Northern Australia's Transport Link to the World

PORT of TOWNSVILLE

Port of Townsville Limited

Cleveland Bay Marine Water Quality (Turbidity & Available Light) Monitoring Plan

POT 1791

REVISION 1

Document Control Sheet

Revision history

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1	04/11/2019	Reformatting and updates to references etc.
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3		
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5		

CONTENTS

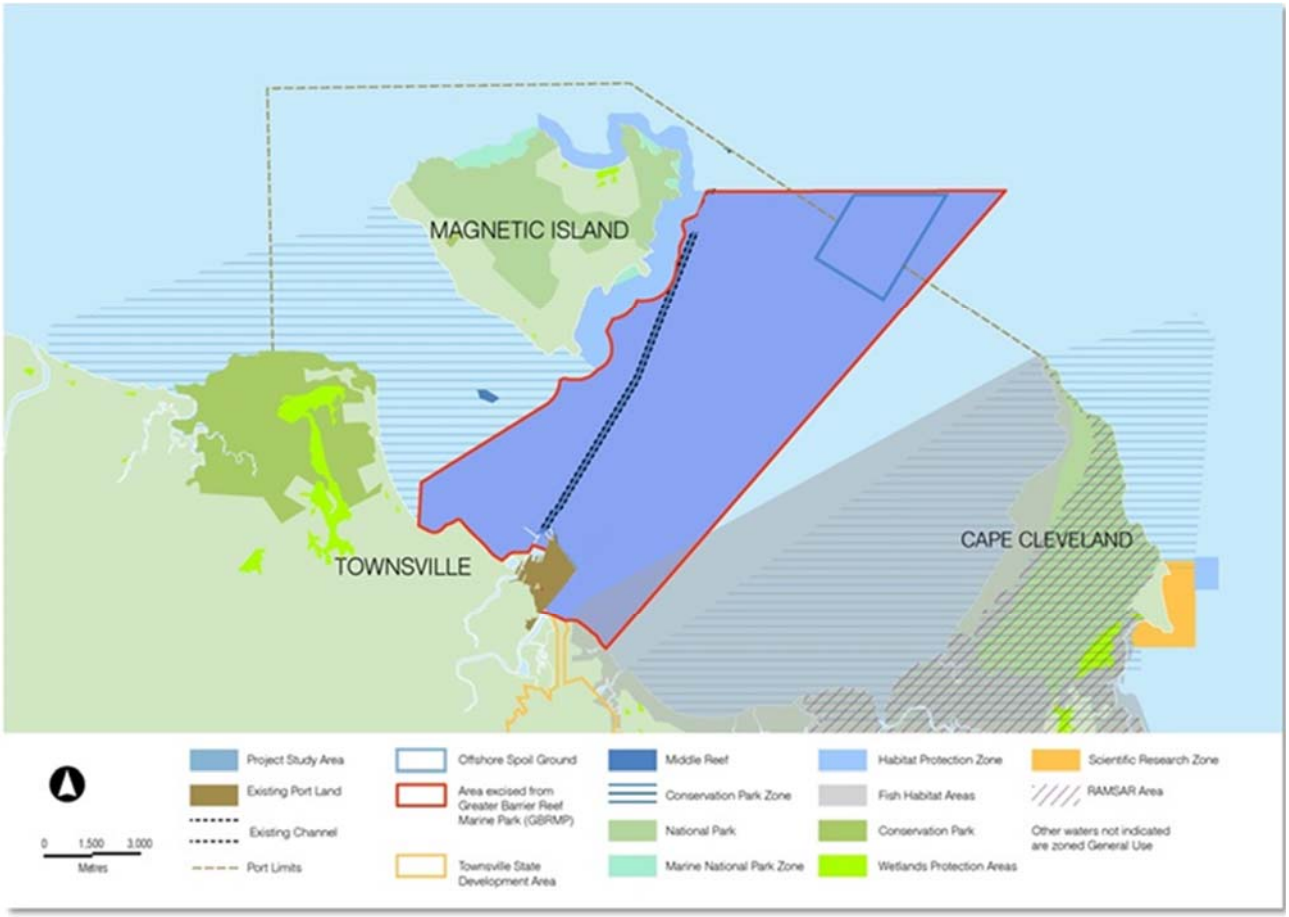
Tables

Figures

1 INTRODUCTION

Port of Townsville Limited (POTL) administers the Ports of Townsville and Lucinda. The Port of Townsville (19°15'S, 146°50'E) is a general-purpose cargo port situated in the centre of the growing city of Townsville, the leading population centre in tropical North Queensland (NQ). The port is located in the southwest of Cleveland Bay, in between the mouths of Ross River and Ross Creek, within an environmentally sensitive area of the coastline in close proximity to mangrove habitats, ecologically important seagrass beds, wetlands as well as fringing coral reefs and residential areas (Figure 1). It has a land and sea jurisdiction in excess of 450 km^2 and the sea jurisdiction encompasses the Great Barrier Reef World Heritage Area, which is also a national heritage place. The port and its marine infrastructure are located within an exclusion area from the Central region of the Commonwealth Great Barrier Reef Marine Park and the State Great Barrier Reef Coast Marine Park (Figure 1).

Figure 1: Coastal Habitats in Cleveland Bay



Due to the potential of port activities to impact on sensitive receiving environments, POTL has a strategic long-term approach to environmental management and conducts a number of monitoring programs to ensure POTL meets both its statutory responsibilities and corporate objectives.

2 SEDIMENT AND TURBIDITY IN CLEVELAND BAY

Cleveland Bay is a north facing bay, bounded to the east and west by Cape Cleveland and Cape Pallarenda respectively, which are approximately 26 km apart. The bay is naturally broad and shallow and is a naturally turbid water body enhanced by significant sediment loads received from the surrounding catchments which maintains significant sediment mobility through natural re-suspension. Research into turbidity and sediment movement within Cleveland Bay has been undertaken by a range of different research groups.

A number of rivers directly feed into Cleveland Bay, including Ross River, which has a number of weirs to control flow and Alligator Creek, which drains a mangrove and mud flat dominated area of coast. Both of these systems are dominated by high-flow events associated with summer monsoon rainfall flows with very low movement during the dry season. Ross River drains an urban area with some sand mining in the upper part of the catchment so, during flood events, significant amounts of fine material can be transported out into the Bay. Approximately 80 kilometres to the south of the Bay is the Burdekin River, one of the major North Queensland rivers, with a catchment area greater than 130 000km^2. Determining the impacts of the Burdekin River on Cleveland Bay is still evolving scientifically, however it is recognised as the largest sediment contributor to the central Great Barrier Reef Region (State of Queensland, 2018). The sediment with Cleveland Bay is mostly fine muds and it is estimated that the Bay is a net accumulator of sediment in non-cyclone years and that import rates are 150-170% of current export rates.

The majority of turbidity studies in Cleveland Bay and the general region, indicate that for dry season periods, most turbidity is related to re-suspension of existing material. Sediment material in deeper waters (below 20m) tends to not re-suspend, except under exceptional conditions such as storms, cyclones etc. This means that most re-suspension is a local within-Bay phenomenon, whereby local in-situ sediment is put back into the water column. While there will be turbidity from processes transporting sediment through the Bay, most upper water column turbidity is a result of local wave and wind driven re-suspension. A previous review undertaken by Orpin *et al.* (2004) examined historical wind records to determine how often events would occur that were strong enough to cause in-situ re-suspension. They found that at 5m depth, conditions favourable to in-situ sediment re-suspension occurred on average 220 days per year; while at 10m depth, it was 110 days per year; and at 15m depth, 40 days per year. The shallow areas of Cleveland Bay therefore experience conditions favourable to re-suspension for a significant part of the year with in-situ sediment re-suspension a “normal” dry-season phenomenon.

While sediment re-suspension may be the main and consistent source of turbidity in Cleveland Bay during the dry season, it is influenced by small scale localised factors and therefore is not uniform across the Bay. Similar geographic, sedimentary and hydrodynamic conditions may result in different turbidity conditions. Previous analysis of the available turbidity data for Cleveland Bay has shown a 10-fold difference in the 50 percentile turbidity value for sites within the Bay, indicating a high degree of localised variability driven by infrequent, localised, high turbidly events.

Many organisms require light for photosynthesis including two of the main biodiversity groups in Cleveland Bay – seagrasses and corals. Changes in turbidity can result in altered light conditions, which in turn can lead to a range of impacts. The amount of available light therefore is a major determinant for the health of many of the benthic communities in Cleveland Bay.

3 PROGRAM SCOPE

In order to maintain navigable depths in port infrastructure, maintenance dredging is regularly undertaken at the Port of Townsville and maintenance dredge material is placed at the approved Dredge Material Placement Area located between Cape Cleveland and Magnetic Island (Figure 1). Maintenance dredging and dredge material placement activities can impact turbidity levels and light availability and there are a number of sensitive areas within close proximity to both the dredge areas (Platypus Channel and/or Sea Channel) and the Dredge Material Placement Area.

Since November 2004, POTL has conducted a long-term marine water monitoring program at the Port of Townsville, primarily to characterise marine water in the environment within and surrounding the port; to ensure a high standard of environmental protection; and to meet relevant approval requirements and conditions. This program monitors the ambient marine water within and in the vicinity of the operational areas of the Port of Townsville in Cleveland Bay (refer to POT 1569 Marine Water Monitoring Plan for further details). It is not designed to monitor maintenance dredging and dredge material placement activities.

The Cleveland Bay Marine Water Quality monitoring program was therefore designed to understand the variations in turbidity and light levels within the Bay at sites known to contain seagrasses and/or corals and to assist with interpreting the impact of maintenance dredging and dredge material placement by POTL. This program originally commenced in September 2014, with equipment retrieval occurring in August 2017 and redeployment in November 2017.

3.1 Objectives

This program measures turbidity (via optical backscatter), underwater light, conductivity, depth and temperature at key sensitive receptor sites (coral and seagrass communities) within Cleveland Bay. The monitoring results are used to develop baseline values for key water quality parameters and to document changes in turbidity/light in relation to prevailing environmental conditions and dredging operations. It is designed to:

- Provide measures of turbidity and photosynthetically active radiation (PAR) using industry standard techniques at five locations that contain seagrass and/or coral situated near dredging and dredge material placement operations;
- Deliver data to understand the relationship between natural environmental forcing factors, such as waves and wind, and localised turbidity as compared with maintenance dredging factors;
- Deliver data to assist in the development of various trigger or environmental targets when combined with information from other related studies; and
- Consider relationships between the three turbidity related parameters – backscatter via the nephelometer, Total Suspended Solids (TSS) via water samples and light as PAR.

3.2 Equipment and Methodology

At each location, a site with a water depth of at least 3m below LAT has been selected to house a bottom frame (these are located close to the dominant benthic community, but in a location that provides easy access for servicing and limits damage to the sensitive receptors). Attached to each frame is:

- A nephelometer giving readings in Nephelometric Turbidity Units (NTU);
- A multi-spectral light sensor, which provides a measurement of underwater light as PAR;
- A CTD (conductivity (salinity), temperature and depth) sensor;
- A logger which measures dissolved oxygen and pH; and
- A deposition logger which measure sedimentation.

All equipment is serviced on a monthly basis at which time water samples are collected for analysis of Total Suspended Solids (TSS). Sampling is undertaken in accordance with the requirements of the Monitoring and Sampling Manual (2018) and is analysed by a National Association of Testing Authorities (NATA) accredited laboratory.

In addition, a Secchi disk is deployed at each location prior to the commencement of monthly service activities. Results from these disks are photographed and time-stamped. Occasionally, a small time-lapse camera will be mounted at some sites to give a visual indication of water clarity. The camera field of view will include the turbidity instrument so that any anomalous turbidity events can be assessed from the camera images.

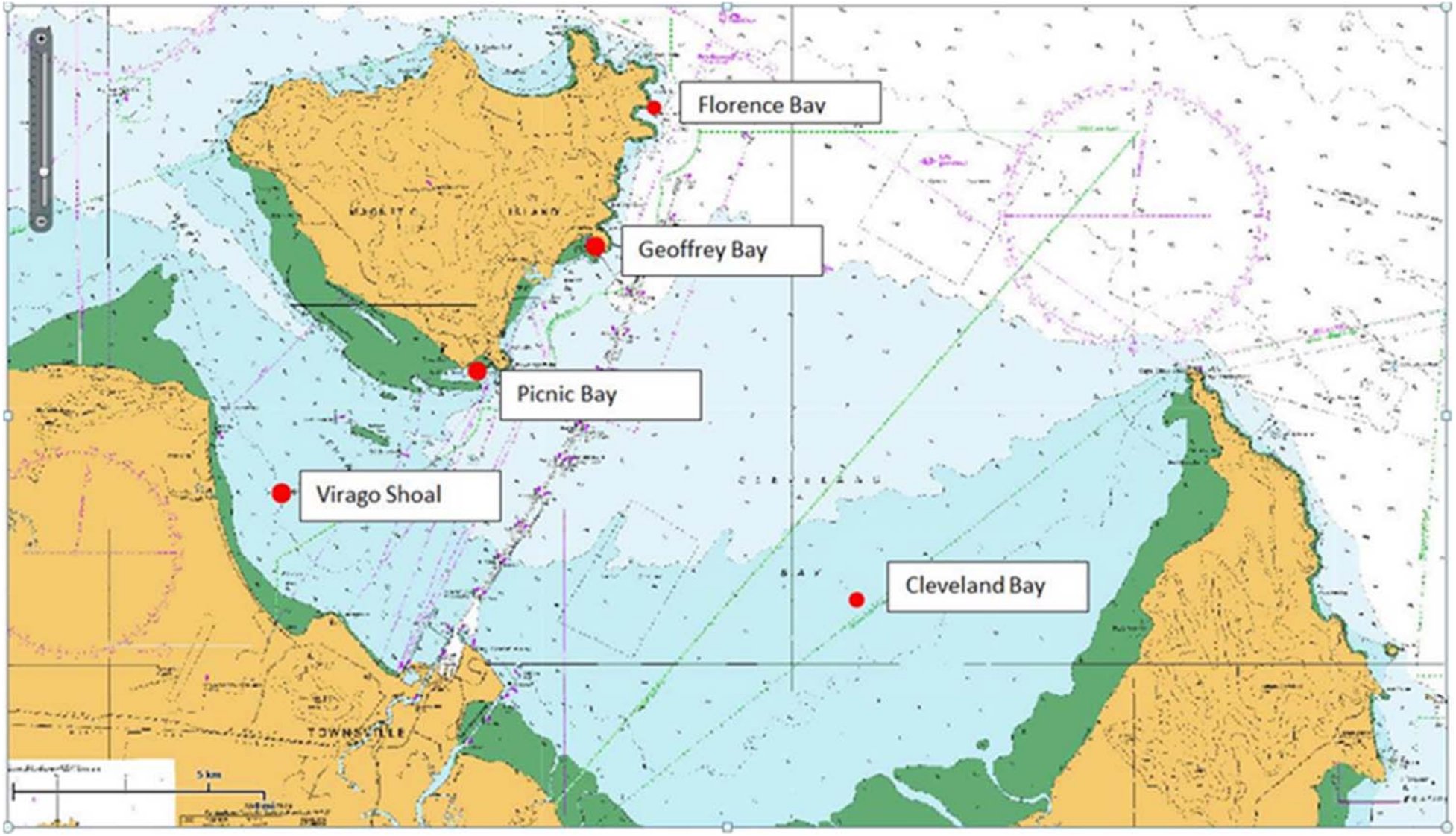
3.3 Monitoring Locations

A total of 5 monitoring locations at key sensitive receptor areas within the Bay have been selected for this program (Figure 2). Three locations represent known coral and seagrass habitats located in near-shore reefal areas along Magnetic Island. The two remaining locations are situated where coral and/or seagrass beds are known to be present within the Bay. Details of the locations, including GPS co-ordinates, are included in Table 1.

Table 1: Cleveland Bay Monitoring Locations

Location	Location Coordinates		Sensitive Receptor	Marine Park Zone
	Easting	Northing		
Picnic Bay	483050	7878552	Coral and Seagrass	Conservation Park
Geoffrey Bay	486151	7882029	Coral and Seagrass	Marine National Park
Florence Bay	487628	7885737	Coral and Seagrass	Marine National Park
Virago Shoal	478181	7875563	Coral and Seagrass	Conservation Park
Cleveland Bay	494679	7874100	Seagrass	General Use

Figure 2: Cleveland Bay Monitoring Locations



3.4 Frequency and Timing

The real-time water quality instruments are deployed all year round, unless they need to be removed in natural events (e.g. cyclones) or require equipment maintenance. All instruments record data every 10 minutes, except for the deposition logger which records data every 2 hours. This corresponds to the timing of the weather data from the weather stations in Cleveland Bay. As many high turbidity events are short lived, obtaining a high temporal resolution dataset over these events can help link the observations to causation parameters.

Regular monthly servicing and calibration is conducted to retrieve data and maintain optimal instrument performance. Generally, this is planned to occur early in the month, but this is highly dependent upon prevailing weather and tidal conditions.

3.5 Parameters

Table 2 lists the parameters monitored in this program and the associated methodology.

Table 2: Marine Water Parameters

Parameter	Relevance	Method
Turbidity	indicates suspended or dissolved particles in the water column	Real-time Measurement
Water Clarity	indicates clarity of water column	Monthly Field Measurement (secchi)
Sedimentation	indicates the amount of sediment that is settling out of the water column	Real-time Measurement
TSS	identifies degree of catchment disturbance or variety of particulate pollutants	Monthly Sample
PAR	indicates the part of the light spectrum that is available for photosynthetic organisms to utilise	Real-time Measurement
pH	identifies presence of acids or alkaline substances	Real-time Measurement
Dissolved Oxygen	indicates chemical or biological activity	Real-time Measurement
Electrical Conductivity	indicates presence of salts / fresh water influence	Real-time Measurement
Temperature	measures temperature	Real-time Measurement
Depth	monitors instrument location	Real-time Measurement

3.6 Quality Assurance/Quality Control

3.6.1 Field management

All field activities are conducted under GBRMP Research Permit (G17/39502.1) and are consistent with the conditions specified in the permit.

3.6.2 Data Management

Marine data loggers, particularly turbidity loggers, are susceptible to environmental influences that can yield anomalous measurements. Each dataset is scanned by automated data screening processes for outliers or spurious results such as recordings at the upper detectable range, prolonged identical and elevated readings, mechanical problems with the loggers (e.g. wiper failure) or readings affected by biofouling. This will deliver descriptive statistics which support data interrogation and provide time efficiencies and quality controls. Though some outliers may be accurate recordings, they are inspected and removed if not representative of the time series at a site or through comparisons across other sites. For example, a piece of debris may result in a high instantaneous turbidity measurement at the location of the sensor, however this "outlier event" is not significant at the scale of a day or several hours. All omitted data is retained in a "raw dataset" for QA/QC measures.

4 MARINE WATER OBJECTIVES

Results from the Cleveland Bay marine water monitoring program are compared by POTL against the local environmental values and water quality objectives scheduled under the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (Ross River Basin and Magnetic Island Environmental Values and Water Quality Objectives Basin No. 118)* (EPP (Water)). These form sub-region guidelines for Townsville and are listed in Table 3.

Table 3: Marine Water Objectives

Parameter	Open and Enclosed Waters Magnetic Island	Enclosed Coastal Waters (Eastern Cleveland Bay)	Ross River – Townsville Port Sub-Zone Waters
Turbidity	0.8–1.3–2.7 NTU	0.4–1.0–4.9 NTU	<4.9 NTU
pH	8.1–8.3–8.4	8.2–8.3–8.5	8.2 to 8.5
Dissolved Oxygen	95–100–105% saturation	90–95–105% saturation	90-105% saturation
Suspended Solids	1.2–1.9–3.7 mg/L	7–10–15 mg/L	13-22-34 mg/L
Secchi depth	3–4–6 m	1.0–1.4 –1.9m	>1.0m

5 REPORTING

A preliminary assessment of the data is undertaken after each monitoring event, with a detailed data and trend analysis undertaken annually.

6 REVIEW

This program is subject to regular review and refinement to ensure it remains fit for purpose. As a minimum, this review occurs every three years.

7 REFERENCES

ANZECC 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Department of Environment and Science 2018. *Monitoring and Sampling Manual: Environmental Protection (Water) Policy*. Department of Environment and Science, Brisbane.

EPP (Water) 2019. *Environmental Protection (Water and Wetland Biodiversity) Policy 2019: Ross River Basin and Magnetic Island Environmental Values and Water Quality Objectives Basin No. 118 including all waters of the Ross River Basin, and adjacent coastal waters (including Magnetic Island)*. Department of Environment and Science, Brisbane.

Orpin, A. R., P. V. Ridd, S. Thomas, K. R. N. Anthony, P. Marshall and J. Oliver 2004. *Mar. Pollut. Bull.*, **49**, pgs. 602-612.

POTL 2019. *POT 1569 Marine Water Monitoring Plan*. Port of Townsville Limited, Townsville.

State of Queensland 2018. Reef 2050 Water Quality Improvement Plan 2017-2022. State of Queensland, Brisbane.

8 DEFINITIONS AND ACRONYMS

ANZECC	Australian and New Zealand Environment and Conservation Council
CTD	Conductivity, Temperature and Depth
EPP (Water)	*Environmental Protection (Water and Wetland Biodiversity) Policy 2019*
GPS	Global Positioning System
NATA	National Association of Testing Authorities
NQ	North Queensland
NTU	Nephelometric Turbidity Units
PAR	Photosynthetically Active Radiation
POTL	Port of Townsville Limited
QA/QC	Quality Assurance / Quality Control
TSS	Total Suspended Solids

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