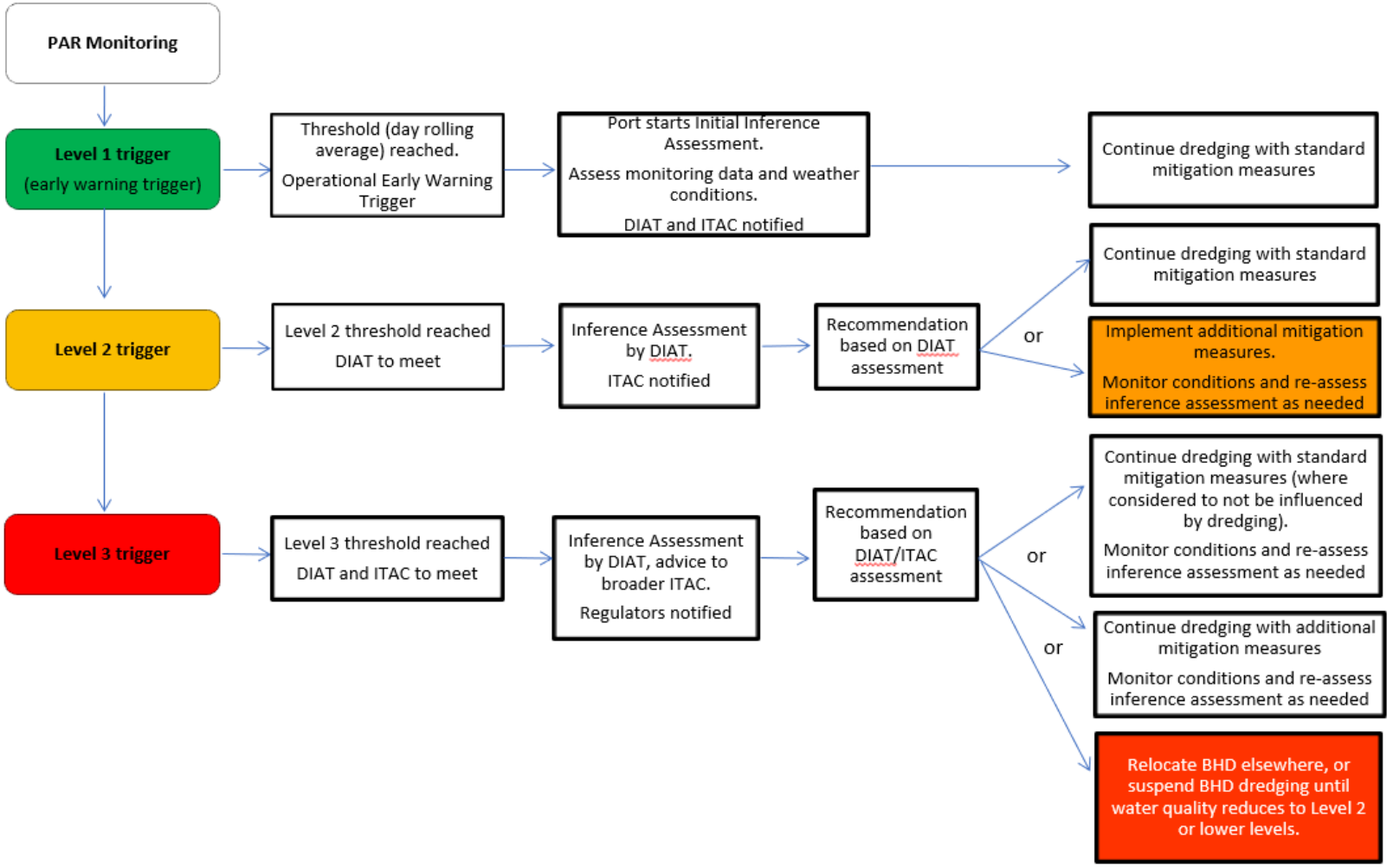
* data analysis provided by Port's water quality consultants (GHD) based on long term baseline data set at each location. Wet season (Nov-Apr), dry season (May-Oct).

REMP operation

In applying these triggers to the REMP, it employs a range of trigger levels for further investigation and instigation of corrective actions.

A schematic of the proposed REMP as it relates to the nominated test/compliance sites that are measuring PAR and how it would function during dredging is shown in Figure 57.

Figure 57. Schematic of the Receiving Environmental Monitoring Plan (REMP) Workflow



The triggers for different levels of action response have also been refined. Consistent with the use of PAR, the trigger levels for test/compliance sites now reflect a combination of light levels and duration of impacts to ensure they are ecologically meaningful (not just a percentage of exceedance). These action triggers are outlined in Table 30 below.

Table 30: Action trigger levels for green (level 1), amber (level 2) and red (level 3) trigger level reviews and inference assessments for test/compliance sites

Compliance Monitoring Site	Sensitive Receptor Type	Parameter	Trigger Levels			Days to Impact*
			Level 1 (Green)	Level 2 (Amber)	Level 3 (Red)	
		Activity Level	Operational Trigger (Watching Brief)	DIAT Trigger (Inference Assessment)	DIAT & ITAC Alert (Notification to regulators)	*days to impacts starts from day 1 rolling average
The Strand	Seagrass (Halophila spinulosa)	PAR	7 day rolling average 2.5 mol/m²/day	Alert at Day 14	Alert at Day 25	28 days
Virago Shoal	Seagrass (Halophila spinulosa)	PAR	7 day rolling average 2.5 mol/m²/day	Alert at Day 14	Alert at Day 25	28 days
Virago Shoal	Coral	PAR	14 day rolling average 2.5 mol/m2/day	Alert at Day 28	Alert at Day 33	40 days
Middle Reef	Coral	PAR	14 day rolling average 2.5 mol/m²/day	Alert at Day 28	Alert at Day 33	40 days

Please note that the above process applies only to the test/compliance sites nominated and the 2.5 mol/m^2/day remains as the relevant threshold for level 1, 2 and 3.

It is important to note that the Level 3 'Red' trigger does not equal an immediate impact upon sensitive receptors. This trigger level has been set at the scientifically recommended thresholds for both coral and seagrass. Each of these thresholds has a 'days to impact' margin to ensure all mitigation measures have been undertaken before an impact is felt by the species.

Once management action (Level 2) triggers are reached and have been determined by the DIAT to be attributable to dredging, the dredge contractor is responsible for taking actions to ensure impacts are avoided at sensitive receptors and impacts are controlled prior to level 3 trigger is reached. The decision regarding which mitigation measures to implement will be discussed at the DIAT with all positions documented. The Port will determine the action to be taken, based on the advice provided by the DIAT and in consultation with the dredging contractor. In some cases, additional actions may not be required as standard mitigations will be adequate. Response from the dredge contractor to protect sensitive receptors may be required even if trigger levels are reached due to natural fluctuations. This will be considered by the DIAT on a case by case basis at the time, as it depends on the site triggered, the information from other locations and sites as well as the dredge activity at the time.

In all cases it should be noted that the dredge contractor - along with the Port - will be monitoring the real-time water quality data on a continual basis (including through use of an electronic monitoring data dashboard**)**. The dredger will be expected to commence implementation of standard mitigation actions prior to any DIAT/ITAC meeting if water quality exceedances are likely.

Inference Assessment Process – Test/Compliance Sites

As outlined above, the 'inference assessment' will be triggered by exceedance of a Level 2 (amber) and Level 3 (red) trigger for PAR as measured by a test/compliance site.

The inference assessment process will involve the following:

- Confirmation of the data checks that have been undertaken to ensure equipment is functioning correctly (by technical specialist hosting the database and monitoring equipment) (Level 2 only)
- Convene DIAT (for level 2 amber) and DIAT + detailed advice to all ITAC members (for Level 3 red) following the triggering of the alert. Within 24 hours of the trigger during business hours (between 9am-5pm AEST) the DIAT Chair will establish the timing for the DIAT meeting, with the meeting timing to be dependent on the trigger level and other associated factors (tracking of other compliance and sentinel sites etc). It is intended that the DIAT will meet within 1-5 business days for a level 2 trigger and within 1 business day of the recorded exceedance for a level 3 alert. On some occasions the DIAT may meet and consider prior to the trigger occurring to determine suitable actions if it does trigger over a weekend, public holiday etc. As triggers are based on rolling averages it should be feasible to coordinate availability however a proxy may be required on some occasions.
- Inference Assessment to assess monitoring data to determine if exceedance of the trigger level could be due to equipment issues including secondary data sets being collected on turbidity and associated trigger levels.
- Inference Assessment to assess weather data from Bureau of Meteorology (BOM) website and monitoring data from reference/control sites to determine if exceedance is from natural weather event, consideration of potential influence from other aspects, e.g. maintenance dredging, natural variation or regional influence e.g. flood etc.
- Review of water quality data at the paired or nearby control/reference sites
- Review of the dredge logs over the period leading up to and during exceedance and position of the dredge compared to the sentinel site
- DIAT (for level 2 amber); DIAT & detailed advice to all ITAC members (for level 3 red) to recommend appropriate mitigation measure(s) to implement, taking into consideration location of exceedance, weather forecast, dredging schedule and other relevant factors. They will consider this recommendation in determining the response action to be taken.

Note that the dredge contractor will be monitoring the real-time water quality data on a continual basis and will likely commence implementation immediate management actions prior to the DIAT/ITAC meeting.

A detailed checklist for the inference assessment process is in preparation with an example appended below:

Inference Assessment / report details: -

- ☐ Time and date of Alert
- ☐ Alert Level number (1, 2, 3)
- ☐ Confirm data stream is accurate and all equipment functioning as expected
- ☐ Current weather conditions (wind, rain, cloud cover)
- ☐ Location of the dredge compared to triggered compliance site
- ☐ Surface PAR reading (Port and AIMS) to compare to monitored sites readings
- ☐ Tidal cycle recorded (neep, king, etc)
- ☐ Compare Compliance site readings to all other monitoring locations
- ☐ Number of days past BHD maintenance day (scheduled dredge shut-down day)
- ☐ Comparison to same period during the baseline (compare to previous natural triggers)
- ☐ Dredge scenarios review (modelling etc)
- ☐ MODIS imaged recorded
- ☐ Reputational risk to continue dredging / location of dredging?
- ☐ Reactive monitoring recommendation based on inference assessment (MODIS, WQ, Coral or Seagrass depending on compliance site triggered)

Checklist:

- ☐ Trigger alert logged in database
- ☐ Details of inference assessment and recommendations signed by Principal's and Contractor's Representatives and ITAC chair
- ☐ Directive for Dredge communicated to Dredge Master
- ☐ DIAT / ITAC / Regulators (as required) notified and provided Inference Assessment Report

Operational Review of Sentinel Site Data

As described previously, the sentinel sites do not set compliance limits but represent an early warning approach (equivalent to the Sediment Plume Associated Monitoring or SPAM from the EA conditions), measuring changes in water quality that could result in an impact on adjacent or nearby sensitive receptors. On this basis, they will be telemetered and subject to real time monitoring and any result above the stated sentinel threshold will trigger an operational review.

Initially this review will be a high level consideration of the trigger and any potential influence by capital dredging, with more detailed review only where there may be influence from dredging. This operational review will be available to DIAT should there be any consideration of influence from capital dredging. This operational review will involve the following –

- Confirm data stream is accurate and all equipment is functioning
- Review of seasonal and current weather conditions
- Review of water quality data at the paired or nearby control/reference sites
- Review of the dredge logs over the period leading up to and during trigger and position of the dredge compared to the sentinel site
- If it is considered that dredging could be causing or contributing to the elevated water quality at the sentinel site, review and implement corrective actions that could be undertaken by the dredge to reduce water quality impacts
- The relevant ITAC expert will be consulted if there is a result above (or in the case of PAR falling below) the threshold at these sites that is attributed to dredging.
- If there are persistent results outside of sentinel site water quality triggers, advice will be sought from ITAC to appropriate responses including additional monitoring approaches.

For the sentinel sites at Florence Bay and Geoffrey Bay, once the Sea Channel dredging is completed as part of the CU Project, the Port will review the data set with the intention of discontinuing data collection from these sites if warranted and in consultation with the ITAC.

The Port may also apply to discontinue other sentinel sites if, after a sufficient period of monitoring and review of the data, it is clear that the dredging activity is not having any detectable or deleterious effect in consultation with the ITAC.

Involvement of ITAC in the REMP

ITAC's involvement in the REMP is commensurate with the risk of impact.

The Chair of ITAC is a member of the DIAT (as outlined above) by invitation (currently a standing invitation). Additional ITAC specialists involved in the process will be identified by the Port and Chair of ITAC and based on the potential impacts (e.g. the ITAC coral specialist brought in to assist with potential impacts to water quality sites that are proximal to corals, etc.).

In summary, ITAC will be engaged as follows –

- For test/compliance sites –

- Notification to ITAC (via the monitoring data / dashboard) will occur at a Level 1 trigger (note only Port and dredge contractor are issued the dashboard alert at level 1 trigger).

- Notification to ITAC (via the monitoring data dashboard alert) and direct contact with the ITAC Chair and relevant ITAC specialist/s will occur following a Level 2 trigger level exceedance of a test/compliance site. Following a meeting of the DIAT (which includes ITAC Chair and relevant technical specialist), the full ITAC will be notified that the Port (through the DIAT) has undertaken an internal inference assessment and the outcome of that assessment. This may include taking corrective actions to reduce the likelihood of the level 2 trigger exceedance becoming a level 3 trigger level exceedance for the monitoring site or is comfortable that the exceedance is not attributable (directly or indirectly) to the dredging or otherwise (e.g. similar levels/values are being observed at control sites, location of the dredge etc.).

  This process will involve a review of the raw or compiled data, initial inference assessment findings as well as opportunity to review and recommend corrective actions. Note a number of ITAC members will be involved via the DIAT but this notification will be disseminated to the full ITAC unless a member has specifically asked to be removed.

- In addition to further meetings of the DIAT, direct involvement of ITAC (e.g. a meeting to discuss the inference assessment and corrective actions or advice via the ITAC Chair) will occur following a Level 3 trigger level exceedance of a test/compliance site. This process will involve a review of weather forecasts, the raw or compiled data, initial DIAT inference assessment findings and the opportunity to review and recommend corrective actions, with ITAC advice and recommendations to be recorded.

- Notification to the regulatory agencies (DES and DCCEEW) is to occur of any level 3 exceedance of a test/compliance site. The ITAC advice and recommendations will form a part of this notification and corrective action follow up.

- For sentinel sites –
  - The sentinel sites will not be subject to the same traffic light approach as test/compliance sites as they are already serving as early-warning mechanisms for possible impacts to water quality.
  - Notification of ITAC to occur via the DIAT review process, if this is triggered for a sentinel site reaching early warning value. This will only be where it is considered the trigger is potentially attributable to the dredging following the operational review process.

MITIGATION MEASURES AND CORRECTIVE ACTIONS

Response procedures corresponding to the Level 1-3 trigger levels for the PAR test/compliance sites are shown in Figure 58 to Figure 60.

Note that the dredge contractor will be monitoring the real-time water quality data on a continual basis and will likely implement immediate management actions prior to the DIAT meeting.

Figure 58. Level 1 green trigger response procedure

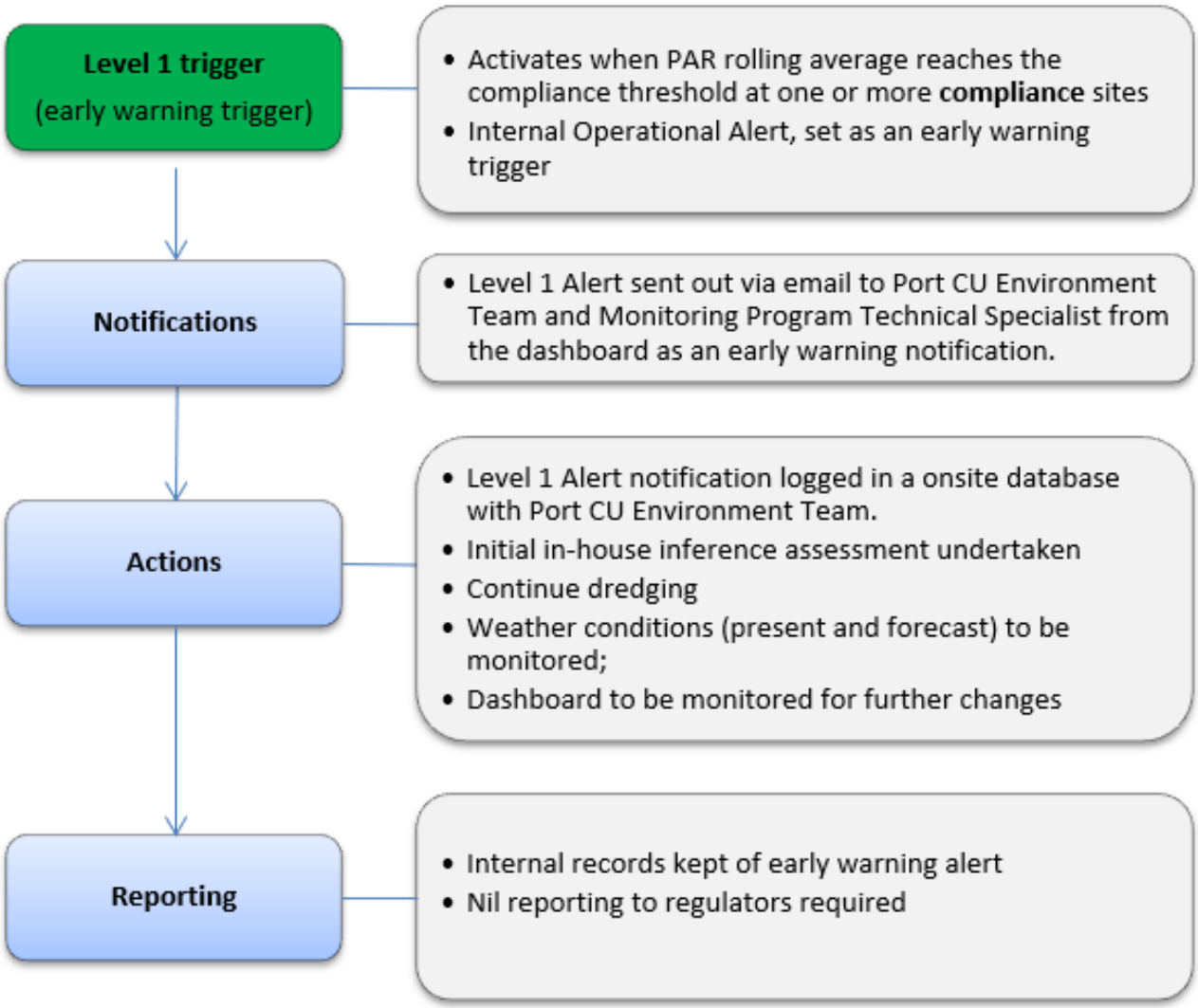


Figure 59. Level 2 amber trigger response procedure

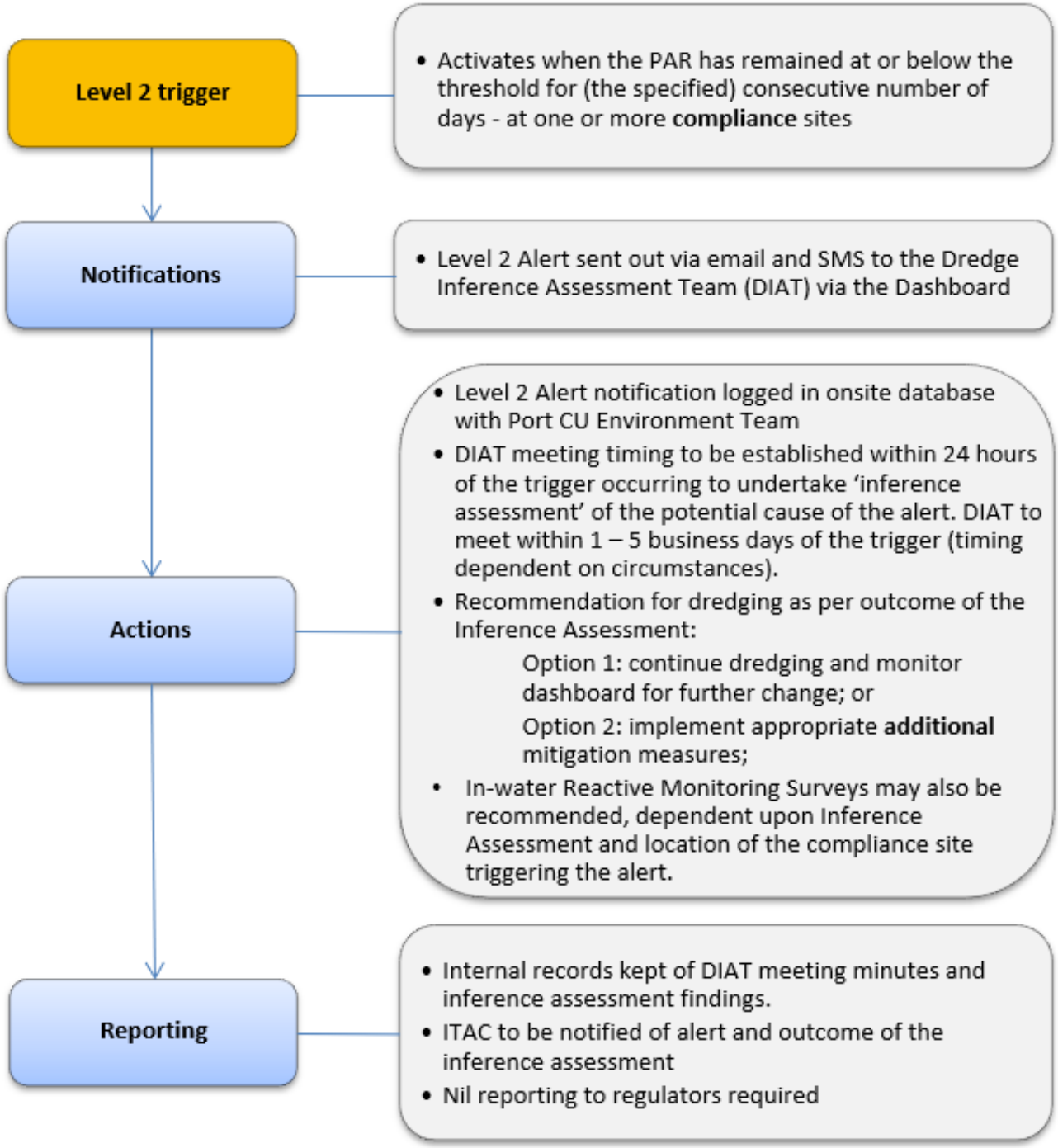
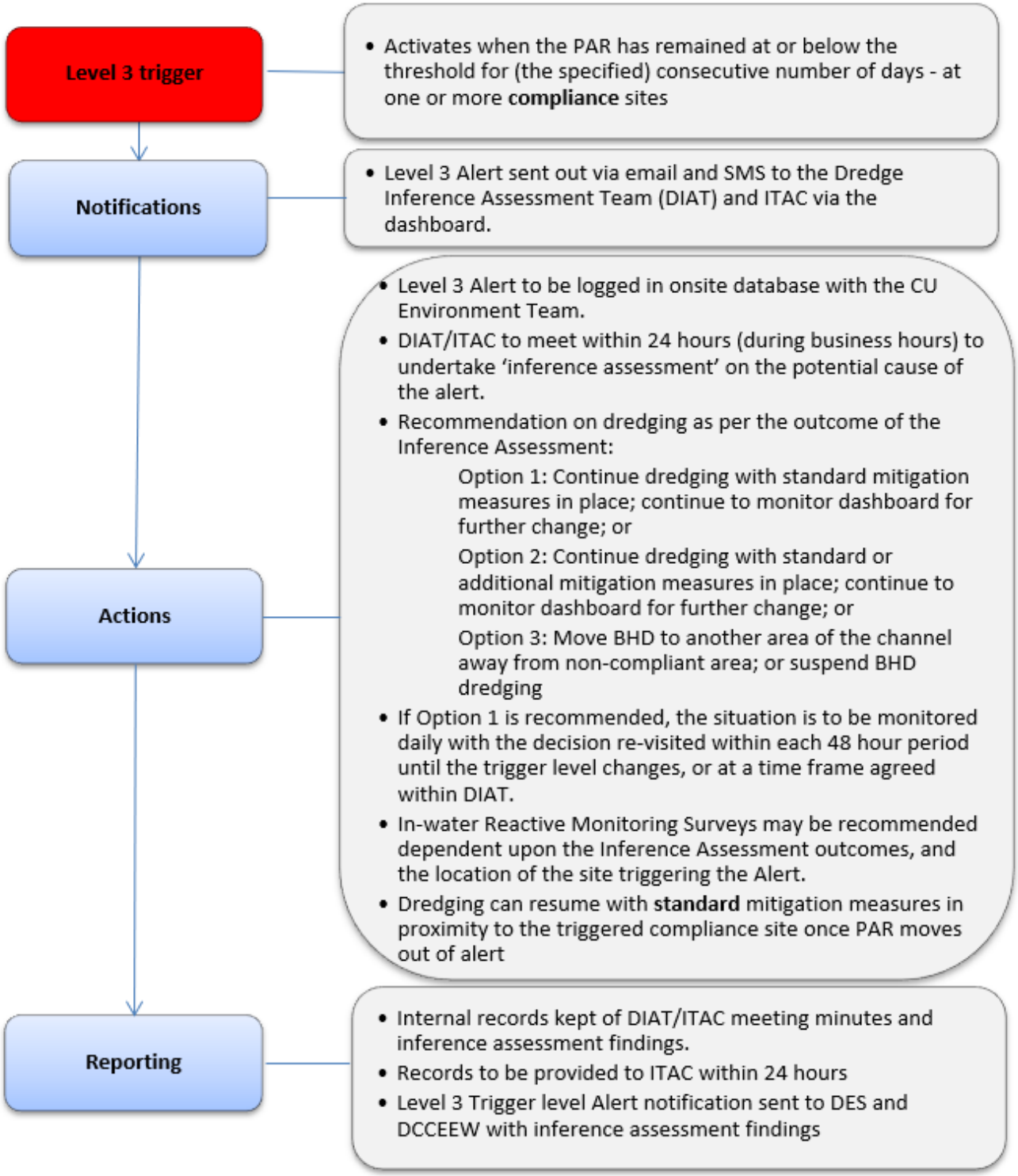


Figure 60. Level 3 (Red) trigger response procedure



The sections below set out the range of potential additional mitigation measures and corrective actions that can be implemented by the Port and its dredge contractor to bring PAR levels back above trigger alert levels.

Similar mitigation measures will be considered following an operational review of a sentinel site that has exceeded the set turbidity water quality limit.

Note that as part of general practice, the dredge contractor will preferentially dredge higher risk areas during better weather conditions, subject to requirements associated with lining the reclamation and meeting the overall dredging program.

Preferential Movement of the Dredge to Other Segments

The dredge contractor will have some flexibility in terms of the sequencing of channel dredging. If impacts are detected at a particular sensitive receptor monitoring location a change to the location of the dredge can occur. Particularly given that the key impacts are light deprivation, preferentially dredging other segments whilst allowing suspended sediments in a particular area to settle can be an important strategy to ensure seagrass and coral environments are obtaining necessary light to maintain photosynthetic processes. Dredging in proximity to sensitive areas during night-time hours is a potential mitigation assuming plume impacts are dispersing quickly, whilst not impacting upon PAR however from operational reasons based on the time required to relocate the dredge it is unlikely that large movements of the dredge location will occur on a daily basis.

Dredging to Weather Conditions

Weather conditions will influence sediment plume behaviour and the short term fate of fine sediment particles that are released to the environment from the dredging. Regular observation and correlation of metocean conditions with the monitoring data will allow the dredger and the DIAT to understand those weather conditions that pose higher risks to sensitive receptors. This would enable dredge activities to be scheduled with consideration of metocean conditions to minimise risk of impact on sensitive receptors.

Optimising scheduled downtime

The backhoe dredge will require regular maintenance to maintain its moving parts in good working order, along with general wear and tear repairs. The Dredging contractor operates a regular maintenance schedule. However should it be required, they also have the opportunity to modify the timing of a maintenance day to cease dredging, instead of stopping works for an environmental delay should a level 2 or 3 trigger be attributed to dredging, or ambient conditions approaching a level 3 trigger.

Installing Additional Sentinel Monitoring Locations

If level 2 exceedances are being regularly experienced at sensitive receptor sites during the dredge campaign that are attributed to dredging, an additional sentinel sediment plume monitoring site may be initiated at an appropriate location upon consultation with the ITAC. The location of the sentinel site will be dictated by the location of the sensitive receptor site being regularly triggered.

The sentinel sites would involve continuous logging of turbidity and PAR along with continuous logging at sensitive receptor sites for comparative purposes and to seek to provide an earlier detection of any plume being detected prior to that plume drifting near sensitive receptor sites.

Once installed, the SPAM sentinel site data would be used to inform corrective actions and would continue until sensitive receptor sites are demonstrating compliance with water quality limits at level 1 (green) or below.

Temporary Suspension of Dredging

Suspension of dredging is generally a last resort option when all other mitigation measures and corrective actions as outlined within this document have been undertaken for compliance (red/level 3) triggers occur; and proved unsuccessful to control dredge related impacts. The decision to temporarily suspend dredging would be determined by the Port based on DIAT and ITAC advice and input, and in consultation with the Principal's Representative for Dredging and Reclamation Works.

Dredging will be able to be recommenced adjacent to the non-compliant site once water quality levels have returned the relevant PAR rolling average achieves 2.5 mol/m2/day (at a minimum).

Benthic receptor resilience

Seagrass and corals are influenced by a range of environmental conditions under normal conditions for example thermal stress, physical damage from storms and cyclones, impacts from fresh water, and low light due to cloud cover. Whilst the above trigger process has been detailed in the case of water quality threshold trigger, the same inference assessment process can be implemented for other local or broad spread events (e.g. in the case of coral bleaching events). In this case the inference assessment will be useful in determining if additional actions or surveys are required to better inform dredging decisions and DIAT/ITAC decision making and/or if review of the established trigger values is needed if the sensitive receptors are in a period of low resilience. As these events can vary significantly no timeframes have been included, however it is envisaged that the routine monitoring events would be utilised to inform the closing of these events.

Review and Cessation of Monitoring

The State approval requirements under the EA provide that continuous monitoring at all monitoring locations must be undertaken during active dredging periods. For the CU project, this expected to be for a period of 2+ years given the adopted approach of using a BHD as opposed to the use of larger TSHD plant.

Assuming the implementation of the REMP demonstrates that the impacts from the BHD dredging campaign are as predicted in the EIS/AEIS and subsequent modelling update; with no (level 3) compliance exceedances attributable to the dredging, the significant cost of deploying and collecting continuous data from 13 compliance and reference sampling sites across Cleveland Bay for the full period of dredging (2+ years) may be disproportionate to the risk of environmental harm from the activity.

To this end, the Coordinator General's Evaluation Report (CGER) highlighted (page 154) -

"…that the Technical Specialist Team will monitor mechanical dredging for one month to confirm the anticipated negligible level of impact. If agreed by the Technical Advisory Committee, this monitoring will stop after one month"

Given this commitment, the Port's intended approach will be to undertake a detailed review of the REMP after the initial period of channel dredging (in consultation with the ITAC. A further review following this may be undertaken to allow for consideration of seasonality and dredge program...

If implementation of the REMP over these initial periods of time demonstrates that the dredging is posing negligible impacts to sensitive receptors and no demonstrable zones of impacts from dredge plumes are detected, then the Port may seek formal amendments to the EA to amend conditions WT5 and G15 as they

apply to the remainder of the dredging campaign; to modify to either a reduction in monitoring frequency, a reduction in the number of sample sites or both. Any proposed amendment will be presented and discussed with the ITAC for technical advice and endorsement of the change prior to presentation to relevant agencies and authorities.

12.3 Validation Monitoring

A number of validation programs are currently proposed to validate the modelling, baseline data, trigger levels, calculations, and expectations derived through the EIS/AEIS and baseline monitoring. The following are the currently proposed validation monitoring programs:

- Section 12.3.1 Water Quality Modelling Validation
- Section 12.3.2 Fine Sediment Validation
- Section 12.3.3 Tailwater Validation
- Section 12.3.4 Biological Validation

12.3.1 Water Quality Modelling Validation

Overview

Hydrodynamic and advection-dispersion modelling was undertaken as part of the EIS/AEIS for the Project. The principal platform applied was the hydrodynamic model TUFLOW FV. This model was appropriately calibrated and validated to provide confidence in predicting potential changes to water quality conditions from the proposed dredging works. It is, however, appropriate to confirm that changes in water quality conditions observed during dredging, including plume conditions, are congruent with model predictions by undertaking validation monitoring once backhoe dredging commences in the channel.

The dredging contractor who will undertake works for the CU Project has been appointed and this has enabled greater resolution of the dredging program and plant to be employed. On this basis, the dredging scenarios and seasonal conditions modelled during the EIS/AEIS are different to those that are planned for delivery of the CU Project. It was, therefore, appropriate to re-run the model for the expected construction approach and timing.

This exercise has been completed, identifying potential changes in water quality conditions for the planned CU dredge program. Results from the re-run modelling, and the methodology that will be implemented to validate the model outputs are described following.

Modelling results

As was the case for the EIS/AEIS and as outlined previously in this document, revised 'zones of impact' have been developed from modelling outputs of the CU Project to assess the potential impacts to marine water quality and ecologically sensitive areas that may result from dredging. These zones are recommended in the GBRMPA Modelling Guidelines and are generally based on environmental assessment guidelines for dredging produced by the Western Australia Environmental Protection Authority (2011).

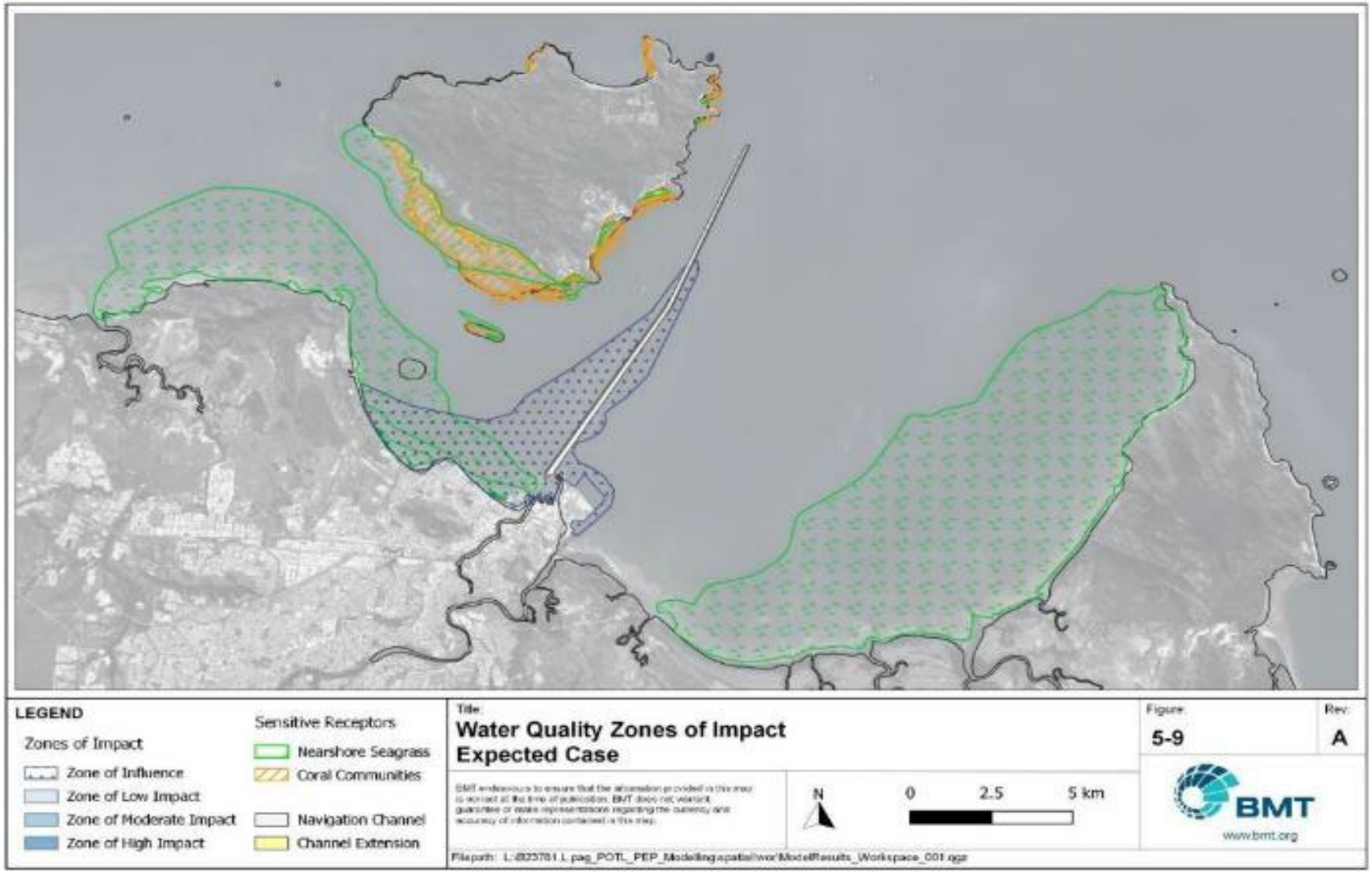
The revised modelling results indicate that the influence of dredging on the 50th and 95th percentiles of the turbidity are highest in close proximity to the dredge, and decrease rapidly with distance away from the channel. The increase in the 95th percentile turbidity due to dredging is generally less than 2 NTU at a distance of

400m from the centreline of the Platypus Channel, and around 5 NTU within 400m of the Port entrance. The increase in the 50th percentile turbidity due to dredging is generally less than 1.5 NTU at a distance of 400m from the centreline of the Platypus Channel, and around 5 NTU within 400m of the Port entrance.

The zones of impact to turbidity from revised modelling for the expected case conditions are provided in Figure 61. Note that in this figure the mapped sensitive receptor areas are reproduced from the AEIS. The mapped distribution area may represent potential coverage of seagrass and coral rather than actual coverage given recent flood and severe storm events.

This affirms the expected case results indicate the zone of influence (where plumes may be noticeable but are unlikely to have any ecological effects) extends along the coastline to the west as far as Rowes Bay, and also extends past the proposed tailwater discharge point on the eastern corner of the reclamation area. In this area a change in water quality conditions may be detectable from sampling but sensitive receptors are not expected to be impacted. This zone also notably doesn't extend to the sensitive receptors at Magnetic Island. Likewise, modelled worst case impacts to water quality, and expected and worst case sediment deposition zones also remain removed from the Magnetic Island sensitive receptors.

Figure 61. Water Quality Zone of Impact – expected case



Validation methodology

The methodology to validate the modelling findings incorporates two complementary approaches:

- Comparison of data collected by the marine water loggers to the time series data from various model extraction points, and
- Nearfield monitoring of the dredge plume.

Time series model validation

The remodelling exercise was designed such that model extraction points are co-located with the marine water monitoring locations. Collected marine water data and extracted model results at these sites will form the foundation of this model validation exercise. The following process will be implemented:

- The numerical model will be run in hindcast mode for a 30 day period prior to dredge commencement, with appropriate boundary conditions
- Confirmation of baseline condition accuracy – This element will compare collected baseline marine water data from 30 days prior to dredge commencement with the modelled ambient turbidity from the hindcast simulation. The 30 day period has been nominated to mirror the model simulation period, which encompassed two consecutive spring-neap tidal cycles.
- A model hindcast of the first 14 days of dredging will be undertaken with the latest dredge plume generation assumptions and with meteorological and oceanic boundary inputs based on prevailing conditions. Modelled time series outputs from the first 14 days (full spring-neap tidal cycle) will be extracted for comparative analysis with collected data.
- Comparative statistical analysis (Chi-squared tests) will be undertaken between the observed data (collected data) and expected data (model time series outputs) to inform accuracy of model predictions.
- Results will be interpreted to identify data gaps, relevancy of analysed scenarios against site conditions and dredging operations, and any scenarios that need further testing not captured by the 14 day period. Two validation activities are to be conducted; this will enable validation of modelled conditions for when the dredge is operating both inshore and offshore and, therefore, take account of varying depth, current, wind and sediment conditions. This method enables validation that water quality conditions predicted by modelling to occur at sensitive receptor sites are congruent with observed conditions during dredging.

The hindcast validation report will be prepared within 3 months of commencement of dredging in the channel, as required under Condition G22 of the EA.

Near-field plume monitoring

Near-field plume monitoring will be undertaken in proximity to the dredging activity and will comprise the following elements:

- Profiling of the water column using turbidity and optical backscatter instruments
- Co-located collection of water samples from the surface, middle and bottom of the water column for analysis of TSS and laser-fraction Particle Size Distribution (PSD)
- Acoustic Doppler Current Profiler (ADCP) measures.

Monitoring will be undertaken from a survey vessel that will run cross and longitudinal section transects through the dredge plume. The vessel mounted ADCP will be configured in backscatter echo intensity mode. This will enable real time visualisation of a surrogate of the suspended particle concentrations within the water column below the vessel to facilitate location and measuring of the dredge plume (if not visible from the water surface).

The monitoring exercise will be repeated over a number of days, enabling capture of the advection and dispersion behaviour of the dredge plume under a range of tidal conditions. All measures will be geo-referenced enabling results to be mapped and compared to predicted outputs from the model. This method enables validation that the plume conditions predicted by modelling are congruent with those observed during dredging.

Model validation report

Results of the time series model validation and near-field plume monitoring will be collated into a Model Validation Report. In accordance with Condition G22 in the Stated Conditions for the Environmental Authority in Appendix 2 of the Coordinator General's Evaluation Report, this report will confirm if the modelled results and predicted effects on water quality conditions from dredging are congruent with observed field conditions. This will inform whether risk mitigation measures mitigation measures and environmental controls prescribed for the project (informed by modelling) are appropriate, or would benefit from being revised. If required, further hindcast modelling can be undertaken incorporating any necessary changes to the dredging plume source rate assumptions and extended over the full duration of the dredging campaign. This hindcast modelling would also be used to identify any consequential changes to the predicted Zones of Influence and Impact.

12.3.2 Fine Sediment Validation

Under Condition 5(k) of the EPBC Approval, the DMP must outline the method for defining, delineating, and quantifying the fine sediment (<15.6 micron fine silt and clay) returned to the marine environment as required by Condition 26(b) and must be reviewed by suitably qualified independent expert.

Condition 26(b) states that at the completion of capital dredging for each stage of the action, the person undertaking the action must submit a Dredging Completion Report to the Minister. The Dredging Completion Report must delineate and quantify in tonnes:

i. Fine sediment returned to the marine environment that was not available for resuspension before commencement [of the dredging]; and

ii. Fine sediment returned to the marine environment that was available for resuspension before commencement.

A Fine Sediment Management Plan to address the Commonwealth and State approval conditions relevant to fine sediments will be prepared by the Port. The Plan will outline the following:

- Assessment approach, review of the geotechnical information and literature to inform estimation of sediment volumes, material types and initial estimation of fine sediment release.
- Validation of the proposed field monitoring approach and hydrodynamic modelling to generate a field verified estimate
- Summary of the independent peer review
- Description of data use, presentation of modelling outputs and informing of offset requirements

A copy of the full Fine Sediment Plan will be attached to the Offset Management Strategy required under the EPBC conditions.

A summary of the methodology to be used to generate the fine sediment estimate that is required in the Dredging Completion Report is contained below and consists of: (i) an assessment of geotechnical conditions, (ii) a review of plume source rates and (iii) field monitoring and modelling.

Assessment of Geotechnical Conditions

From review of all available geotechnical information in the dredge footprint, the volumes of dredge material and material types to be dredged have been estimated in Table 31.

Table 31. Estimated Breakdown of Dredge Material by Area and by Extent of Consolidation

Area or Chainage	Total volume to be excavated (m^3)	Volume of unconsolidated material (m^3)[4]	Volume of consolidated material (m^3)
Temporary Unloading Facility	100,000	100,000	0
Diagonal Breakwater	60,000	30,180	29,820
Platypus Ch0-Ch2500	1,446,000	727,338	718,662
Platypus Ch2500-Ch5000	1,281,000	644,343	636,657
Platypus Ch5000-Ch7500	544,000	273,632	270,368
Sea channel Ch7500-Ch10000	222,000	126,540	95,460
Sea channel Ch10000-Ch14000	131,000	74,670	56,330
Approximate total m^3:	3,784,000	1,976,703	1,807,297

Plume Source Rates

Comprehensive literature review has found a range of published fine sediment source term factors that provided a reasonably consistent measure of the proportion of in-situ dredged mass that is released into the far-field dredge plume.

Critical review of the data found that the vast majority (80%) of reported backhoe/ grab dredge sediment source term factors were less than 2.3%. The review also found that the published range, particularly source term factors above 2.3%, were influenced by, inter alia:

- Source factors included the dredging of unconsolidated soils with overflow from the barge.
- Source factors were for the proportion of fines fraction <75 µm (Australia/ United States projects) and <63 µm (European projects), rather than proportion of fines fraction -15.6 µm.
- Source factors included hydrodynamic effects and other mobilisation/sediment disturbance sources (e.g. propeller wash from self-propelled barges, spillage from grab buckets and spillage from split hopper barges).

All of the above influences are expected to result in higher range loss factors than would apply to backhoe dredging at the CU Project, taking into account:

- The backhoe dredge methodology for the CU Project has been developed to minimise influence of other dredge sources, including use of watertight flattop barges without overflow that will propelled by tugboat and excavator/ dump truck disposal, with spill covers, at the onshore reclaim.

[4] The unconsolidated material represents material that would be available for resuspension prior to

- The CU Project is concerned with the estimation of fine sediment < 15.6 µm, which would invariably be significantly less than the percentage of particles <75 µm or <63 µm.
- Other factors expected to reduce sediment source term factors at the CU Project including flocculation of fine particles < 15.6 µm to effectively create larger 'lumped' particles[5].
- Organic particles, which are beneficial to the environment, also present in sediments and representing particles that are < 15.6 µm
- Some of the fine sediment disturbed and resuspended by capital dredging activities will re-settle within the capital dredge footprint (and be picked up as capital dredge material), so is not technically 'returned to the environment'.

The source term factor at the CU Project can therefore be expected to be in the low-end range of fine sediment source term factors quoted in literature, and it is considered that:

- a fine sediment source term factor of 3.5% can be considered a reasonable and conservative estimate for the backhoe dredge of unconsolidated soils at the CU Project
- a fine sediment source term factor of 2.5% can be considered a reasonable and conservative estimate for the backhoe dredge of consolidated soils at the CU Project.

Field Validation and Modelling

Most reviewed papers and articles for field validation and modelling of dredge plumes are referenced back to a white paper (VBKO 2003), entitled "Protocol for the Field Measurement of Sediment Release from Dredgers", produced for the VBKO TASS Project by HR Wallingford and Dredging Research Ltd. The protocol was developed by HR Wallingford as a secondary outcome of an industry funded program to develop models to predict the rate of sediment release from various types of dredging plant. The primary study identified issues with varying and inconsistent approaches to the field measurement methods and thus it was an attempt to try and standardise the process.

The protocol espouses a set of 3 basic principles to guide dredge plume monitoring aimed at deriving source rates:

- Measure as much as possible as close as possible to the Practical Source and at varying distances away from it.
- Measurements must be supported by full details of the dredging operation - otherwise they are worthless.
- Measurements will be more reliable if made at open, unobstructed locations with uniform soil conditions and low background sediment concentrations.

Based on the literature review and experience undertaking similar monitoring programs for the Cairns Shipping Development Project and Gladstone Clinton Vessel Interaction Project, the monitoring and modelling approach outlined in Table 32 is proposed for the CU Project.

[5] WAMSI (2016b) note that flocculation (inter-particle attraction of fine sediments which causes aggregation of sediment particles) tends to occur in salt water because cations (positively charged ions) tend to neutralize the repulsive force. WAMSI noted that this was an important factor that is not modelled in sediment transport models and reported that Wolanski et al. (1992) reported flocculation in a density current from dredge offshore spoil dumping in Cleveland Bay.

Up to four validation field trips are proposed at this stage that are representative of the different areas and geotechnical conditions expected to be encountered in the dredge footprint: –

- Validation of the outer harbour dredging (when dredging consolidated and unconsolidated material)
- Validation of the Platypus Channel dredging x2 (when dredging consolidated and unconsolidated material)
- Validation of the Sea Channel dredging (dredging unconsolidated material only)

Table 32. Monitoring Methods Summary Table

Measurement Method	Method of Implementation	Comment on Data Provided
ADCP	This is the primary means of measuring sediment concentration and sediment flux within the plume. ADCP measurements will be taken via a support vessel through the active plume generated by the dredge.	The transect TSS and flux measurements, once properly calibrated, provide a very good description of the extents and intensity of the dredging-related plume.
Optical Sensor	Concurrent optical sensor profile measurements will be undertaken using LISST and OBS instruments. The boat will be stationary during profiling for practical reasons.	These measurements are most useful as a means of calibrating the ADCP acoustic backscatter measurements (they do not have sufficient spatial coverage by themselves to fully characterise the plume). The LISST PSD measurements will also be used to characterise plume particle sizing.
Water Sampling	A large number of water samples will be collected on each of the field trips at a variety of depths and locations using a pump sampler.	These water samples will be analysed for TSS and PSD. The TSS measurements are very important for calibration of the optical sensor measurements (NTU to TSS) and ADCP backscatter.
Tailwater Discharge	Measure tailwater discharge and turbidity during active releases. Collect regular water samples from discharge for calibrating NTU to TSS conversion and analysing PSD.	Due to the single location and controlled nature of tailwater discharge the monitoring should be effective to characterise tailwater discharge quality.
Numerical Hindcast Modelling	The numerical modelling will be used to assess the likely dredge plume source rate by comparing modelled TSS and suspended sediment flux to each measured transect TSS and sediment flux.	The numerical modelling is very useful since it accounts for the plume advection, dispersion and settling that occurs between the point of discharge (the BHD bucket) and the measurement transect. It also accounts for temporal variability of plume generation since the dredging logs are used to estimate how the plume release rate varies with time, and it provides an estimate for the proportion of the measured TSS that is likely to be ambient suspended sediment.

12.3.3 Tailwater Validation

As per Condition WT3 of the State (EA) Conditions, a Tailwater Management validation monitoring program was undertaken to define the spatial extent of the mixing zone for sediments and toxicants associated with reclamation tailwater and to identify and describe any adverse impacts to the receiving water environmental values due to the authorising tailwater release. This validation monitoring was also generally compared to the modelled outputs from the AEIS to assess the suitability of the current tailwater release limits set out in the Environmental Authority for the project. This tailwater validation monitoring program is set out in the CEMP for the works in accordance with the EPBC Condition 10.

12.3.4 Biological Validation

The biological validation monitoring will monitor seagrass and corals as biological indicators of changes to marine ecosystems and to ensure that water quality management measures in the REMP have achieved their intended outcomes in protection of sensitive receptor habitats. Negligible impacts are expected to other ecological receptors (i.e. fish, prawns, mangroves etc.), and for this reason, will not be monitored in the Validation Monitoring Program (VMP).

The aim of the biological validation monitoring programs are to monitor any changes to seagrass meadows and coral community / health during and after capital dredging. These programs will continue as currently programmed and their methods as outlined in Section 12.1.

12.4 Post-Dredge Completion Reporting

Monitoring reports will be provided to relevant approval agencies outlining the results of the above REMP and VMPs in accordance with approval requirements, including the Dredging Completion Report required by Condition 26 of the EPBC Controlled Action approval.

These monitoring reports will generally contain the following:

- The results of all monitoring undertaken and the associated methodologies;
- Whether the expected impacts from the AEIS and previous assessments have been effectively validated;
- Exceedances of set water quality trigger levels including the extent and duration of exceedance and corrective actions implemented;
- An assessment as to whether any sensitive receptors (delineated by type and extent) present outside of the approved dredge footprint:
    - Are likely to have experienced sub-lethal impacts as a result of the action; and/or
    - Have experienced lethal impacts as a result of the action.

In addition to regulatory agencies, these reports will be submitted to ITAC for technical advice.

13 Contingency Plans

As part of its Quality Management System, the Port has established contingency and emergency response plans for a range of emergencies and incidents, including marine and land incidents and natural disasters. Relevant considerations and contingency actions associated with the CU Project are incorporated into these broader Port contingency and emergency response plans. Additionally, a number of the CU Project specific management plans address specific contingency procedures for specific emergencies / incidents where they have been identified as a key requirement. Table 33 details the contingency plans in place for the CU Project.

TABLE 33: CU PROJECT CONTINGENCY PLAN

Contingency	Response	Responsibility	Timeframe
Medical emergency	Implement Contractor's and/or the Port Emergency Response Plan	Dredging and Reclamation Contractor Safety Advisor CU	Immediately
Personnel fall into water	Implement Contractor's and/or the Port Emergency Response Plan	Dredging and Reclamation Contractor Safety Advisor CU	Immediately
Cyclone or other extreme weather event	Implement the Contractor's and/or the Port Cyclone Response Plan which details the Port's authorities and responsibilities for the management of infrastructure, vessels, port users, tenants and personnel during a cyclone or other extreme weather event. This plan establishes clear actions and steps to be taken in the preparation for, response to and recovery from a cyclone event for the Port of Townsville. Specific requirements for the CU Project equipment, including monitoring equipment deployed as part of the project, will be incorporated into this document. In addition, the RHM has established requirements for all vessels in the event of a cyclone that will be applicable to any construction and reclamation vessels.	Dredging and Reclamation Contractor Principal's Site Representative for Dredging and Reclamation Works	As detailed in the cyclone readiness chart
Breach in reclamation structure	Implement CU Reclamation Integrity Management Plan	Principal's Site Representative for Dredging and Reclamation Works	Immediately

Contingency	Response	Responsibility	Timeframe
Securing of water management systems in the event of extreme (severe) weather forecast	Implementation of the CU Tailwater Management Plan and the Stormwater and Erosion Control Plan; including preparatory maintenance of management systems and drains prior to wet season commencement, Water management systems (bunds, stormwater drains) will be fit for purpose designed to withstand moderate weather conditions.	Dredging and Reclamation Contractor Principal's Site Representative for Dredging and Reclamation Works	Prior to extreme (severe) weather (where possible)
Equipment falls into water	Implement Safe Work Methods as detailed in Project specific Safe Work Method Statements for rockwall construction/ reclamation activities.	Dredging and Reclamation Contractor	Immediately
Uncontrolled tailwater release	Implement mitigation actions in Tailwater Management Plan	Dredging and Reclamation Contractor Manager Environment CU	Immediately
Marine megafauna incident	In all situations, should a marine megafauna interaction or incident occur, the activity will be ceased while the animal and its injuries are assessed. Where it is safe to do, reasonable efforts will be made by the construction and reclamation crews to assist any marine megafauna following any incident. An incident report will be completed, with corrective actions to be considered and implemented, to minimise the risk of the incident being repeated. All interactions will be recorded and reported immediately.	Dredging and Reclamation Contractor Principal's Site Representative for Dredging and Reclamation Works Manager Environment CU	Immediately

Contingency	Response	Responsibility	Timeframe
Non-CU Project related impacts on MNES (Given the length of this project, it is possible an environmental incident or impact on MNES could occur that is not directly associated with the project activities (i.e. megafauna mortality, seagrass dieback from a cyclone event etc)	In the event of such a non-project related incident, the Port will discuss these impacts within the core and project teams, with the Port ITAC and other relevant parties (i.e. monitoring contractors) to review known information of the cause and extent of the incident and impact. As part of the adaptive management of the project, consideration will be made of any relevant modifications that could be made to the project activities which may assist in minimising the pressure on and providing significant improvement to the recovery and response of the relevant MNES. Any changes to the project activities to address non-project impacts will have a financial or program impact to the project. Should such changes be proposed, the Port will engage with the relevant regulators prior to making changes to discuss the proposed changes and the likely benefits to be achieved.	Port Environmental & Planning Team	To be determined according to the nature of the incident / impact

14 Audit, Review, Reporting and Consultation

14.1 Environmental Auditing

Environmental audits of the dredging and placement activities of the CU Project will be scheduled and conducted in accordance with the Port of Townsville's environmental management system (EMS) requirements. The audit's objectives will be to verify compliance with this DMP and applicable environmental permits and approvals. Auditing will occur annually, with specific aspects of the project to be audited as required in response to specific risks, or incidents of concerns being identified. Audits will be undertaken within the Port's Quality Management Framework.

Audits of the requirements of the DMP (including legislative changes) will be undertaken by a suitably qualified or experienced person. This is to ensure that the measures, responsibilities, and corrective actions remain achievable, effective and suitable to the construction activities at all times.

Records of on-going site monitoring, inspections etc. will be maintained for review by regulators. Permanent records will be kept on-site and updated regularly, to enable audit/review.

14.2 DMP Review

The DMP is a living document which is subject to regular reviews (at least annually) for continuous improvement to ensure the plan remains relevant and achieves the required objectives, integrates any emerging/changing environmental risks and/or mitigation measures.

Review of this DMP was undertaken by the Port after the commencement of dredging in the Platypus Channel as an Initial Performance Review, to align with model validation and inform further discussions with ITAC.

Ongoing reviews occur:

- Every 12 months in line with the anniversary date in association with the Annual Compliance Reporting function; and
- Active DMP review in the event of a reportable incident (as per section 11 elements of risk).

Other triggers for DMP review may include:

- Changes to organisational structure, roles and responsibilities;
- Changes in environmental legislation and/or policies;
- New technologies / innovation relevant to applied methods and mitigation measures that provide innovative means of executing activities in order to meet performance criteria;
- Extreme weather events, including cyclones, that may change the 'baseline' context for the DMP (e.g. damage to condition of seagrass and coral communities).

There have been actions required from two DMP reviews, with an updated version submitted 5 months after dredging to align with port organisation structure and incorporate changes to the DIAT process, and this review. This review is primarily to incorporate the Eastern Entrance widening and capture any changes in programs as a result.

The DMP review will be conducted by the CU Environment Manager and/or Environment Advisor. Changes to the DMP may be developed and implemented in consultation with relevant regulators, ITAC and other

stakeholders over time, with any changes to the REMP and/or contingency measures in the DMP to be endorsed by the ITAC.

If the revised DMP meets Condition 38 of EPBC Approval No. 2011/5979, the Port will notify DCCEEW in writing and provided with an electronic copy of the revised plan. Otherwise, the revised DMP will be submitted to the Minister for approval (and to DES for awareness).

14.2.1 Independent Peer Review of the DMP

In accordance with Condition 31 of EPBC Approval No. 2011/5979, the DMP was peer reviewed by Dr Rick Morton of Rick Morton Consulting before submission to the Minister for approval. This review includes 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 (Condition 31). The DMP was also reviewed by the ITAC for the suitability of limits and triggers, and the DMP to protect environmental values.

A copy of all advice and recommendations made by the independent peer reviewer and ITAC, including how the Port has addressed these recommendations will be provided to the Minister in line with the Condition 33.

14.3 Annual Reports

As required in legislative conditions, an annual report will be produced by the Environmental Advisors CU within three months of every 12 month anniversary of commencement of the action on 4 March 2020. The report will detail the Compliance with the conditions of the EPBC Approval 2011/5979 including an overview of environmental incidents, complaints or impacts related to MNES, and corrective actions as needed, noting exception reporting occurs throughout the year. Copies of this annual report(s) will be kept on-site, will be published on the CU Project website in accordance with Condition 36 of EPBC Approval No. 2011/5979 and will be available for regulatory inspection. The link to the annual reports on the Port's website will be made available to each determining authority.

The Port will report to DCCEEW (or successor agency) any exceedance of performance criteria, along with the implemented risk management, adaptive management strategies, corrective actions or emergency response measures, within 21 days of an exceedance or action/response.

14.4 Records

During construction activities in the marine environment, records relevant to the MEMP will be maintained as objective evidence of compliance with environmental requirements. All records will be maintained according to the Port's Record Keeping Procedures or as required by the legislative conditions. All DMP records will be retained electronically, including but not limited to:

a) Induction and any specific environmental training records;

b) DMP reviews and version control;

c) Monitoring data sheets, calibration records, results and internal and external environmental reports; and

d) Environmental incidents, complaints and non-conformance and corrective action reports.

Records will allow auditing and encourage the use of preventative action, as well as corrective action following any non-conformances or early warning triggers. Records will be made available to the regulators as requested.

14.5 Community and Stakeholder Engagement

A Community and Stakeholder Engagement Plan (CSEP) has been developed which details the engagement methods which will be used during the CU Project. This document is published on the Port's website (https://www.townsville-port.com.au/projects-development/channel-upgrade/management-monitoring-plans/). Consultation on the implementation of the DMP has been undertaken through the mechanisms established in the CSEP, including working with Traditional Owner Groups, and holding Public ITAC information sessions, etc.

General contact details for the CU Project are:

Telephone: 1800 531 561

Email: cugeneral@townsvilleport.com.au.

Address: PO Box 1031, Townsville QLD 4810

Contact can also be made electronically via the Port's website "Contact Us" page (https://www.townsville-port.com.au/contact/).

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POTL Channel Upgrade Project Dredge Plume Dispersion Modelling; Reference: R.B23781.001.03.POTL_PEP_Dredge_Plume_Modelling.docx; Date: January 2021

Appendix 1

Extract from Pot 442 – Risk Management Guidelines

Qualitative Measures of Consequence or Impact

Rank		Operations (Trade)	Financial Loss	Asset Loss	Interruption to Services	Reputation, Image & Political Implications	Performance	Criminal Penalty	Information Security	Safety	Health	ENVIRONMENT	
												Nature & Extent of Potential / Actual Environmental Harm	Frequency, Intensity, Duration, Offensiveness of Activity
1	Insignificant	Insignificant impacts on operations and trade. No navigation closure. Insignificant delays.	$0 - $50K	Little or no impact on assets	< ½ day	Unsubstantiated, low impact, low profile or no news items. No political implications.	Up to 5% variation to KPI	Pecuniary	Can be dealt with by routine operations.	Minor temporary – irritation, first aid treatment required.	Reversible health effects of concern.	Environmental Nuisance resulting in insignificant impacts on the natural receiving environment, plants and/or wildlife. No impact on community or business.	Low frequency / intensity / duration activity (days). No substantiated offensive amenity impacts on surrounding area.
2	Minor	Minor impact on operations and trade. No navigation closure but minor revenue loss due to loading or unloading delays.	$50K - $500K	Minor loss or damage to assets	½ - 1 day	Substantiated, low impact, low news profile. Minor political implications resulting in minor local media attention.	5 -10% variation to KPI	Pecuniary	May threaten the efficiency or effectiveness of some aspect of the infrastructure but would be dealt with internally.	Minor temporary – medical treatment required.	Severe reversible health effects of concern.	Environmental Nuisance resulting in minor adverse impacts on or unreasonable interference with the natural receiving environment, plants and/or wildlife, but noticeable effect on amenity. Minimal impact on community or businesses.	Minor frequency / intensity / duration activity carried out during normal operating hours over a short term (weeks). Minor amenity impacts experienced within surrounding area with potential to trigger complaints.
3	Serious	Temporary navigation closure or prolonged restriction of navigation.	$500K - $5m	Major damage to assets	1 day – 1 week	Substantiated, public embarrassment, moderate impact, moderate (local) media attention. Political implications resulting in directions given by the shareholding Ministers.	10-25% variation to KPI	Imprisonment	Would not threaten the infrastructure but would mean that the program could be subject to significant review or changed ways of operating.	Major permanent – loss of body part or function.	Short term health problems or irreversible health effects of concern.	Actual or potential Material Environmental Harm resulting in noticeable adverse or unreasonable impact on the natural environment, plants and/or wildlife within surrounding area. Noticeable impact on community or businesses.	Medium frequency / intensity / duration activity carried out for a significant period of time on most days or over a period of months. Adverse amenity impacts on community giving rise to multiple/sustained substantiated complaints.
4	Major	Temporary closure of a navigation channel affecting movements to the port for several days. Ensuing loss of trade.	$5m - $10m	Significant loss of assets	1 week – 1 month	Substantiated, public embarrassment, high impact, high (local and national) news profile, third party actions. Political implications resulting in state/ national inquiry.	25-50% variation to KPI	Imprisonment	May threaten the survival or continued effective functioning of the infrastructure or project and require top-level management intervention.	Major permanent– single fatality, total blindness, quadriplegia.	Health impacts, long term/chronic health problems or life threatening or disabling illness.	Material Environmental Harm resulting in significant adverse or unreasonable impact on the natural receiving environment, plants and/or wildlife over an extensive area as a result of the duration or magnitude or nature of impact. Extended disruption/impact to community or businesses. Potential exists to remedy the impact if the activity is ceased or impact is reversible.	High frequency / intensity / duration activity carried out during most hours of the day or impact is long term (years). Significant adverse impacts on community.
5	Catastrophic	Port closes, navigation seriously disrupted for an extended period. Serious and long term loss of trade.	>$10m	Complete loss of assets	> 1 month	Substantiated, public embarrassment, very high multiple impacts, high widespread (national and international) news profile, third party actions. Political implications resulting in state/ national inquiry. Significant national and worldwide attention from governments and media condemning activity.	>50% variation to KPI	Imprisonment	May threaten the survival of not only the infrastructure but also the business, possibly causing major problems for clients.	Multiple fatalities	Long term, permanent or irreversible health problems. Chronic health affects too many people.	Serious Environmental Harm resulting in irreversible, high or widespread adverse impact on the natural receiving environment/high conservation or special significance area. Severe and protracted disruption/impact to community or businesses. Irreversible loss of amenity experienced.	Permanent high frequency / intensity / duration activity carried out 24/7. Serious adverse impacts on community.

Qualitative Measure of Likelihood

Level	Descriptor	Description	Ongoing Activities	Projects
1	Rare	May only occur in exceptional circumstances	Unlikely in the life of the facility	0.1% chance
2	Unlikely	Could occur at some time	Once in 20 years	1% chance
3	Possible	Might occur at some time	Once in 5 years	10% chance
4	Likely	Will probably occur in most circumstances	Once per year	50% chance
5	Almost Certain	Expected to occur in most circumstances	Many times per year, continuous	99% chance

Risk Evaluation Factors

	Consequence	Insignificant	Minor	Serious	Major	Catastrophic
Likelihood	***Score***	***1***	***2***	***3***	***4***	***5***
Rare	***1***	**L** ***1***	**L** ***2***	**L** ***3***	**L** ***4***	**M** ***5***
Unlikely	***2***	**L** ***2***	**L** ***4***	**M** ***6***	**M** ***8***	**S** ***10***
Possible	***3***	**L** ***3***	**M** ***6***	**M** ***9***	**S** ***12***	**H** ***15***
Likely	***4***	**L** ***4***	**M** ***8***	**S** ***12***	**H** ***16***	**E** ***20***
Almost Certain	***5***	**M** ***5***	**S** ***10***	**H** ***15***	**E** ***20***	**E** ***25***

L = Low M = Medium S = Serious H = High E = Extreme

Appendix 2

Summary of project specific management controls, performance criteria, early warning triggers and corrective actions relevant to MNES for capital dredging activities.

Objective	Performance Criteria	Controls	Performance Indicators	Early-warning trigger levels	Corrective Actions
To avoid or minimise impacts to MNES by preventing or minimising impacts from capital dredging activities	No injury or fatality to marine megafauna as a result of capital dredging related activities	Ensure suitably trained Marine Fauna Observers for are on board all dredge related vessels to undertake visual observation of marine megafauna around each vessel. Conduct daily pre-start checks, or pre-start checks following breaks or changed activities, for marine fauna in the nominated observation zone prior works commencing Maintain active awareness of marine megafauna throughout daily activities, including within the exclusion zones. Cease all dredge related activities if marine megafauna enter the deemed exclusion zones to avoid injury or loss of megafauna. Works do not commence until the marine megafauna has exited the exclusion zone, or a period of 30 minutes has elapsed **since** the last sighting of the animal in the exclusion zone.	Marine megafauna exclusions zones are implemented for the duration of capital dredging related activities. 100% of personnel undertaking marine megafauna observations are suitably trained. Construction works are ceased on 100% of occasions when marine megafauna are observed within the relevant exclusion zones. Site based inspections/audits of marine megafauna observers do not identified any significant non-conformances. Daily megafauna logs maintained by fauna observers. Daily megafauna logs audited by the Port regularly. No complaints received in relation capital dredge related impacts on marine megafauna. No marine megafauna stranding reports associated with capital dredge related activities. Protocol followed to remove individuals safely if entrapment occurs.	Change in site personnel involved in activities that require marine megafauna observation. Daily megafauna logs missing or not present for all days of operation. Non-conformance identified from audits relating to marine megafauna observation. Abrupt changes / decreases in recorded stop works frequency. Any reported marine megafauna stranding or deaths in Cleveland Bay. Any injured marine megafauna seen in the vicinity of capital dredge related vessels. Annual results of CU megafauna monitoring programs (i.e. Inshore Dolphins, Shorebirds etc).	All megafauna observers undergo refresher training. Review of onboarding process / training matrix for new employees. Number of megafauna observation audits increased to ensure no further non-conformances. Attend Toolbox meetings with construction contractors. Escalation through contractual process if consecutive CAR raised relating to marine megafauna observation. Engagement of relevant marine megafauna experts to review best approach to removing trapped megafauna.
	No significant long-term behavioural impacts to marine megafauna from construction activities.	Suitably trained Marine Megafauna Observers undertake visual observation of marine megafauna around active construction fronts and vessel movements. Activity ceased for dredging construction activities if marine megafauna enter the	100% of personnel undertaking marine megafauna observations are suitably trained. Dredging works are ceased on 100% of occasions when marine megafauna are observed within the relevant exclusion zone.	Rockwall Construction works, dredging or Piling do not cease when marine megafauna are observed in the exclusion zone. Any change in dolphin behaviour and/or reduced presence in known habitat areas.	Confirm reasons for decreasing trend, additional survey is necessary. Number of megafauna observation audits increased to ensure no further non-conformances. Consultation with ITAC / Department.

		exclusion zones as specified in the MEMP (POT 2135). Works do not commence until the marine megafauna has exited the exclusion zone, or a period of 30 minutes has elapsed since the last sighting of the animal in the exclusion zone Consider noise mitigation when operating construction plant and equipment. Active awareness maintained of marine megafauna throughout daily construction activities, including within the exclusion zone.	Audits of marine megafauna observers and pile driving procedure do not identify any non-conformances. Daily megafauna logs maintained by marine megafauna observers. Daily megafauna logs audited by the Port regularly.	Any reduction in the sightings of marine megafauna (turtles, dolphins) in Cleveland Bay. Annual results of CU megafauna monitoring programs (i.e. Inshore Dolphins).	
	All capital dredge works are kept within the boundary of the approved footprint.	Capital dredge footprint restricted to location and size as per EPBC Act approval 2011-5979. Capital dredge works will be spatially/cadastral surveyed to ensure works remain within the approved footprint.	100% of capital dredging is kept within the boundary of the approved area. The dredge has up to date geo referenced surveys of the capital dredge footprint	dredge quantities not matching those expected. Routine on site audits identifies a potential deviation in dredge area alignment Contractor Toolbox meetings identifies concerns with dredging methodologies.	Revisit the dredging methodology. Increase frequency of surveys. Escalation through contractual process.
	Release of emissions including waste, light, noise and hazardous materials are avoided or minimised. Where discharge-related impacts to MNES are detected, they are reported in a timely manner to facilitate and inform appropriate responsive action.	Only project required material is bought/retained onsite/onboard capital dredge related vessels. All bins are fitted with secure lids to prevent waste material being blown into the marine environment during storage or handling. Storage areas include appropriate bunding to contain spillages in accordance with applicable standards and are covered to prevent rain/wave/swell spray infiltration. Site specific emergency response procedures and equipment (spill boom).	Inspections of waste storage containers result in 100% compliance with industry standards. Inspections of on-site facilities result in 100% compliance of correct waste storage, handling, disposal and transporting standards. 100% of fuel/chemical storage and hazardous material handling is compliant with appropriate standards. All spills reported and adequately contained and promptly cleaned up. No direct residual impacts to sensitive receptors, including marine megafauna as a	Any reported marine megafauna stranding or deaths in Cleveland Bay. Any injured marine megafauna in the vicinity of capital dredging construction activities Any reduction in the sightings of Marine megafauna (turtles, dolphins) in Cleveland Bay. Multiple minor spills occur on site. Reports of grease balls are reported washing up on surrounding beaches.	Review onboard management practices and DMP Maintain and repair any damage to storage areas and/or bunds promptly. Investigate any incidents relating to hazardous materials and/or fuel bunkering and undertake appropriate corrective or remedial actions, as required to render the area safe and avoid or minimise environmental harm. Review procedures if procedures breakdown or a spill occurs and train staff about appropriate responses.

		Fuel / chemical storage is kept in a secure area, and bunded to prevent spills.	result of light emissions from dredging related activities; as measured through the MEMP (POT 2135) monitoring programs.	Non-conformances with on-site storage arrangements have been identified in inspections/audits. Contractor toolbox meetings identifies waste management / storage issues or concerns. Annual results of CU megafauna monitoring programs (i.e. Inshore Dolphins, Shorebirds etc).	Investigate any incidents or complaints relating to emission impacts from the dredging activity and undertake appropriate corrective or remedial actions. Review and modify plant, equipment, vessel movement practices where noise, air or light issues have been identified.
	Risks to MNES that may result from the effects of extreme weather events on capital dredge related activities are identified. Identified risks are assessed and managed where reasonable and practicable. Where risks are realised, impacts to MNES are reported in a timely manner to facilitate appropriate responsive action.	Implement the Port's Cyclone Response Plan. Implement Contractor and Port Cyclone plans which includes ceasing operation of capital dredging activities, and relocation of equipment to the contractor's designated safe location in the event of extreme weather conditions (e.g. cyclone). Where possible, schedule capital dredging activities within the Sea Channel to be undertaken in dry seasons where risk of severe weather conditions are reduced. Operate all capital dredge related vessels within their standard safe work conditions (for safe sea condition operations).	Conduct monitoring and observation of weather conditions and alerts relevant to the area, including extreme weather events. The Port's and Contractor's Cyclone emergency response procedures are implementation fully; and 100% of CU Project related actions completed as designated (i.e. Condition Green – 1 November). The Port's and Contractor's Cyclone emergency response procedures are implementation fully; and 100% of CU Project related actions completed as designated (i.e. Condition Yellow – Intensifying risk of cyclone).	Monitor the Bureau of Meteorology Tropical Cyclone for warning. Project contractors do not enact cyclone response actions as per the cyclone procedures. Monitor the Townsville Regional Harbour Master, and Local Disaster Management Group alerts for disaster alert activation. Capital dredging program deviates from works schedule	Revisit capital dredge timeframes and planning should dredge related impacts occur as a result of extreme weather events. Revise capital dredge sequence dredge related impacts occur as a result of extreme weather events. Review the Cyclone Response Plans Attend Construction Toolbox meetings for Learning Moments and Improvements. Engage ITAC for advice and response actions should dredge related impacts occur from extreme weather events.
To avoid or minimise impacts to MNES from capital dredge related marine water quality impacts	Identify and report natural/ non-project related impacts to MNES from extreme weather events (e.g. flood impacts, bleaching events).	Fully implement the scientifically robust monitoring programs for key aspects (seagrass, coral and marine water), including the use of baseline and reference site. Regular reporting from monitoring programs ITAC to review and provide advice on data from monitoring programs and ITAC members expert knowledge	100% of instances are communicated / referred to ITAC. 100% of monitoring programs undertaken. 100% of Green Trigger Alerts are responded to, and reported to the DIAT. 100% of Amber and Red Trigger Alerts are investigated and responded to by the DIAT	GBRMPA water quality data indicate change (including predicting a bleaching event); Reef Outlook report identifies local or regional shifts; Healthy Reef updates identify concerns; Any reported marine megafauna stranding or deaths in Cleveland Bay.	On advice from the ITAC: • Undertake additional or reactive Monitoring, • Review Trigger Levels, • Review monitoring plans, On advice from the DIAT: • Relocation of dredging to another part of the dredge footprint • Reduce dredging frequency • Opportunistically scheduling maintenance shutdown days • Installing sentinel monitoring sites

		Regular (minimum daily) monitoring of the water quality dashboard for trigger alerts, trends, spikes in data etc. Dredge Inference Assessment Team (DIAT) meets within the required timeframe after an Amber of Red Alert has been recorded.	Dredging activities follow the requirements of the DIAT within the required timeframes to prevent impacts to sensitive receptors and MNES	Any injured marine megafauna in the vicinity of dredging related vessels or activities. ITAC Specialist identifies changes in their specialised field; Routine environmental monitoring programs of Seagrass and Coral indicate natural change since previous surveys	• Temporarily suspend dredging • A combination of any or all of the above Report findings to the relevant Departments.
	No marine water contamination from vessel accidents, oil spills or leaks on-board or from any capital dredge related vessels.	Maintain an appropriate spill kit, personal protective equipment and relevant operator instructions / emergency procedures for the management of hazardous materials, fuel and chemicals are on all vessels. Spills response procedures are in place and implemented. Spill response drills are undertaken regularly. Conduct plant and equipment maintenance and refuelling only in designated areas. Fuel / chemical storage is kept in a secure area and bunded on board vessels to prevent spills. Contractors to establish and implement a bunkering procedure in compliance with Port and MSQ requirements.	Vessel inspections result in 100% compliance of hazardous waste storage containers meeting industry standards. Vessel inspections result in 100% compliance for fuel transferring and equipment meeting industry standards. All spills are self-reported to the Port, and effectively contained and cleaned up in a timely manner.	Non-conformances with on-site storage arrangements have been identified. Non-conformances with fuel transferring equipment and procedure are identified. Small volume spills or spills that do not reach marine water occur on multiple occasions.	Improvement in Management practices (bunkering procedures~~,~~ chemical storage). Maintain and repair any damage to storage areas and/or bunds promptly. Review fuelling practices and rectify immediately if an unintentional release or spill occurs. Attend Toolbox meetings with contractors. Increase frequency of audits undertaken on vessels to ensure no further non-conformances. Review procedures if procedures breakdown or a spill occurs and train staff about appropriate responses.