Gove Procedure Manual
HSE Department

Document Type: Procedure
Document Title: Marine Health Monitoring Program
Document Number: APM-EHS-039

KEY POINTS

- This procedure highlights marine related issues in Gove Operations; sets purpose and monitoring objectives.
- It specifies sampling requirements, methodologies for collecting marine samples.
- Procedure is to be used as supporting document for undertaking marine monitoring.
- Defines protocol for sampling marine environment.

This procedure to be read in conjunction with the Gove EBA if applicable.

006	March 2022	Environmental Superintendent	Environment Senior Advisor	HSE Business Partner
Rev No	Date	Document Owner	Reviewer 1	Authorised by

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1. INTRODUCTION

1.1 Site Setting

Gove Operations is located on the Gove Peninsula in North East Arnhem land in the Northern Territory (NT), 650 kilometres (km) east of Darwin. Gove Operations commenced bauxite mining in the 1970s to supply a local alumina refinery and the export market.

The bauxite mine is located approximately 20km to the east of Gove Harbour, the ore is transported via a conveyor to stockpiles at the refinery and port at Gove Harbour. These operations are undertaken 24 hours a day, seven days a week, the current rate is approximately 13 Million dry tonnes (Mdt) of bauxite per year. At this mining rate, there are sufficient reserves available within the existing leases to continue mining up until 2029.

Based on the functional status, location, and closure planning, the operations can be considered as four functional areas:

- Mine – currently active mining of bauxite ore reserves.
- Refinery – curtailed alumina refinery.
- Residue disposal area (RDA) – storage of mineral processing waste.
- Marine – receiving environment.

The Gove Operations Water Management Plan (GPM-EHS-100) establishes the overall rationale and justification for separate monitoring plans for surface water, groundwater, and marine aspects (this plan). This Marine Health Monitoring Program (MHMP) establishes management and monitoring requirements for Gove Operations.

Marine monitoring of the Gove Operations marine domain is undertaken through the MHMP, which was designed following the 2004-2005 baseline studies of southern Melville Bay, and continues to be optimised with consideration of changes in operations and closure planning.

1.2 Objectives

The objectives of MHMP are presented below; these objectives are specific to different aspects of the monitoring program and can be summarised as:

Seawater

- Ensuring that wastewater discharges from the operation do not adversely affect the current Declared Beneficial Uses and Objectives for the Gove Area marine waters, being aquatic ecosystem protection;
- Establishing site-specific water quality Trigger Values (TVs) to facilitate protection of the marine environment;
- Assessing compliance with discharge water quality TVs and Limits for protection of the marine environment, with the level of protection for the marine receiving environment being 95% species protection; and
- Maintaining regulatory compliance reporting requirements.

Marine sediment

- To assess sediment quality based on spatial and temporal trends, comparison to sediment quality guideline values (where available) and comparison to background concentrations for Melville Bay;

- To assess if the environmental risk posed by impacted sediment in inner Gove Harbour, based on biological, physical, and chemical parameters, is decreasing with time; and
- Provide data that will allow for an Ecological Risk Assessment to be conducted in order to make informed decisions on closure options.

Oysters

The oyster monitoring program aims to assess bioaccumulation of contaminants of concern within oysters at selected sites and the target for this program is for reported concentrations to be less than Food Standards Australia New Zealand (FSANZ) Maximum Limits (where available) and allow comparison to background reference sites.

Marine pests

The objective of the marine pest monitoring program is to provide early detection of marine pests at the Export and Cargo wharfs and the target is to report marine pests (if detected) to NT Fisheries Bio-Security Unit within 48 hours.

Waste Discharge Licence (WDL) 171 is the overarching licence, granted and regulated by the Department of Environment, Parks and Water Security (DEPWS) that relates to water discharge to the marine receiving environment at Gove Operations. This allows Gove Operations to discharge treated process water and surface water. The WDL specifies sampling and analysis requirements, trigger values and limits for environmental parameters and contaminants of potential concern. Gove Operations regularly reports the results of these monitoring events to the DEPWS as specified in the WDL.

1.3 Contaminants of potential concern

Contaminants of potential concern associated with discharge from Gove Operations can be classified in the following categories:

- Contaminants from the curtailed alumina refining process – include metal(loid)s (aluminium, arsenic, gallium, molybdenum, iron, and vanadium). These contaminants are also found in wastewater treated via waste water neutralisation plant (WWNP);
- Contaminants from the sewage treatment plant (STP) – treated water from STP may contain nutrients (nitrogen and phosphorous) and bacteria (Enterococci);
- Contaminants from hydrocarbon sources (including fuel storage areas (tank farms) and oily-water separator units) - includes total petroleum hydrocarbons (TPH).

Further details on the proposed analytical schedule are provided in section 4.

1.4 Targets

The targets for the MHMP are to:

- Maintain detailed information on non-compliance events against WDL conditions (TVs and limits);
- Submit regulatory reports within agreed timeframes; and
- Document long-term monitoring data trends to allow for impact evaluation of discharge from RTA Gove Operations on the marine environment and inform closure decisions.

WDL compliance trigger values for authorised mixing zone boundary sites SW9, SW10 and RR2 are included below in **Table 1**.

Table 1 WDL171-11 compliance trigger values for authorised mixing zone sites

Parameter	Unit	Analysis Type	SW9	SW10	RR2	TV
			Frequency			
Field Measurements						
pH	pH	In situ	M	M	M	7.7-8.4[1]
EC	µS/cm		M	M	M	-
Turbidity	NTU		M	M	M	20[2]
Dissolved oxygen	mg/L		M	M	M	5.8*[1]
Other						
Alkalinity	mg/L	Total	M	M	M	
Total suspended solids	mg/L		M	M	M	
Metals & Metalloids[6]						
Aluminium	µg/L	Total & Filtered (0.45µm)	M	M	M	56[3]
Arsenic	µg/L		M	M	M	20[4]
Gallium	µg/L		M	M	M	800[3]
Iron	µg/L		M	M	M	
Magnesium	µg/L		M	M	M	
Molybdenum	µg/L		M	M	M	3880[3]
Vanadium	µg/L		M	M	M	100[5]
Nutrient Indicators						
Total Phosphorous	µg/L	Filtered (0.45µm)	M	M	M	14^[1]
Total Nitrogen	µg/L		M	M	M	170^[1]
Hydrocarbons						
TPH	µg/L	Total	M^	M^	M^	-
PAH	µg/L		M^	M^	M^	-
Benzene	µg/L		M^	M^	M^	-
Toluene	µg/L		M^	M^	M^	-
Ethyl benzene	µg/L		M^	M^	M^	-
Xylene	µg/L		M^	M^	M^	-

Key:
I = Incidental: Within 1 week of a result >35cfu/100mL at S094 and monthly thereafter until concentrations at the compliance points return to normal levels
M = Monthly
M^ - Monthly when discharging from S086, S087, S088 & S044 only and when safe to do so, acknowledging some discharge events will occur during monsoonal conditions
[1] = Site specific trigger value derived based on 15 years of monthly data collected from Melville Bay
[2] = Default trigger values for chemical stressors for inshore marine, slightly disturbed ecosystem, ANZG 2018
[3] = 95% species protection trigger levels from van Dam, J.W., Trenfield, M.A., Streten, C. Harford, A.J., Parry, D., van Dam, R.A. (2018) Water quality guideline values for aluminium, gallium and molybdenum in marine environments. Environmental Science Pollution Research, 25: 26592-26602. https://doi.org/10.1007/s11356-018-2702-y
[4] = Based on 95% protection trigger value for As(V) from van Dam J.W. 2017. Assessing the biological effects of arsenate on tropical marine biota. Report prepared for Rio Tinto. Australian Institute of Marine Science, Darwin. (49 pp)[4] = 95% species protection trigger levels, ANZG 2018
[5] = 95% species protection trigger levels, ANZG 2018
[6] = Trigger values apply to filtered (0.45µm) concentrations
* = 20th %ile based on 4 background sites
^ = 80th %ile based on 4 background sites

2. MARINE HEALTH MONITORING PROGRAM

Marine monitoring at Gove Operations is required under the Waste Discharge Licence (WDL 171). The MHMP constitutes the current marine monitoring for Gove Operations and includes all marine environmental aspects surrounding Gove Operations. The MHMP includes consideration of releases to the marine environment as a result of Gove Operation's activities, including surface water discharges, groundwater seepage, atmospheric deposition and effects of shipping.

The MHMP was designed from the 2004-2005 baseline studies of Melville Bay and formed the basis for establishing the sample types (water, sediment, and oysters), monitoring sites and analytes. Pest monitoring is not a requirement of WDL 171; this is conducted on behalf of the Aquatic Biosecurity Unit (NT Fisheries).

Monthly seawater monitoring for the MHMP commenced in May 2005. The MHMP is a process, not an end result. It is a collaborative, adaptive management strategy with a process for review and continuous improvement. An overview of the MHMP sampling regime is provided in **Table 2.**

Table 2 Monitoring Programs as Components of the MHMP

Program	Description
Seawater Monitoring	Monthly seawater monitoring at 4 background sites, 3 test sites and 15 information sites across Melville Bay, Drimmie Arm and the northern beaches to satisfy compliance commitments under WDL 171 and under attachment C of the MMP. Samples are analysed for contaminants of concern and results compared against background levels, and WDL 171 stipulated trigger levels and limits where applicable.
Sediment Monitoring	Annual sediment monitoring is conducted at 32 sites across Melville Bay to assess impacts of RTA Gove discharge on marine sediments. Results are compared against sediment quality under the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) and background concentrations. In addition, a Closure marine sediment monitoring program commenced in 2019. This monitoring program will be conducted over 7 years up until 2025. Details of the program are provided in Appendix A.
Oyster Monitoring	Bi-annual oyster monitoring at four sites across Melville Bay for the purpose of assessing bioaccumulation of contaminants of concern. Results are compared against the Food Standards Australia New Zealand (FSANZ) and background.
Marine Pest Monitoring	Monthly observation and quarterly sampling at the Export (M009) and Cargo (M008) wharfs, for the purpose of detecting invasive marine pests.

3 SAMPLING METHODOLOGY

Maintaining a consistent sampling methodology allows for meaningful conclusions when assessing data. Summary of sampling methodologies, including quality assurance and quality control (QA/QC) for each monitoring program are included within the following sections. Detailed description of the sampling methodology is provided in relevant standard work procedures.

Details of QA/QC measures which are implemented during each program (seawater, sediment, oyster and marine pest) to check the accuracy, precision and overall validity of the results obtained are included in Section 3.6 below.

3.1 Seawater Sampling

Seawater is sampled monthly; detailed step by step process of seawater sampling methodology is described in the Marine sampling standard work procedure. Documentation for analytical methods is available upon request from the respective

contracting laboratories. The following is a summary of the program:

- pH, dissolved oxygen, turbidity, and conductivity profiles are collected in-situ with YSI and Hydrolab 6-series water quality sondes (or equivalent) at every site;
- Seawater sample bottles are supplied to Gove Operations cleaned, pre-conditioned and filled with 0.01% HCl storage solution in clean, zip-lock plastic bags. These bags should only be opened immediately prior to sampling and must be kept clean at all times. A peristaltic pump is used to collect unfiltered and filtered (0.45µm acid-washed in-line filter capsule) water samples from approximately 0.5m depth at every site. At each site, the pump and tubing are rinsed by pumping to waste (downstream / away from sampling tube) without a filter capsule attached. A 0.45µm filter cartridge is then attached and rinsed a further 30 seconds;
- Rinse bottles three times with the pumped seawater before collecting the sample. For an unfiltered sample the bottles are rinsed with unfiltered seawater and for filtered samples rinsed with filtered seawater. Water is pumped directly into the rinsed bottles. The bottled samples should be placed in an esky with ice bricks for transport to the RT Gove Environmental Wet laboratory for storage in a fridge. Nutrients and chlorophyll samples should be placed in a fridge. The samples are placed in an esky with ice bricks for dispatch to the external laboratory for analysis in a timely manner; and
- Samples are analysed for metal and arsenic concentrations by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or equivalent using a method to reduce saltwater matrix interference. Total dissolved nitrogen and phosphorus concentrations are determined by Flow Injection Analysis and chlorophyll a concentrations by fluorometric analysis. Acid neutralising capacity and total suspended solids are measured using standard methods.

3.2 Hydrocarbons Sampling

When sampling for hydrocarbon compounds (TPH, PAH and BTEX) in seawater, care must be taken to ensure hydrocarbon samples are collected in an appropriate manner that minimise the risks of cross contamination and maintain sample integrity, the following method must be applied:

- Collect unfiltered sample in dedicated glass sampling bottles (amber glass for TPH and PAH, VOC vials for BTEX);
- There is no requirement to pre-rinse sampling bottle; use sample bottle directly to collect the sample;
- Completely fill sampling bottle, zero headspace;
- Use packing material around sample bottle to prevent breakage; and
- Keep sample at a temperature of 4^{o}C, do not freeze.

3.3 Marine Sediment Sampling

Marine sediment samples are collected annually. Seafloor sediments are sampled from the top 5-10cm of sediment using a Van-Veen stainless steel grab sampler. Sediment is placed in a clean plastic tray and transferred with a plastic or stainless-steel trowel to zip-lock plastic bags, double bagged and placed in an esky on ice bricks for transport to the RT Gove Environmental Wet laboratory for storage in a freezer, prior to dispatch to the external analytical laboratory.

3.4 Oyster Sampling

Oysters are sampled bi-annually. Oysters are collected whole from rocks using a hammer and chisel. Any oysters that are damaged during collection should be discarded. Whole

oysters are placed in double zip-lock plastic bags and placed in an esky on ice bricks for transport to the RT Gove Operations Environment Wet laboratory where they are immediately frozen before transport to the analytical laboratory.

The three main species of oysters commonly found in Southern Melville Bay are *Saccostrea cucullata*, *Saccostrea mordax* and *Saccostrea mytiloides*. The species collected is recorded for each site.

3.5 Marine Pest Sampling

The NT Aquatic Bio-security Unit is responsible for monitoring the NT coastline for the presence of marine pests. Gove Operations environmental staff deploy and collect settlement plates and rope mops designed to attract juvenile marine plants and animals in Gove Harbour on behalf of the unit. There are two monitoring sites; Cargo Wharf (M008) and Export Wharf (M009) which are monitored monthly (photo) and sampled quarterly (plates and rope mops). Further details on sampling methodology are summarised below:

- Wearing gloves, the deck hand will hold onto pest trap cable to maintain vessel position;
- Monthly: Wearing gloves, the skipper will pull up the pest trap and take photos of each pest trap, outsides, gap between plates and ropes. Photos are sent to NT Fisheries for assessment; and
- Quarterly: Wearing gloves, the skipper will remove plates and rope and store in containers and place into esky for transport to NT Aquatic Biosecurity Unit in Darwin. Wearing gloves, the skipper will deploy new trap back into water.

3.6 Quality Assurance / Quality control

Field and laboratory quality assurance involves all the planned actions, procedures, checks and decisions which have been made and undertaken through quality control measures to ensure the representativeness and integrity of collected samples is that of the true conditions. Essential components of the field and laboratory QAQC for all or part of each monitoring program including seawater, sediment, oyster and marine pest include the following:

- **Experienced Personnel**: Field work will be undertaken by Rio Tinto field technicians with previous experience in environmental site assessments, field sampling techniques and health and safety procedures;
- **Record Keeping**: Full records of all field activities including monitoring data and sample collection will be maintained on standard field data sheets;
- **Sampling Methodology**: The adopted sampling methods for each media (seawater, sediments, oyster and pest) are followed;
- **Field Equipment Calibration**: All field equipment (Hydrolab and/or YSI water quality sondes) is calibrated daily before being used to collect data. All equipment, including contractor supplied equipment, is calibrated in accordance with the manufacturers' specifications. All calibration records are to be maintained for reference and reporting purposes;
- **Decontamination**: All sediment sampling equipment, Van Veen grab, trowel and plastic tray, should be rinsed with seawater immediately after collecting the sample and then rinsed again before collecting the sample at the next site;
- **Sample Collection**: New nitrile gloves will be worn during sampling, and replaced between each sample collection. New sediment sample jars and new water sample containers will be used for each sample;
- **Sample Labelling**: A unique sample number will be used for each sample to clearly

specify the sample origin (site, date, sampler) and preservation standards. Sample numbers will be written on laboratory affixed sample labels;

- **Sample Transport and Preservation**: All collected samples will be transferred to approved sampling containers with appropriate preservation as required and then placed in cool storage prior to transfer to a National Association of Testing Authorities (NATA) accredited or equivalent laboratory; and
- **Chain of Custody**: All samples are transferred to the NATA accredited laboratory or equivalent under Chain of Custody (COC). Custody sheets should list sample numbers; date of collection and analyses required and be signed by each person transferring and accepting custody.

Field Duplicates

In addition to the primary samples, quality control field duplicate (intra-laboratory duplicates) samples will be collected to assess aspects of field protocols and laboratory performance and to classify the validity of the laboratory data.

The duplicate should be collected at the same time as the primary sample but identified as a separate sample. This will allow an assessment of the ability for the laboratory to replicate analysis (primary versus duplicate). It is important to note where the duplicate sample was collected (e.g duplicate collected from SW08 and identified as Duplicate 1).

- Water duplicates should be collected at a ratio of one duplicate for each ten primary samples collected.
- Sediment duplicates should be collected at a ratio of one duplicate for each twenty primary samples collected.

Field Blank

Field blank samples are prepared in the field using empty bottles and the laboratory supplied distilled water used for the cleaning of non-disposable sampling equipment. Field blank samples are collected each day by pumping the laboratory supplied water through the program dedicated tubing prior to commencing sampling.

Trip Blanks

Trip blanks are a check on sample contamination, in particular volatile compounds, originating from containers, sample transport, shipping and site conditions. The trip blank is a pre-prepared laboratory sample filled with ‘clean’ deionised solution. The Trip Blank remains with the field sample containers during sampling procedures and during the return trip to the laboratory. At no time during these procedures will the blanks be opened. Upon return to the laboratory the blank will be analysed.

Laboratory Control Procedures

The laboratories used in the investigations will be NATA approved or equivalent for the analyses required, where applicable. Quality Assurance procedures adopted by the analytical laboratory will include analysis of blanks, duplicates, laboratory control (QC) samples, matrix spikes and surrogate spikes (for organics).

Analytical laboratories are requested to provide their laboratory QAQC data in final reports. Analytical laboratories are NATA accredited or assessed as at least equivalent. Laboratories without NATA accreditation (CDU Laboratory) are only selected where the analytical techniques and practices used have demonstrated an equivalent or greater analytical precision and accuracy than a comparable NATA accredited lab.

Analytical data received by Gove Operations are quality checked by an Environmental Advisor.

4 MARINE HEALTH MONITORING SCHEDULES

4.1 Seawater Monitoring Schedules

Table 3 Seawater Monitoring Key

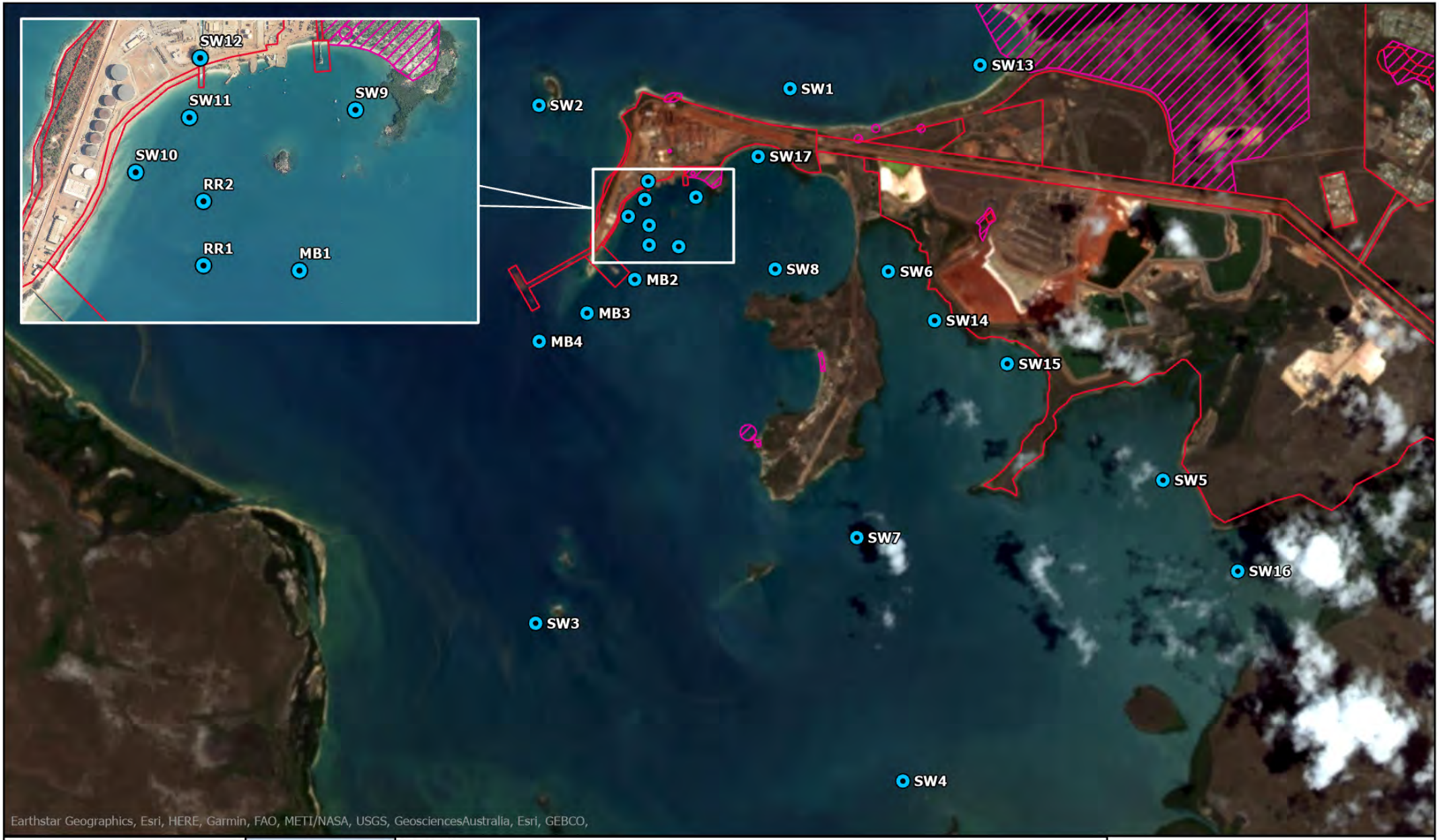
Sampling Schedule Key - Seawater	
***In situ* measurements**	**Recorded using a Water Quality Probe -** pH, Dissolved Oxygen, Turbidity, Conductivity, Temperature
Seawater Samples (Analysed by external laboratory)	**Seawater – unfiltered sample:** Alkalinity (measured as acid neutralising capacity), Total Suspended Solids, Chlorophyll a, Enterococci, metal(loid)s (Al, V, Mn, Fe, Cu, Zn, As, Ga, Mo, U)
	Seawater – filtered sample - 0.45µm: Metal(loid)s: Al, V, Mn, Fe, Cu, Zn, As, Ga, Mo, U, Total Dissolved P and N
QAQC Sampling Program	
Field Blank	One per day for filtered and unfiltered metal(loid)s, and TDP/TDN.
Duplicates	One per 10 samples
Trip Blank	One per day

Table 4 Seawater Monitoring Locations and Schedule

Monitoring Location	Site Type	In-situ (pH, EC, temp, turbidity, DO)	Seawater Samples		Coordinates (GDA 1994 MGA Zone 53)	
			*Seawater – unfiltered sample	**Seawater – filtered sample - 0.45µm	Easting	Northing
SW1	Background	M	M	M	685072	8652667
SW2	Information	M	M	M	681867	8652453
SW3	Background	M	M	M	681825	8645842
SW4	Background	M	M	M	686512	8643828
SW5	Information	M	M	M	690131	8648481
SW6	Information	M	M	M	686326	8650333
SW7	Background	M	M	M	685924	8646936
SW8	Information	M	M	M	684882	8650363
SW9	WDL Test Site	M	M	M	683870	8651281
SW10	WDL Test Site	M	M	M	683007	8651036
SW11	Information	M	M	M	683218	8651251
SW12	Information	M	M	M	683270	8651450
MB1	Information	M	M	M	683650	8650650
MB2	Information	M	M	M	683090	8650230
MB3	Information	M	M	M	682480	8649800
MB4	Information	M	M	M	681870	8649440
RR1	Information	M	M	M	683273	8650670
RR2	WDL Test Site	M	M	M	683273	8650922

Monitoring Location	Site Type	In-situ (pH, EC, temp, turbidity, DO)	Seawater Samples		Coordinates (GDA 1994 MGA Zone 53)	
			*Seawater – unfiltered sample	**Seawater – filtered sample - 0.45µm	Easting	Northing
SW13	Information	M	M	M	683818	8651167
SW14	Information	M	M	M	683002	8650910
SW15	Information	M	M	M	687871	8649071
SW16	Information	M	M	M	690785	8646499
SW17	Information	M	M	M	684662	8651810

M= monthly



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Spatial Reference:
GDA 1994 MGA Zone 53

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Legend

- Seawater
- Gove Operations Leases
- Cultural Heritage Areas

GOVE OPERATIONS
MARINE HEALTH MONITORING PLAN

Marine Seawater Monitoring Locations

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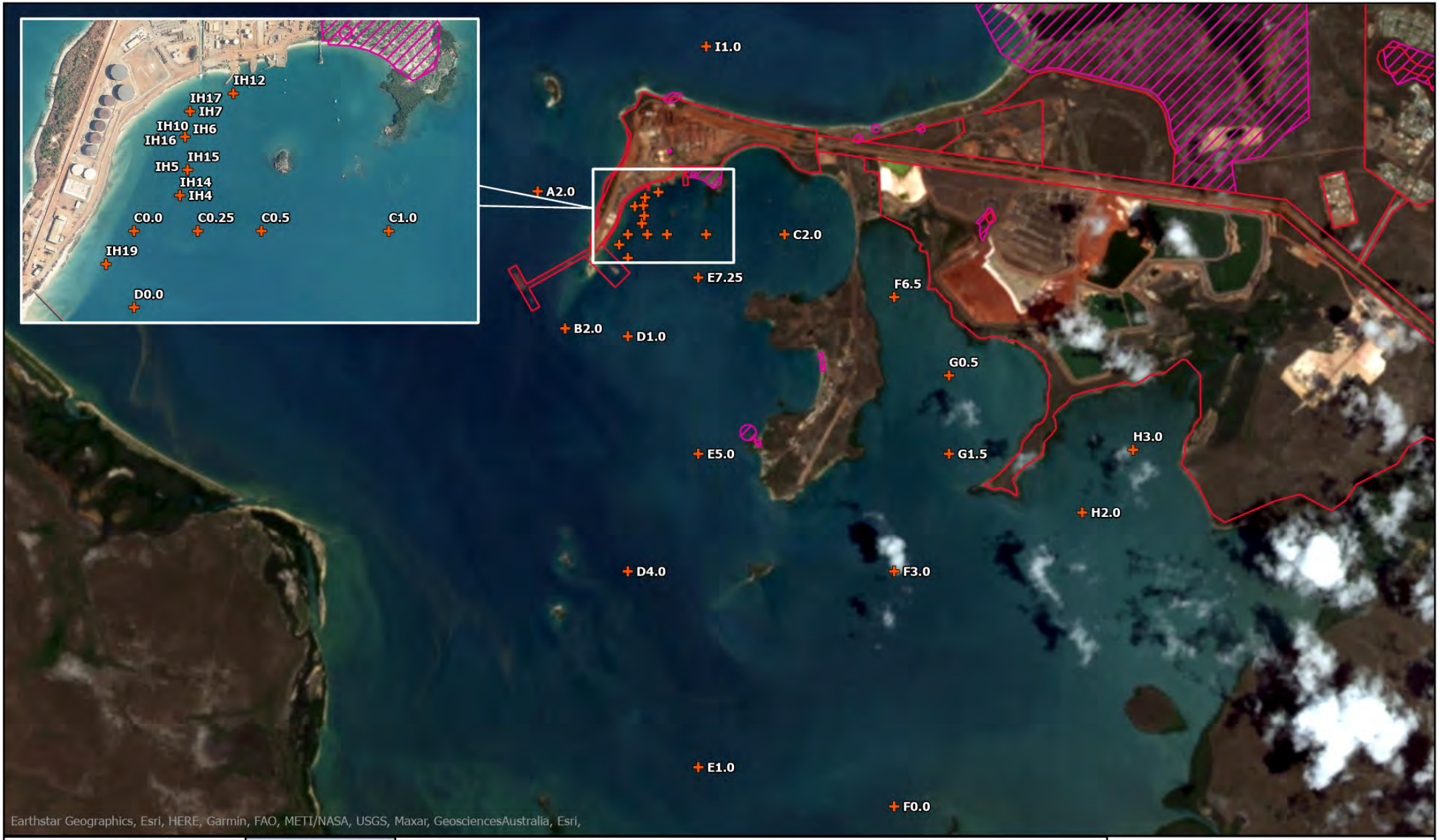
4.2 Marine Sediment Monitoring Overview and Schedules

Table 5 Marine Sediment Monitoring Key

Sampling Schedule Key - Sediment	
Surface sediment samples	Sediments – sieved to <0.063mm: Al, As, Cd, Fe, Ga, Mg, Mo, Pb, U, V, Zn
	Sediments – sieved to <2mm: Total Kjeldahl N
QAQC	
Duplicate	One per 20 samples

Table 6 Annual Marine Sediment Monitoring Locations and Schedule

Sample Site	Sample Type	MHMP	Coordinates (GDA 1994 MGA Zone 53)	
			Easting	Northing
A2.0	S	A	681,850	8,651,350
B2.0	S	A	682,200	8,649,600
C0.0	S	A	683,000	8,650,800
C0.25	S	A	**683,000**	**8,650,800**
C0.50	S	A	683,250	8,650,800
C1.0	S	A	683,500	8,650,800
C2.0	S	A	**683,500**	**8,650,800**
D0.0	S	A	684,000	8,650,800
D1.0	S	A	685,000	8,650,800
D4.0	S	A	683,000	8,650,500
E1.0	S	A	**683,000**	**8,650,500**
E5.0	S	A	683,000	8,649,500
E7.25	S	A	**683,000**	**8,649,500**
F0.0	S	A	683,000	8,646,500
F3.0	S	A	683,900	8,644,000
F6.5	S	A	683,900	8,648,000
G0.5	S	A	683,900	8,650,250
G1.5	S	A	**683,900**	**8,650,250**
H2.0	S	A	686,400	8,643,500
H3.0	S	A	686,400	8,646,500
I1.0	S	A	686,400	8,650,000
IH4	S	A	687,100	8,649,000
IH5	S	A	687,100	8,648,000
IH6	S	A	688,800	8,647,250
IH7	S	A	689,450	8,648,050
IH10	S	A	684,000	8,653,200
IH12	S	A	683,180	8,650,940
IH14	S	A	**683,180**	**8,650,940**
IH15	S	A	683,210	8,651,040
IH16	S	A	683,200	8,651,170
IH17	S	A	**683,200**	**8,651,170**
IH19	S	A	683,220	8,651,270



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Legend

- Sediment
- Gove Operations Leases
- Cultural Heritage Areas

GOVE OPERATIONS
MARINE HEALTH MONITORING PLAN

Marine Sediment Monitoring Locations

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4.3 Oyster Monitoring Schedules

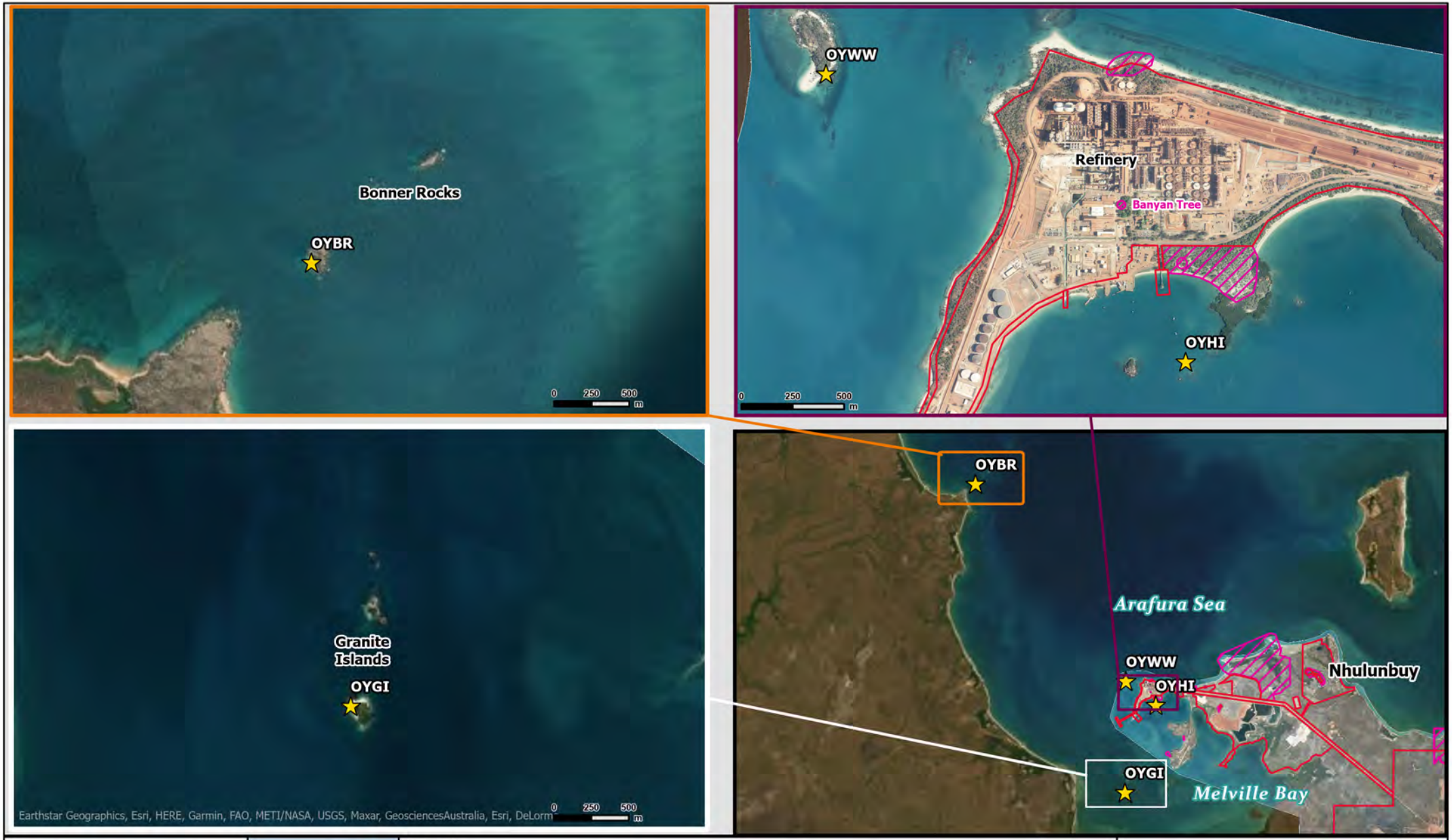
Table 7 Marine Oyster Monitoring Key and Schedule

Sampling Schedule Key - Oysters	
Soft Tissue Sample (Analysed by external laboratory)	Al, V, Fe, Cu, Zn, Ga, As, Mo, Cd, Pb

Table 8 Oyster Monitoring Locations and Schedule

Monitoring Location	Site Type	Frequency	Coordinates (GDA 1994 MGA Zone 53)	
			Easting	Northing
OYGI	Information	B	682050	8646000
OYWW	Information	B	682100	8652500
OYHI	Information	B	683850	8651100
OYBR	Background	B	673307	8664102

B= Bi-annual



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GDA 1994 MGA Zone 53

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Legend

- Oyster
- Cultural Heritage Areas
- Gove Operations Leases

GOVE OPERATIONS
MARINE HEALTH MONITORING PLAN

Marine Oyster Monitoring Locations

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4.4 Pest trap monitoring schedule and locations

Table 9 Pest trap monitoring Locations and Schedule

Monitoring Location	Site Type	Frequency	Coordinates (GDA 1994 MGA Zone 53)	
			Easting	Northing
M008	Cargo Wharf	M	681668	8650143
M009	Export Wharf	M	682790	8650360

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Spatial Reference
Name: GDA 1994 MGA Zone 53

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◊ Pest Trap

GOVE OPERATIONS
MARINE HEALTH MONITORING PLAN

Marine Pest Monitoring Locations

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5 DATA MANAGEMENT

5.1 Data Management

Gove Operations utilises EnviroSys, maintained by acQuire, for storing and managing environmental monitoring data. The EnviroSys database is managed by the Environment Department. In addition, copy of the laboratory reports are stored on the site drive at: \\AUGOVNA1\Groups\HSE\02. HSEQ MS\10. Operational Control\03. Environment\000 Water Management\3. Marine. Refer to GPM-EHS-080, data and records management procedure for further information.

5.2 Data Screening

As a component of monitoring activities, the monitoring contractors, and the Rio Tinto Environmental Technicians work collaboratively to implement the monitoring plan. Deviations from the monitoring plan and significant field results are communicated to the Gove Operations Environmental Team during a daily meeting.

After each monitoring event, data is screened against relevant values to provide a brief overview of marine health. Screening for filtered concentrations of metal(loid)s and nutrients should be less than or equal to total concentrations. Filtered concentrations should not be greater than the corresponding total, within analytical error. This screening is completed by the consultant after assessment of lab results (only for seawater samples). Target criteria are as follows:

- Trip blank and field blank should be less than laboratory limits of reporting;
- Duplicate relative percentage difference (RPD) between primary and duplicate sample are less than 30% where both samples are greater than five times laboratory limits of reporting;
- Laboratory blanks less than limit of reporting;
- Certified reference material (CRM) within criteria limits for the CRM; and
- Laboratory duplicates RPD less than 30%.

6 REPORTING

Gove Operations maintain the following internal and external reporting commitments related to marine health.

6.1 Incident Reporting

Incidents related to marine monitoring must be captured in Rio Tinto Business Solution (RTBS) and meet the requirements of *GPM-EHS-020, Incident and Action Management*. Environmental Incidents breaching WDL conditions may require notification to regulatory bodies and should be immediately raised with the Environment Superintendent.

6.2 WDL Non-compliance Report

If WDL license conditions are found to be non-compliant, a report will be prepared which includes the required elements specified in the current licence.

The report will include the following information:

1. When the non-compliance was detected and by whom.
2. The date and time of the non-compliance.
3. The actual and potential causes and contributing factors to the non-compliance.
4. The risk of environmental harm arising from the non-compliance.

5. The action that has or will be undertaken to mitigate any environmental harm arising from the non-compliance.
6. Corrective actions that have or will be undertaken to ensure the non-compliance does not re-occur.
7. A plan for additional monitoring relevant to the non-compliance.
8. where a non-compliance relates to an exceedance of total nitrogen (as specified in the WDL) further analysis to speciate for nitrate and nitrite must be conducted and provided as part of the incident investigation report.
9. If no action was taken, why no action was taken.
10. A date when an incident investigation report will be submitted to the Administering Authority.

WDL non-compliance incident report will be provided to DEPWS (Regulator).

6.3 Marine Health Monitoring Reporting

Annual Marine Health Monitoring Report

Data collected as part of MHMP are used to produce the Annual Marine Health Monitoring Report. This report assesses long-term trends in water quality, provides an update of marine health and provides an update on the progress of improvement projects. The structure of the report is generally prescribed by the Administering Authority at the time of reporting but should consider the minimum requirements for environmental reporting presented in the Guideline for Reporting on Environmental Monitoring (NT EPA, 2016). Report is delivered to the Regulators DITT and DEPWS and shared with the Traditional Owners.

Annual WDL Report

This report presents monitoring data against WDL conditions during the reporting period, with consideration of long-term trends and recent improvement projects. The structure of the report is generally prescribed by the Administering Authority at the time of reporting but should consider the minimum requirements for environmental reporting presented in the Guideline for Reporting on Environmental Monitoring (NT EPA, 2016). Report is delivered to DEPWS.

Annual Audit and Compliance Report

This report presents non-compliances recorded against WDL conditions during the reporting period in accordance with the conditions of WDL171 issued under part 7 of the Water Act. The report template is obtained from NT EPA website and follows the NT EPA Guideline for Completing an Annual Return (2016). Report is delivered to DEPWS.

Annual Environmental Mining Report

Provides an updated summary on overall marine health over the reporting period, including changes to site conditions which may impact surface water quality, and progress on improvement projects. Report is delivered to DITT.

Oyster Monitoring Report

Provides high-level summary of the oyster monitoring in accordance with *Special Permit No 2018-2019/S17/3462*. The report is delivered to NT Fisheries annually.

7 RELATED REFERENCE DOCUMENTS

Reference documents related to the MHMP at Gove Operations are listed in **Table 10**.

Table 10 Marine Health Management Documents and Procedures

Document Number	Document Title
E11	Water quality protection and water management
EPMS03	MMP 2019, Marine water quality management plan
EPMS11	MMP 2019, Exotic species management plan
GPM-EHS-080	Data and Records Management
GPM-EHS-020	Incident and Action Management
GO MMP	Gove Operations, Mine Management Plan - Version 2, 28 June 2019
GMP-EHS-100	Gove Operations Water Management Plan 2021
ANZG 2018	ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018
WDL171	Northern Territory of Australia, Waste Discharge Licence. Licence Number - WDL171.

8 RACI

Table 11 below outlines roles and responsibilities of relevant stakeholders involved in the entire implementation of the MHMP and appended Closure monitoring projects. RACI stands for Responsible, Accountable, Consulted and Informed.

	Superintendent (RTA)	Senior Advisor (RTA)	Environmental Advisor (RTA)	Field Technician (RTA)	CDU	AIMS	AIMS/CSIRO	ALS	acQuire	Principal Advisor (RTA)
Plan field sampling (schedules) in line with the contractors	A	I	R	I	C	C	C			
Organise mobilisation & demobilisation of contractors	A		R		C	C	C			
Preparation of sample containers and other field equipments (ice bricks, eskies, Hi pure water), equipments calibration & maintenance	A			R	C	C	C			
Conduct sample collection for the MHMP (seawater, marine sediment, oyster and pests) as per the program schedule	A	I	C	C	R					
Conduct TPH samples collection in the marine monitoring sites as stated in WDL 171	A		C	R				I		
Conduct sediment sample collection for the Marine Sediment Monitoring Program, MSMP (Closure projects)	C		C	I			R	I		A
Conduct benthic communities surveys as required (Closure projects)	C		C	I		R				A
Prepare MHMP samples for dispatch to internal and external labs	A		I	R	C					
Prepare MSMP samples for dispatch to external labs				R			C			A
Conduct testing of the samples, prepare lab report and data screening (MHMP)	A	C	I		R					I
Report lab data to RTA and upload data to Envirosys	A	I			R	C				
Fix erroneous data identified in Envirosys		A			C				R	
Prepare and submit annual monitoring report to RTA (MHMP)	A	C			R					
Prepare and submit technical report to RTA (MSMP)							R			A
Prepare and submit technical report to RTA (Benthic Communities Surveys)						R				A

9 REFERENCES

ANZG 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

NT EPA 2016. *Guideline for Reporting on Environmental Monitoring*, dated May 2016

NT EPA 2018. *Waste Discharge Licence (WDL171-08)* Licence for Rio Tinto Gove Operations from 17 July 2018 – 17 July 2020

NT EPA 2020, Waste Discharge Licence (WDL171-10). Licence for Rio Tinto Gove Operations from 17 September 2020 – 15 February 2022

NT EPA 2020, Waste Discharge Licence (WDL171-11). Current licence for Rio Tinto Gove Operations dated 15 February 2022

Northern Territory Government 2016. Methodology for the sampling of surface water

Rio Tinto Alcan 2016. Gove Operations Water Monitoring Plan - Version 2.0, 2 May 2016

Rio Tinto Alcan 2019. Gove Operations Mining Management Plan for the Period July 2019 to July 2031. Report dated 28 June 2019

Government of Western Australia Department of Water. Surface water sampling methods and analysis – technical appendices. Standard operating procedures for water sampling. January 2009

10 REVISION HISTORY

Version no:	Effective date:	Authorised by:	
Version no:	**Revision date:**	**Authorised by:**	**Reason for change:**
5	01/10/2019	Specialist MPA	
6	23/03/2022	HSE BP	Complete re-write

11 APPENDICES CLOSURE MONITORING PROGRAMS

Appendix A – Closure marine sediment monitoring 2019 – 2025

Appendix B - Monitoring benthic communities in Drimmie Arm, Whatta (No Name) Bay and Northern Beaches

12 APPENDIX A – CLOSURE MARINE SEDIMENT MONITORING 2019 – 2025

Overview

In 2019 RTA Gove Closure initiated a new marine sediment monitoring program (MSMP). The program was designed by the Australian Institute of Marine Science (AIMS) and CSIRO for a period of seven years (from 2019-2025) to inform closure decisions on handling the impacted marine sediment (Streten and Logan, 2018). It is estimated that approximately 136,000 m^3 of sediment in the inner Gove Harbour have been chemically and physically altered. RTA Gove Operations is assessing four options for handling the impacted sediment as part of Gove closure plan:

1) leave the sediment in place to naturally attenuate;
2) dredge the sediment and dispose offshore;
3) dredge sediment and dispose on shore in the RDA; and
4) sand capping.

The assessment of the feasibility of these closure options will consider a range of factors, with one key factor in the decision making focusing on the environmental risk posed by sediment in Melville Bay. This is an additional sediment monitoring on top of RTA Gove sediment monitoring under the current MHMP. Data from this sediment monitoring will supplement the data from the MHMP.

Objectives

To assess the environmental risk, RTA Gove Operations require the development of a sediment monitoring program that meets the following objectives:

- To provide baseline data that will allow for an Ecological Risk Assessment to be conducted;
- To assess if the environmental risk posed by impacted sediment in inner Gove Harbour, based on biological, physical and chemical parameters, is decreasing with time; and
- Provide data of appropriate quality to undertake an assessment of sediment quality in accordance with the National Assessment Guidelines for Dredging (NAGD 2009) assessment framework.

Sampling methodology

To meet these objectives, sediment sampling needs to occur in the area predicted to be influenced by discharge from Gove Operations. Due to the absence of sediment quality guideline values (SQGVs) for contaminants of concern in Gove sediment, the program needs is designed to collect sediments samples from background sites to meet step two in the tiered assessment. In this document, reference sites are sampling locations not influenced by RTA Gove's discharge (uncontaminated by the refinery). In accordance with the ANZECC sediment quality assessment guidelines these reference sites can be considered to represent 'background/reference metals data' for step 2 of the tiered assessment framework.

Van Veen stainless-steel grab sampler is used to samples the top 5-10cm surface sediment layer. This method of sampling is consistent with the surface sediment sampling method recommended in the 'Handbook of Sediment Quality Assessment'.

There are a range of methods available for the collection of sediment cores and the selection of coring equipment is based on sediment particle size, site access, core length and water depth. The 2016 sediment coring project reported the contaminated sediment at Inner Harbour sites in Melville Bay extends to a depth of approximately two metres and the coring equipment used in the study was sufficient to collect cores to depths that reached below the contaminated

sediment. The 2016 sediment coring project used a VibeCore-D corer (Specialty Devices Inc.); this coring equipment, or similar models, should be used for future sediment coring projects in Melville Bay.

For both the annual surface sediment sampling and three-yearly core sampling, the sampling practices used should adhere to those recommended in Sections 3.2–3.5 of the 'Handbook of Sediment Quality' and Appendix D of 'National Assessment Guidelines for Dredging'.

Sediment monitoring program

The overall sediment monitoring program will provide RTA Gove Operations with sufficient data to conduct a weight-of-evidence assessment of contaminated sediment in accordance with the recommendations provided in the Sediment Quality Assessment: a practical guide.

The current annual sediment sampling and analysis conducted as part of the MHMP should be retained in its current form. The additional marine sediment sampling and analysis listed under this program should be conducted from 2019-2025 to supplement the data from the MHMP. In 2020 and 2021, surface sediment samples were collected from the annual sediment monitoring sites and the corresponding analysis conducted as well as toxicity testing on the samples from IH6, IH4, GOS01, GOS03, G0.5 and H3.0.

Table A1 Marine surface and core sediment sampling and analysis key

Sampling analysis Key - Sediment			
CMSMP	S	Surface Sediment Sample	0-10cm depth
	C	Core Sediment sample	Coring to max depth of core refusal.
	✓	Analysis Required	Analysis required annually in 2019-2023. Analysis required once in wet season and once in dry season in 2024-2025
	Analysis*	**Sediment fraction analysed and method**	**Analytes**
	Total metal(loid)s	<63µm Total (nitric/perchloric)	Al, As, Cd, Cd, Fe, Ga, Mg, Mo, Pb, U, V, Zn Ca, Hg, Total Kjedahl Nitrogen
	AEM (1N HCl) metal(loid)s	<63µm Dilute acid extractable (1N HCl)	Al, As, Cd, Cd, Fe, Ga, Mg, Mo, Pb, U, V, Zn
	Pore water	Pore water < 0.45µm filtered (nitric)	Al, As, Cd, Cd, Fe, Ga, Mg, Mo, Pb, U, V, Zn
	Sulfide/ammonia	Pore water: Ammonia < 0.45µm filtered, Sulfide - Total (acid volatile sulfide)	Ammonia Sulfide
	Particle Size Distribution (PSD)	Light scattering method	
	Toxicity testing	Using *M. plumulosa* @ CSIRO	
	Total Organic Carbon	LECO Furnace combustion	

*Chemical analyses at ALS

Table A2 CMSMP Monitoring Overview (Streten and Logan 2018)

Year(s)	MSMP Monitoring Component
2019-2025	• Comparison of annual sediment chemistry data for metal(loid)s at impact sites against reference/background sites, for all of 2019-2025. • Continued frequency of annual sampling at all current **surface** (0-10cm) sediment monitoring sites as part of the MHMP for the duration of 2019-2025. • **Core** samples at select sites collected in 2022 and 2025. • Addition of D1.0 and E7.25 to the sediment **coring** sampling sites to increase the number of background samples through the sediment profile to eight by 2025. • Particle sizing analysis completed for all annual **surface** sediments every year. • Particle sizing analysis completed for all **cores** collected in 2019, 2022 and 2025. • In addition to the current metal analysis conducted under the MHMP, metal concentrations to be assessed by dilute-acid extraction (1N HCl) on all annual **surface** sediment samples every year. • Metal concentrations to be assessed by dilute-acid extraction (1N HCl) on all **core** samples in 2019, 2022 and 2025. • Metal concentrations to be assessed by **pore water** in 2019, 2022 and 2025 at all sites. • Total organic carbon analyses to be conducted in 2019, 2022 and 2025 for all samples at all sites. • Ammonia and sulfide to be measured in Inner Harbour sediment **pore water** in 2019, 2022 and 2025 at all sites. • Toxicity testing, using the amphipod *Melita plumulosa*, is included in the sediment monitoring program for select sites in 2019-2023 and turbidity is measured in the laboratory aquaria during toxicity tests.
2021	• Spatio-temporal modelling undertaken in 2021 to assess whether current annual **surface** sediment monitoring sites need to be revised to provide finer resolution of footprint of contaminated sediment in Melville Bay.
2022	• Locations of sediment **coring** sites should be reviewed in 2022 to identify if the sites need to be shifted in response to changes in the contaminated sediment footprint in inner Gove Harbour. • Sediment sampling sites for toxicity testing should be reassessed in 2022 for spatial adequacy in relation to the contamination footprint.
2024-2025 Sampling to be conducted in dry and wet seasons.	• Particle sizing analysis completed for all **cores** collected in 2019, 2022 and 2025 and on samples collected for sediment toxicity testing in the wet and dry seasons of 2024 and 2025. • Metal concentrations to be assessed by **pore water** on samples collected for sediment toxicity testing in the wet and dry seasons of 2024 and 2025. • Total organic carbon analyses to be conducted on samples collected for sediment toxicity testing in the wet and dry seasons of 2024 and 2025. • Ammonia and sulfide are measured in Inner Harbour sediment **pore water** on samples collected for sediment toxicity testing in the wet and dry seasons of 2024 and 2025.

Year(s)	MSMP Monitoring Component
	• Toxicity testing in 2024-2025 using the amphipod *Melita plumulosa*, is conducted at select sites based on toxicity data review conducted in 2022. Turbidity is measured in the laboratory aquaria during toxicity tests • A genomic-based approach (eukaryotic testing) is used in the sediment monitoring program in 2024 - 2025 to assess the ecology of the sediment, based on benthic community structure. Eukaryotic testing to be conducted at toxicity testing sites during both the wet and dry seasons in both 2024 and 2025, to account for seasonal variation in benthic community structure. • MHMP oyster monitoring data to be used as the bioaccumulation line of evidence as part of an ecological risk assessment framework.

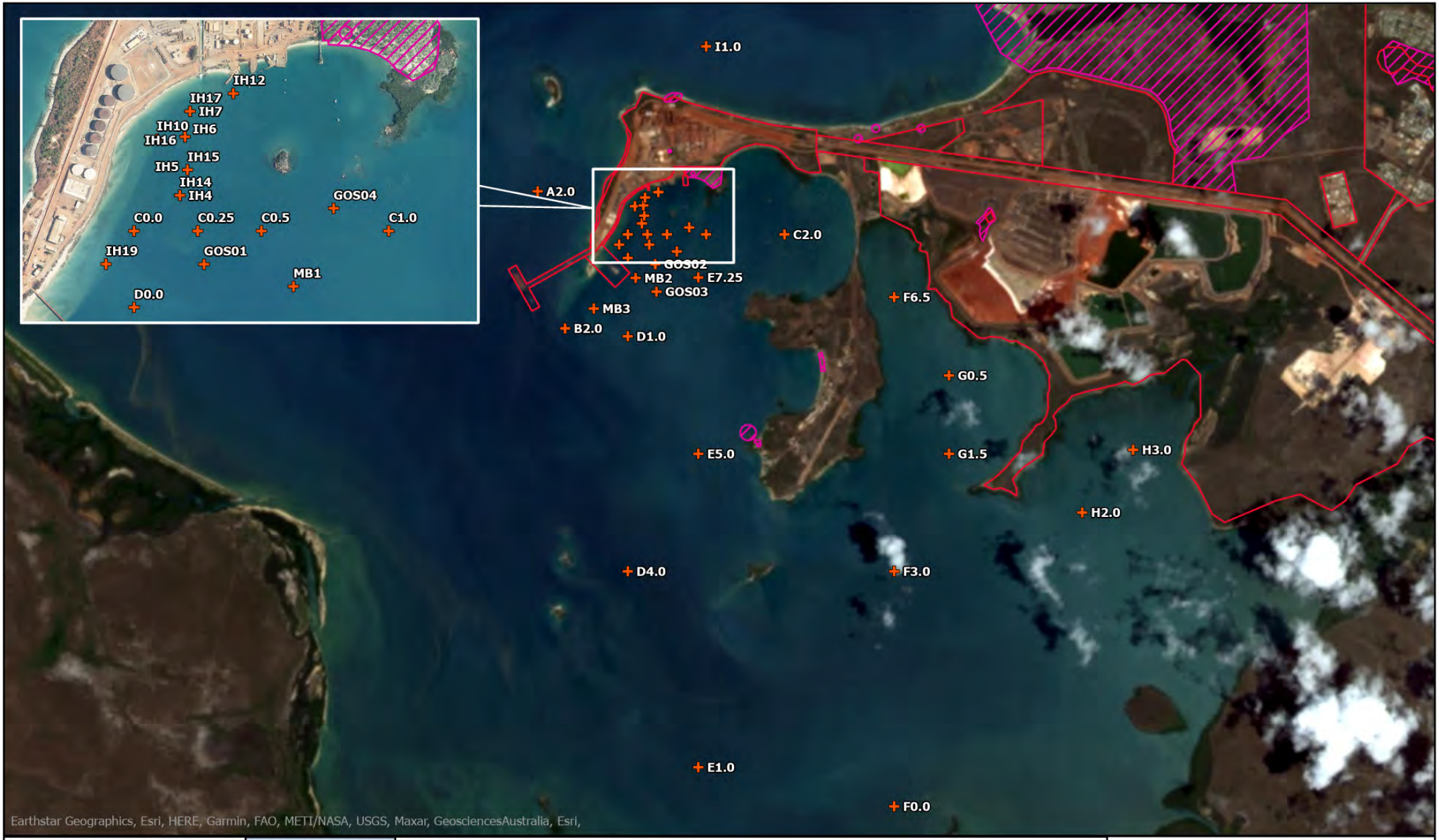
Table A3 Closure marine Sediment Monitoring - 2021

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample Type	CMSMP – 2021 Program					
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
681,850	8,651,350	A2.0	S	✓	✓			✓	
682,200	8,649,600	B2.0	S	✓	✓			✓	
683,000	8,650,800	C0.0	S	✓	✓			✓	✓
683,000	**8,650,800**	**C0.0**	**C**						
683,250	8,650,800	C0.25	S	✓	✓			✓	
683,500	8,650,800	C0.50	S	✓	✓			✓	
683,500	**8,650,800**	**C0.50**	**C**						
684,000	8,650,800	C1.0	S	✓	✓			✓	
685,000	8,650,800	C2.0	S	✓	✓			✓	
683,000	8,650,500	D0.0	S	✓	✓			✓	
683,000	**8,650,500**	**D0.0**	**C**						
683,000	8,649,500	D1.0	S	✓	✓			✓	
683,000	**8,649,500**	**D1.0**	**C**						
683,000	8,646,500	D4.0	S	✓	✓			✓	
683,900	8,644,000	E1.0	S	✓	✓			✓	
683,900	8,648,000	E5.0	S	✓	✓			✓	
683,900	8,650,250	E7.25	S	✓	✓			✓	
683,900	**8,650,250**	**E7.25**	**C**						
686,400	8,643,500	F0.0	S	✓	✓			✓	
686,400	8,646,500	F3.0	S	✓	✓			✓	
686,400	8,650,000	F6.5	S	✓	✓			✓	
687,100	8,649,000	G0.5	S	✓	✓			✓	✓
687,100	8,648,000	G1.5	S	✓	✓			✓	

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample Type	CMSMP – 2021 Program					
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
688,800	8,647,250	H2.0	S	✓	✓			✓	
689,450	8,648,050	H3.0	S	✓	✓			✓	✓
684,000	8,653,200	I1.0	S	✓	✓			✓	
683,180	8,650,940	IH4	S	✓	✓			✓	✓ x 3
683,180	**8,650,940**	**IH4**	**C**						
683,210	8,651,040	IH5	S	✓	✓			✓	
683,200	8,651,170	IH6	S	✓	✓			✓	✓
683,200	**8,651,170**	**IH6**	**C**						
683,220	8,651,270	IH7	S	✓	✓			✓	✓
683,090	8,651,160	IH10	S	✓	✓			✓	✓
683,390	8,651,340	IH12	S	✓	✓			✓	✓
683,730	8,651,410	IH14	S	✓	✓			✓	✓
683,920	8,651,330	IH15	S	✓	✓			✓	✓
683,770	8,651,240	IH16	S	✓	✓			✓	
683,770	**8,651,240**	**IH16**	**C**						
683,470	8,651,200	IH17	S	✓	✓			✓	
683,470	**8,651,200**	**IH17**	**C**						
682,890	8,650,670	IH19	S	✓	✓			✓	✓
683,275	8,650,669	**GOS01**	S	✓	✓			✓	✓ x 3
683,275	**8,650,669**	**GOS01**	**C**						
683,351	8,650,420	**GOS02**	S	✓	✓			✓	✓
683,351	**8,650,420**	**GOS02**	**C**						
683,367	8,650,069	**GOS03**	S	✓	✓			✓	✓
683,367	**8,650,069**	**GOS03**	**C**						

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample Type	CMSMP – 2021 Program					
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
683,784	8,650,889	GOS04	C						
683,626	8,650,582	MB1	C						
683,100	8,650,244	MB2	C						
682,566	8,649,853	MB3	C						

In 2021, spatio-temporal modelling or other statistical analysis to be conducted to assess whether current annual surface sediment monitoring sites need to be revised to provide finer resolution of footprint of contaminated sediment in Melville Bay.



RioTinto

Map Scale: 1:65,000(A4)

Spatial Reference
Name: GDA 1994 MGA Zone 53

N

Kilometres
0 0.5 1 1.5 2

Legend

- Sediment
- Gove Operations Leases
- Cultural Heritage Areas

GOVE OPERATIONS
MARINE HEALTH MONITORING PLAN

Closure Marine Sediment Monitoring Locations

\\augovna1\GISStorage\RTA_GoveGIS\RTA_GoveGIS\25_ArcGISProProjects\Figures\2021_GoveOperationsWaterManagementPlan\2022_GoveOperationsMarineHealthMonitoringPlan.aprx Author: Sangeetha.Banakar Date:4/03/2022

Table A4 Marine Sediment Monitoring - 2022

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	CMSMP - 2022 Program						
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
681,850	8,651,350	A2.0	S	✓	✓	✓	✓	✓	✓	
682,200	8,649,600	B2.0	S	✓	✓	✓	✓	✓	✓	
683,000	8,650,800	C0.0	S	✓	✓	✓	✓	✓	✓	
683,000	**8,650,800**	**C0.0**	**C**	✓	✓	✓	✓	✓	✓	
683,250	8,650,800	C0.25	S	✓	✓	✓	✓	✓	✓	
683,500	8,650,800	C0.50	S	✓	✓	✓	✓	✓	✓	
683,500	**8,650,800**	**C0.50**	**C**	✓	✓	✓	✓	✓	✓	
684,000	8,650,800	C1.0	S	✓	✓	✓	✓	✓	✓	
685,000	8,650,800	C2.0	S	✓	✓	✓	✓	✓	✓	
683,000	8,650,500	D0.0	S	✓	✓	✓	✓	✓	✓	
683,000	**8,650,500**	**D0.0**	**C**	✓	✓	✓	✓	✓	✓	
683,000	8,649,500	D1.0	S	✓	✓	✓	✓	✓	✓	
683,000	**8,649,500**	**D1.0**	**C**	✓	✓	✓	✓	✓	✓	
683,000	8,646,500	D4.0	S	✓	✓	✓	✓	✓	✓	
683,900	8,644,000	E1.0	S	✓	✓	✓	✓	✓	✓	
683,900	8,648,000	E5.0	S	✓	✓	✓	✓	✓	✓	
683,900	8,650,250	E7.25	S	✓	✓	✓	✓	✓	✓	
683,900	**8,650,250**	**E7.25**	**C**	✓	✓	✓	✓	✓	✓	
686,400	8,643,500	F0.0	S	✓	✓	✓	✓	✓	✓	
686,400	8,646,500	F3.0	S	✓	✓	✓	✓	✓	✓	
686,400	8,650,000	F6.5	S	✓	✓	✓	✓	✓	✓	
687,100	8,649,000	G0.5	S	✓	✓	✓	✓	✓	✓	✓

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	CMSMP - 2022 Program						
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
687,100	8,648,000	G1.5	S	✓	✓	✓	✓	✓	✓	
688,800	8,647,250	H2.0	S	✓	✓	✓	✓	✓	✓	
689,450	8,648,050	H3.0	S	✓	✓	✓	✓	✓	✓	✓
684,000	8,653,200	I1.0	S	✓	✓	✓	✓	✓	✓	
683,180	8,650,940	IH4	S	✓	✓	✓	✓	✓	✓	✓
683,180	**8,650,940**	**IH4**	**C**	✓	✓	✓	✓	✓	✓	
683,210	8,651,040	IH5	S	✓	✓	✓	✓	✓	✓	
683,200	8,651,170	IH6	S	✓	✓	✓	✓	✓	✓	✓
683,200	**8,651,170**	**IH6**	**C**	✓	✓	✓	✓	✓	✓	Up to 2m
683,220	8,651,270	IH7	S	✓	✓	✓	✓	✓	✓	
683,090	8,651,160	IH10	S	✓	✓	✓	✓	✓	✓	
683,390	8,651,340	IH12	S	✓	✓	✓	✓	✓	✓	
683,730	8,651,410	IH14	S	✓	✓	✓	✓	✓	✓	
683,920	8,651,330	IH15	S	✓	✓	✓	✓	✓	✓	
683,770	8,651,240	IH16	S	✓	✓	✓	✓	✓	✓	
683,770	**8,651,240**	**IH16**	**C**	✓	✓	✓	✓	✓	✓	
683,470	8,651,200	IH17	S	✓	✓	✓	✓	✓	✓	
683,470	**8,651,200**	**IH17**	**C**	✓	✓	✓	✓	✓	✓	
682,890	8,650,670	IH19	S	✓	✓	✓	✓	✓	✓	
683,275	8,650,669	**GOS01**	S	✓	✓	✓	✓	✓	✓	✓
683,275	**8,650,669**	**GOS01**	**C**	✓	✓	✓	✓	✓	✓	
683,351	8,650,420	**GOS02**	S	✓	✓	✓	✓	✓	✓	
683,351	**8,650,420**	**GOS02**	**C**	✓	✓	✓	✓	✓	✓	
683,367	8,650,069	**GOS03**	S	✓	✓	✓	✓	✓	✓	✓

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	CMSMP - 2022 Program						
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
683,367	8,650,069	GOS03	C	✓	✓	✓	✓	✓	✓	
683,784	8,650,889	GOS04	C	✓	✓	✓	✓	✓	✓	
683,626	8,650,582	MB1	C	✓	✓	✓	✓	✓	✓	
683,100	8,650,244	MB2	C	✓	✓	✓	✓	✓	✓	
682,566	8,649,853	MB3	C	✓	✓	✓	✓	✓	✓	

In 2022, the location of sediment coring sites should be reviewed to identify if the sites need to be shifted in response to changes in the contaminated sediment footprint in inner Gove Harbour. Sediment sampling sites for toxicity testing should also be reassessed in 2022 with respect to spatial adequacy of the contaminated sediment footprint.

Table A5 Marine Sediment Monitoring - 2023

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	CMSMP - 2023 Program					
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
681,850	8,651,350	A2.0	S	✓	✓			✓	
682,200	8,649,600	B2.0	S	✓	✓			✓	
683,000	8,650,800	C0.0	S	✓	✓			✓	
683,000	**8,650,800**	**C0.0**	**C**						
683,250	8,650,800	C0.25	S	✓	✓			✓	
683,500	8,650,800	C0.50	S	✓	✓			✓	
683,500	**8,650,800**	**C0.50**	**C**						
684,000	8,650,800	C1.0	S	✓	✓			✓	
685,000	8,650,800	C2.0	S	✓	✓			✓	
683,000	8,650,500	D0.0	S	✓	✓			✓	
683,000	**8,650,500**	**D0.0**	**C**						
683,000	8,649,500	D1.0	S	✓	✓			✓	
683,000	**8,649,500**	**D1.0**	**C**						
683,000	8,646,500	D4.0	S	✓	✓			✓	
683,900	8,644,000	E1.0	S	✓	✓			✓	
683,900	8,648,000	E5.0	S	✓	✓			✓	
683,900	8,650,250	E7.25	S	✓	✓			✓	
683,900	**8,650,250**	**E7.25**	**C**						
686,400	8,643,500	F0.0	S	✓	✓			✓	
686,400	8,646,500	F3.0	S	✓	✓			✓	
686,400	8,650,000	F6.5	S	✓	✓			✓	

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	CMSMP - 2023 Program					
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
687,100	8,649,000	G0.5	S	✓	✓			✓	✓
687,100	8,648,000	G1.5	S	✓	✓			✓	
688,800	8,647,250	H2.0	S	✓	✓			✓	
689,450	8,648,050	H3.0	S	✓	✓			✓	✓
684,000	8,653,200	I1.0	S	✓	✓			✓	
683,180	8,650,940	IH4	S	✓	✓			✓	✓
683,180	**8,650,940**	**IH4**	**C**						
683,210	8,651,040	IH5	S	✓	✓			✓	
683,200	8,651,170	IH6	S	✓	✓			✓	✓
683,200	**8,651,170**	**IH6**	**C**						
683,220	8,651,270	IH7	S	✓	✓			✓	
683,090	8,651,160	IH10	S	✓	✓			✓	
683,390	8,651,340	IH12	S	✓	✓			✓	
683,730	8,651,410	IH14	S	✓	✓			✓	
683,920	8,651,330	IH15	S	✓	✓			✓	
683,770	8,651,240	IH16	S	✓	✓			✓	
683,770	**8,651,240**	**IH16**	**C**						
683,470	8,651,200	IH17	S	✓	✓			✓	
683,470	**8,651,200**	**IH17**	**C**						
682,890	8,650,670	IH19	S	✓	✓			✓	
683,275	8,650,669	**GOS01**	S	✓	✓			✓	✓
683,275	**8,650,669**	**GOS01**	**C**						
683,351	8,650,420	**GOS02**	S	✓	✓			✓	

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	CMSMP - 2023 Program					
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Pore water	Sulfide/ ammonia	PSD	Toxicity tests
683,351	**8,650,420**	**GOS02**	**C**						
683,367	8,650,069	**GOS03**	S	✓	✓			✓	✓
683,367	**8,650,069**	**GOS03**	**C**						
683,784	**8,650,889**	**GOS04**	**C**						
683,626	**8,650,582**	**MB1**	**C**						
683,100	**8,650,244**	**MB2**	**C**						
682,566	**8,649,853**	**MB3**	**C**						

Table A6 Marine Sediment Monitoring – 2024 – Dry Season

				CMSMP - 2024 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Dry Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
681,850	8,651,350	A2.0	S	✓	✓				✓		
682,200	8,649,600	B2.0	S	✓	✓				✓		
683,000	8,650,800	C0.0	S	✓	✓				✓		
683,000	**8,650,800**	**C0.0**	**C**								
683,250	8,650,800	C0.25	S	✓	✓				✓		
683,500	8,650,800	C0.50	S	✓	✓				✓		
683,500	**8,650,800**	**C0.50**	**C**								
684,000	8,650,800	C1.0	S	✓	✓				✓		
685,000	8,650,800	C2.0	S	✓	✓				✓		
683,000	8,650,500	D0.0	S	✓	✓				✓		
683,000	**8,650,500**	**D0.0**	**C**								
683,000	8,649,500	D1.0	S	✓	✓				✓		
683,000	**8,649,500**	**D1.0**	**C**								
683,000	8,646,500	D4.0	S	✓	✓				✓		
683,900	8,644,000	E1.0	S	✓	✓				✓		
683,900	8,648,000	E5.0	S	✓	✓				✓		
683,900	8,650,250	E7.25	S	✓	✓				✓		
683,900	**8,650,250**	**E7.25**	**C**								
686,400	8,643,500	F0.0	S	✓	✓				✓		
686,400	8,646,500	F3.0	S	✓	✓				✓		
686,400	8,650,000	F6.5	S	✓	✓				✓		

				CMSMP - 2024 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Dry Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
687,100	8,649,000	G0.5	S	✓	✓	✓	✓	✓	✓	✓	✓
687,100	8,648,000	G1.5	S	✓	✓				✓		
688,800	8,647,250	H2.0	S	✓	✓				✓		
689,450	8,648,050	H3.0	S	✓	✓	✓	✓	✓	✓	✓	✓
684,000	8,653,200	I1.0	S	✓	✓				✓		
683,180	8,650,940	IH4	S	✓	✓	✓	✓	✓	✓	✓	✓
683,180	**8,650,940**	**IH4**	**C**								
683,210	8,651,040	IH5	S	✓	✓				✓		
683,200	8,651,170	IH6	S	✓	✓	✓	✓	✓	✓	✓	✓
683,200	**8,651,170**	**IH6**	**C**								
683,220	8,651,270	IH7	S	✓	✓				✓		
683,090	8,651,160	IH10	S	✓	✓				✓		
683,390	8,651,340	IH12	S	✓	✓				✓		
683,730	8,651,410	IH14	S	✓	✓				✓		
683,920	8,651,330	IH15	S	✓	✓				✓		
683,770	8,651,240	IH16	S	✓	✓				✓		
683,770	**8,651,240**	**IH16**	**C**								
683,470	8,651,200	IH17	S	✓	✓				✓		
683,470	**8,651,200**	**IH17**	**C**								
682,890	8,650,670	IH19	S	✓	✓				✓		
683,275	8,650,669	**GOS01**	S	✓	✓	✓	✓	✓	✓	✓	✓
683,275	**8,650,669**	**GOS01**	**C**								

				CMSMP - 2024 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Dry Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
683,351	8,650,420	GOS02	S						✓		
683,351	**8,650,420**	**GOS02**	**C**								
683,367	8,650,069	GOS03	S	✓	✓	✓	✓	✓	✓	✓	✓
683,367	**8,650,069**	**GOS03**	**C**								
683,784	**8,650,889**	**GOS04**	**C**								
683,626	**8,650,582**	**MB1**	**C**								
683,100	**8,650,244**	**MB2**	**C**								
682,566	**8,649,853**	**MB3**	**C**								

*Sediment sampling sites for toxicity testing in 2024-2025 under the MSMP, to be determined based on review of 2022 data for spatial adequacy in relation to impacted sediment.

**It is recommended that suitable target genes are identified prior to sequencing of samples in 2024-2025 for eukaryotic assessments. Eukaryotic community and sediment chemistry relationship analysis should be assessed by multivariate analysis such as that provided in the PRIMER or VEGAN packages.

Table A7 Marine Sediment Monitoring – 2024 – Wet Season

				CMSMP - 2024 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Wet Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
681,850	8,651,350	A2.0	S	✓	✓				✓		
682,200	8,649,600	B2.0	S	✓	✓				✓		
683,000	8,650,800	C0.0	S	✓	✓				✓		
683,000	**8,650,800**	**C0.0**	**C**								
683,250	8,650,800	C0.25	S	✓	✓				✓		
683,500	8,650,800	C0.50	S	✓	✓				✓		
683,500	**8,650,800**	**C0.50**	**C**								
684,000	8,650,800	C1.0	S	✓	✓				✓		
685,000	8,650,800	C2.0	S	✓	✓				✓		
683,000	8,650,500	D0.0	S	✓	✓				✓		
683,000	**8,650,500**	**D0.0**	**C**								
683,000	8,649,500	D1.0	S	✓	✓				✓		
683,000	**8,649,500**	**D1.0**	**C**								
683,000	8,646,500	D4.0	S	✓	✓				✓		
683,900	8,644,000	E1.0	S	✓	✓				✓		
683,900	8,648,000	E5.0	S	✓	✓				✓		
683,900	8,650,250	E7.25	S	✓	✓				✓		
683,900	**8,650,250**	**E7.25**	**C**								
686,400	8,643,500	F0.0	S	✓	✓				✓		
686,400	8,646,500	F3.0	S	✓	✓				✓		
686,400	8,650,000	F6.5	S	✓	✓				✓		

				CMSMP - 2024 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Wet Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
687,100	8,649,000	G0.5	S	✓	✓	✓	✓	✓	✓	✓	✓
687,100	8,648,000	G1.5	S	✓	✓				✓		
688,800	8,647,250	H2.0	S	✓	✓				✓		
689,450	8,648,050	H3.0	S	✓	✓	✓	✓	✓	✓	✓	✓
684,000	8,653,200	I1.0	S	✓	✓				✓		
683,180	8,650,940	IH4	S	✓	✓	✓	✓	✓	✓	✓	✓
683,180	**8,650,940**	**IH4**	**C**								
683,210	8,651,040	IH5	S	✓	✓				✓		
683,200	8,651,170	IH6	S	✓	✓	✓	✓	✓	✓	✓	✓
683,200	**8,651,170**	**IH6**	**C**								
683,220	8,651,270	IH7	S	✓	✓				✓		
683,090	8,651,160	IH10	S	✓	✓				✓		
683,390	8,651,340	IH12	S	✓	✓				✓		
683,730	8,651,410	IH14	S	✓	✓				✓		
683,920	8,651,330	IH15	S	✓	✓				✓		
683,770	8,651,240	IH16	S	✓	✓				✓		
683,770	**8,651,240**	**IH16**	**C**								
683,470	8,651,200	IH17	S	✓	✓				✓		
683,470	**8,651,200**	**IH17**	**C**								
682,890	8,650,670	IH19	S	✓	✓				✓		
683,275	8,650,669	**GOS01**	S	✓	✓	✓	✓	✓	✓	✓	✓
683,275	**8,650,669**	**GOS01**	**C**								

				CMSMP - 2024 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Wet Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
683,351	8,650,420	GOS02	S								
683,351	**8,650,420**	**GOS02**	**C**								
683,367	8,650,069	GOS03	S	✓	✓	✓	✓	✓	✓	✓	✓
683,367	**8,650,069**	**GOS03**	**C**								
683,784	**8,650,889**	**GOS04**	**C**								
683,626	**8,650,582**	**MB1**	**C**								
683,100	**8,650,244**	**MB2**	**C**								
682,566	**8,649,853**	**MB3**	**C**								

*Sediment sampling sites for toxicity testing in 2024-2025 under the MSMP, to be determined based on review of 2022 data for spatial adequacy in relation to impacted sediment.

**It is recommended that suitable target genes are identified prior to sequencing of samples in 2024-2025 for eukaryotic assessments. Eukaryotic community and sediment chemistry relationship analysis should be assessed by multivariate analysis such as that provided in the PRIMER or VEGAN packages.

Table A8 Marine Sediment Monitoring – 2025 – Dry Season

				CMSMP - 2025 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Dry Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
681,850	8,651,350	A2.0	S	✓	✓	✓	✓	✓	✓		
682,200	8,649,600	B2.0	S	✓	✓	✓	✓	✓	✓		
683,000	8,650,800	C0.0	S	✓	✓	✓	✓	✓	✓		
683,000	**8,650,800**	**C0.0**	**C**	✓	✓	✓	✓	✓	✓		
683,250	8,650,800	C0.25	S	✓	✓	✓	✓	✓	✓		
683,500	8,650,800	C0.50	S	✓	✓	✓	✓	✓	✓		
683,500	**8,650,800**	**C0.50**	**C**	✓	✓	✓	✓	✓	✓		
684,000	8,650,800	C1.0	S	✓	✓	✓	✓	✓	✓		
685,000	8,650,800	C2.0	S	✓	✓	✓	✓	✓	✓		
683,000	8,650,500	D0.0	S	✓	✓	✓	✓	✓	✓		
683,000	**8,650,500**	**D0.0**	**C**	✓	✓	✓	✓	✓	✓		
683,000	8,649,500	D1.0	S	✓	✓	✓	✓	✓	✓		
683,000	**8,649,500**	**D1.0**	**C**	✓	✓	✓	✓	✓	✓		
683,000	8,646,500	D4.0	S	✓	✓	✓	✓	✓	✓		
683,900	8,644,000	E1.0	S	✓	✓	✓	✓	✓	✓		
683,900	8,648,000	E5.0	S	✓	✓	✓	✓	✓	✓		
683,900	8,650,250	E7.25	S	✓	✓	✓	✓	✓	✓		
683,900	**8,650,250**	**E7.25**	**C**	✓	✓	✓	✓	✓	✓		
686,400	8,643,500	F0.0	S	✓	✓	✓	✓	✓	✓		
686,400	8,646,500	F3.0	S	✓	✓	✓	✓	✓	✓		
686,400	8,650,000	F6.5	S	✓	✓	✓	✓	✓	✓		

				CMSMP - 2025 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Dry Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
687,100	8,649,000	G0.5	S	✓	✓	✓	✓	✓	✓	✓	✓
687,100	8,648,000	G1.5	S	✓	✓	✓	✓	✓	✓		
688,800	8,647,250	H2.0	S	✓	✓	✓	✓	✓	✓		
689,450	8,648,050	H3.0	S	✓	✓	✓	✓	✓	✓	✓	✓
684,000	8,653,200	I1.0	S	✓	✓	✓	✓	✓	✓		
683,180	8,650,940	IH4	S	✓	✓	✓	✓	✓	✓	✓	✓
683,180	**8,650,940**	**IH4**	**C**	✓	✓	✓	✓	✓	✓		
683,210	8,651,040	IH5	S	✓	✓	✓	✓	✓	✓		
683,200	8,651,170	IH6	S	✓	✓	✓	✓	✓	✓	✓	✓
683,200	**8,651,170**	**IH6**	**C**	✓	✓	✓	✓	✓	✓		
683,220	8,651,270	IH7	S	✓	✓	✓	✓	✓	✓		
683,090	8,651,160	IH10	S	✓	✓	✓	✓	✓	✓		
683,390	8,651,340	IH12	S	✓	✓	✓	✓	✓	✓		
683,730	8,651,410	IH14	S	✓	✓	✓	✓	✓	✓		
683,920	8,651,330	IH15	S	✓	✓	✓	✓	✓	✓		
683,770	8,651,240	IH16	S	✓	✓	✓	✓	✓	✓		
683,770	**8,651,240**	**IH16**	**C**	✓	✓	✓	✓	✓	✓		
683,470	8,651,200	IH17	S	✓	✓	✓	✓	✓	✓		
683,470	**8,651,200**	**IH17**	**C**	✓	✓	✓	✓	✓	✓		
682,890	8,650,670	IH19	S	✓	✓	✓	✓	✓	✓		
683,275	8,650,669	**GOS01**	S	✓	✓	✓	✓	✓	✓	✓	✓
683,275	**8,650,669**	**GOS01**	**C**	✓	✓	✓	✓	✓	✓		

				CMSMP - 2025 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Dry Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
683,351	8,650,420	GOS02	S	✓	✓	✓	✓	✓	✓		
683,351	**8,650,420**	**GOS02**	**C**	✓	✓	✓	✓	✓	✓		
683,367	8,650,069	GOS03	S	✓	✓	✓	✓	✓	✓	✓	✓
683,367	**8,650,069**	**GOS03**	**C**	✓	✓	✓	✓	✓	✓		
683,784	**8,650,889**	**GOS04**	**C**	✓	✓	✓	✓	✓	✓		
683,626	**8,650,582**	**MB1**	**C**	✓	✓	✓	✓	✓	✓		
683,100	**8,650,244**	**MB2**	**C**	✓	✓	✓	✓	✓	✓		
682,566	**8,649,853**	**MB3**	**C**	✓	✓	✓	✓	✓	✓		

*Sediment sampling sites for toxicity testing in 2024-2025 under the MSMP, to be determined based on review of 2022 data for spatial adequacy in relation to impacted sediment.

**It is recommended that suitable target genes are identified prior to sequencing of samples in 2024-2025 for eukaryotic assessments. Eukaryotic community and sediment chemistry relationship analysis should be assessed by multivariate analysis such as that provided in the PRIMER or VEGAN packages.

Table A9 Marine Sediment Monitoring – 2025 – Wet Season

				MSMP - 2025 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Wet Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
681,850	8,651,350	A2.0	S	✓	✓	✓	✓	✓	✓		
682,200	8,649,600	B2.0	S	✓	✓	✓	✓	✓	✓		
683,000	8,650,800	C0.0	S	✓	✓	✓	✓	✓	✓		
683,000	**8,650,800**	**C0.0**	**C**	✓	✓	✓	✓	✓	✓		
683,250	8,650,800	C0.25	S	✓	✓	✓	✓	✓	✓		
683,500	8,650,800	C0.50	S	✓	✓	✓	✓	✓	✓		
683,500	**8,650,800**	**C0.50**	**C**	✓	✓	✓	✓	✓	✓		
684,000	8,650,800	C1.0	S	✓	✓	✓	✓	✓	✓		
685,000	8,650,800	C2.0	S	✓	✓	✓	✓	✓	✓		
683,000	8,650,500	D0.0	S	✓	✓	✓	✓	✓	✓		
683,000	**8,650,500**	**D0.0**	**C**	✓	✓	✓	✓	✓	✓		
683,000	8,649,500	D1.0	S	✓	✓	✓	✓	✓	✓		
683,000	**8,649,500**	**D1.0**	**C**	✓	✓	✓	✓	✓	✓		
683,000	8,646,500	D4.0	S	✓	✓	✓	✓	✓	✓		
683,900	8,644,000	E1.0	S	✓	✓	✓	✓	✓	✓		
683,900	8,648,000	E5.0	S	✓	✓	✓	✓	✓	✓		
683,900	8,650,250	E7.25	S	✓	✓	✓	✓	✓	✓		
683,900	**8,650,250**	**E7.25**	**C**	✓	✓	✓	✓	✓	✓		
686,400	8,643,500	F0.0	S	✓	✓	✓	✓	✓	✓		
686,400	8,646,500	F3.0	S	✓	✓	✓	✓	✓	✓		
686,400	8,650,000	F6.5	S	✓	✓	✓	✓	✓	✓		

Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	MSMP - 2025 Program							
				Wet Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
687,100	8,649,000	G0.5	S	✓	✓	✓	✓	✓	✓	✓	✓
687,100	8,648,000	G1.5	S	✓	✓	✓	✓	✓	✓		
688,800	8,647,250	H2.0	S	✓	✓	✓	✓	✓	✓		
689,450	8,648,050	H3.0	S	✓	✓	✓	✓	✓	✓	✓	✓
684,000	8,653,200	I1.0	S	✓	✓	✓	✓	✓	✓		
683,180	8,650,940	IH4	S	✓	✓	✓	✓	✓	✓	✓	✓
683,180	**8,650,940**	**IH4**	**C**	✓	✓	✓	✓	✓	✓		
683,210	8,651,040	IH5	S	✓	✓	✓	✓	✓	✓		
683,200	8,651,170	IH6	S	✓	✓	✓	✓	✓	✓	✓	✓
683,200	**8,651,170**	**IH6**	**C**	✓	✓	✓	✓	✓	✓		
683,220	8,651,270	IH7	S	✓	✓	✓	✓	✓	✓		
683,090	8,651,160	IH10	S	✓	✓	✓	✓	✓	✓		
683,390	8,651,340	IH12	S	✓	✓	✓	✓	✓	✓		
683,730	8,651,410	IH14	S	✓	✓	✓	✓	✓	✓		
683,920	8,651,330	IH15	S	✓	✓	✓	✓	✓	✓		
683,770	8,651,240	IH16	S	✓	✓	✓	✓	✓	✓		
683,770	**8,651,240**	**IH16**	**C**	✓	✓	✓	✓	✓	✓		
683,470	8,651,200	IH17	S	✓	✓	✓	✓	✓	✓		
683,470	**8,651,200**	**IH17**	**C**	✓	✓	✓	✓	✓	✓		
682,890	8,650,670	IH19	S	✓	✓	✓	✓	✓	✓		
683,275	8,650,669	**GOS01**	S	✓	✓	✓	✓	✓	✓	✓	✓
683,275	**8,650,669**	**GOS01**	**C**	✓	✓	✓	✓	✓	✓		

				MSMP - 2025 Program							
Coordinates (GDA 1994 MGA Zone 53)		Sample Site	Sample type:	Wet Season							
Easting	Northing			Total metal(loid)s	AEM (1N HCl) metal(loid)s	Total Organic Carbon	Pore water	Sulfide/ ammonia	PSD	Toxicity tests*	Eukaryotic assessments**
683,351	8,650,420	GOS02	S	✓	✓	✓	✓	✓	✓		
683,351	**8,650,420**	**GOS02**	**C**	✓	✓	✓	✓	✓	✓		
683,367	8,650,069	GOS03	S	✓	✓	✓	✓	✓	✓	✓	✓
683,367	**8,650,069**	**GOS03**	**C**	✓	✓	✓	✓	✓	✓		
683,784	**8,650,889**	**GOS04**	**C**	✓	✓	✓	✓	✓	✓		
683,626	**8,650,582**	**MB1**	**C**	✓	✓	✓	✓	✓	✓		
683,100	**8,650,244**	**MB2**	**C**	✓	✓	✓	✓	✓	✓		
682,566	**8,649,853**	**MB3**	**C**	✓	✓	✓	✓	✓	✓		

*Sediment sampling sites for toxicity testing in 2024-2025 under the MSMP, to be determined based on review of 2022 data for spatial adequacy in relation to impacted sediment.

**It is recommended that suitable target genes are identified prior to sequencing of samples in 2024-2025 for eukaryotic assessments. Eukaryotic community and sediment chemistry relationship analysis should be assessed by multivariate analysis such as that provided in the PRIMER or VEGAN packages.

13 APPENDIX B – MONITORING BENTHIC COMMUNITIES IN DRIMMIE ARM, NO NAME BAY AND NORTHERN BEACHES

BACKGROUND

Rio Tinto Gove commissioned a study of the benthic communities in Drimmie Arm, Whatta (No Name) Bay and Northern Beaches in 2002 [1]. This was followed by surveys in 2007 and 2018 by AIMS [2, 3]. Comparison of the benthic communities in all three surveys showed the distribution and density of seagrass beds in Whatta (No Name) Bay and Drimmie Arm varied between surveys. However, the 2002, 2007 and 2018 surveys all used slightly different methodology and covered different spatial extents, hence it was difficult to assess changes in seagrass communities, furthermore the surveys were conducted five or 11 years apart. Therefore, observations in seagrass changes were qualitative, it appears that seagrass is relatively persistent in Whatta (No Name) Bay but has declined in Drimmie Arm. The distribution and density of seagrass beds in the tropics is naturally dynamic and driven by a range of variables such as species composition, temperature, runoff, tides, currents, cyclones and biological activity [4]. Seagrass beds in Darwin Harbour have been reported as exhibiting extremely high levels of natural variation [5], in the Caribbean seagrass die back occurs due to intense storm events and in Queensland (Australia) intertidal seagrass meadows are reduced by flood waters [4]. It is difficult to determine what factors (such as cyclone Nathan, freshwater inputs associated with large storm events and normal spatio-temporal variability of seagrass communities) have influenced the distribution of seagrass beds within Drimmie Arm and Whatta (No Name) Bay due to the absence of adequate time series data.

Seagrass surveys were conducted in November 2019 and late October 2020 in Whatta (No Name) Bay and Drimmie Arm to start building time series data for seagrass and benthic communities in these areas. Surveys of seagrass beds and benthic communities in Drimmie Arm and Whatta (No Name) Bay were conducted in April (post wet season) and October/November 2021 (late dry season) using the same methodology as the November 2018, 2019 and 2020 surveys. This will provide spatial and temporal data on seagrass and benthic communities in Drimmie Arm and Whatta (No Name) Bay.

In addition surveys of the benthic communities along Northern Beaches are conducted. Comparison of the coral cover survey in 2018 to 2007 at Northern Beaches showed coral mortality appears to have been high during this period, although it was not completely devastating and seemed to have largely affected *Acropora* species, which can re-establish over periods of 5-10 years [6, 7]. Certainly, the numerous small (up to 20cm) *Acropora* colonies observed in 2018 is indicative of recovery following a major disturbance [8], for example following a bleaching event or die-back caused by thermal stress. Bleaching events were reported for Arnhem Land in April 2016 (http://www.abc.net.au/news/2016-07-11/indigenous-rangers-on-the-frontline-of-coral-bleaching/7557646). Cyclones also cause significant damage to coral reefs [9] and cyclone Nathan passed near Gove in 2015. The time since death of colonies along the Northern Beach area was difficult to determine and likely attributable to a series of mortality events through the 10 years since the area had last been surveyed.

The 2018 survey revealed issues with using the 2007 transect lines as part of a monitoring program. Firstly, the 2007 and 2018 survey lines transverse high-relief rocky outcrops with vertical walls which extend a significant height above the seafloor making it difficult, if not impossible, to capture downward facing photos of the benthic organisms colonising the rock surfaces. Furthermore, the navigation hazards caused by the rocky outcrops, and the irregularly aligned transects makes it difficult to repeat the survey lines. Another issue with the 2007 transect lines arose because the reef along Northern Beaches is unevenly distributed, the patchy nature meant that benthic fauna was not captured on the downward facing stills but was on the forward-facing camera. The advantage of downward stills is that by maintaining a consistent field-of-view, the size of individuals and the density of benthic communities can be quantified which is not possible with forward facing video (with an unknown field-of-view).

To address these issues and to ensure that communities occurring at the full scale of depths within the site; the previous transects have been replaced with new, more evenly spaced and straightened transect lines running perpendicular to the shoreline. This enables transects to be more easily repeated in the future while still ensuring the rich vertical benthic communities are captured in the monitoring program. These lines will also traverse a longer section of the reef compared to 2007 (Figure **1**) and increase the likelihood of capturing the benthic fauna on the downward facing camera survey. Additionally new transect lines which skirt around the rocks (NB_2021T5 and NB_2021_T6) will be surveyed using a remotely operated vehicle (ROV) (Figure **1**) giving greater control over the position of the towbody, and enabling more stable, imagery close to vertical obstacles as well as enhanced safety for operators.

The objectives of the monitoring program are to:

- Identify and report on the distribution of benthic communities (seagrass, coral and sponges) in Drimmie Arm, Whatta (No Name) Bay and Northern beaches;
- Report on spatial and temporal changes in benthic communities in Drimmie Arm and Whatta (No Name) Bay based on comparative analysis of 2018, 2019 and 2020 survey data; and,
- Report qualitative spatial and temporal changes in benthic communities at Northern Beaches compared to previous surveys e.g. 2018 and 2021.

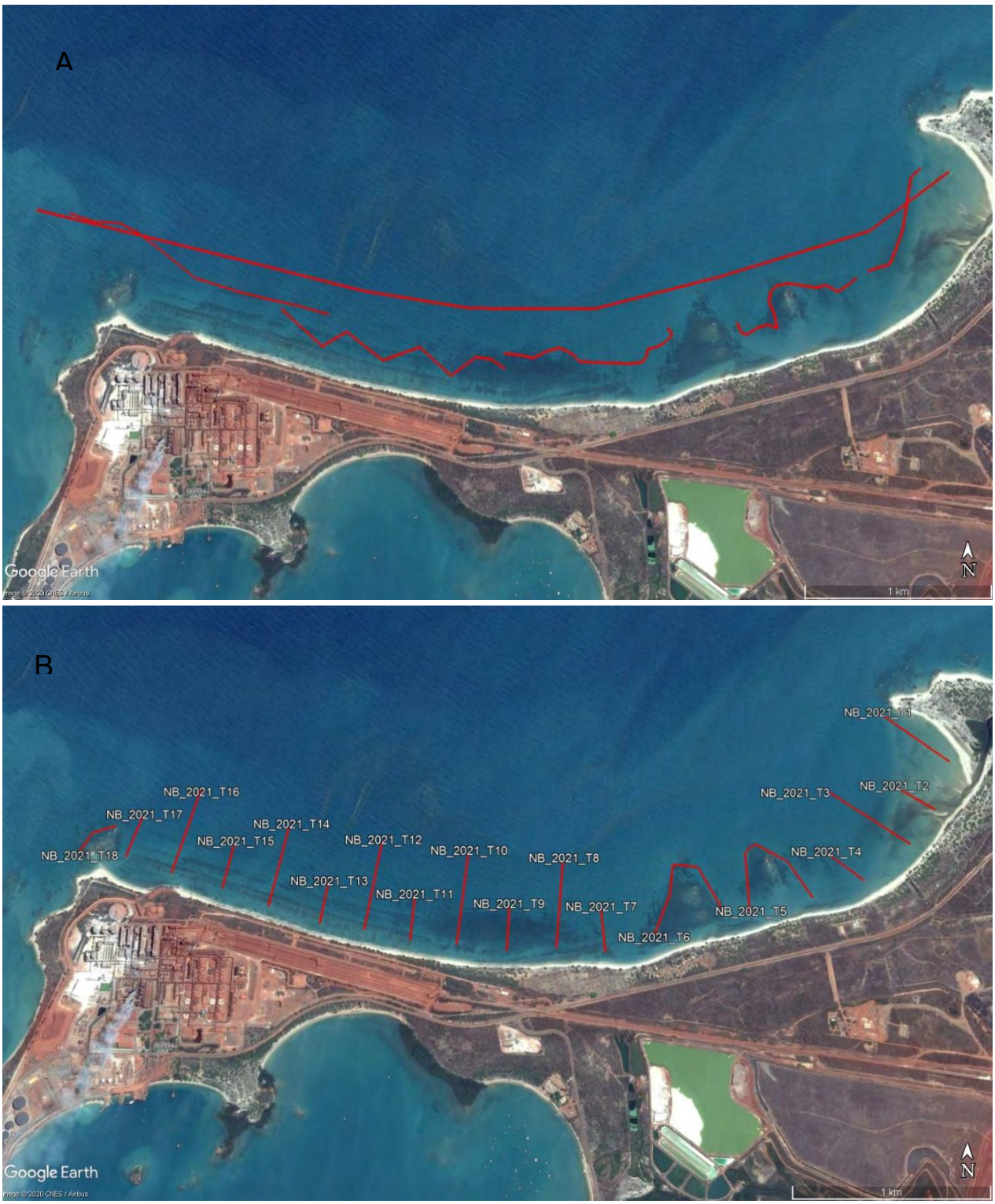


Figure 1: (A) 2007 transects and (B) new survey lines as of 2021 for benthic community survey at Northern Beaches. Survey lines are shown in red.

METHODOLOGY

Slow-video surveys were conducted in Drimmie Arm and Whatta (No Name) Bay in April (post wet season) and October/November (late dry season), along the same transects as AIMS's 2018, 2019, 2020 and 2021 studies (Figure **2**) [3, 10] to allow a comparative analysis of the changes in the benthic communities. At Northern Beaches, new 250 – 500m transects running perpendicular to the coastline will be surveyed using AIMS's remotely operated vehicle (ROV) (Figure 1). New survey lines will be undertaken at Northern Beaches after the 2018 study identified the 2007 as not optimal to capture the benthic diversity at this location. At Northern Beaches, a total distance of 8 kilometres will be surveyed by ROV.

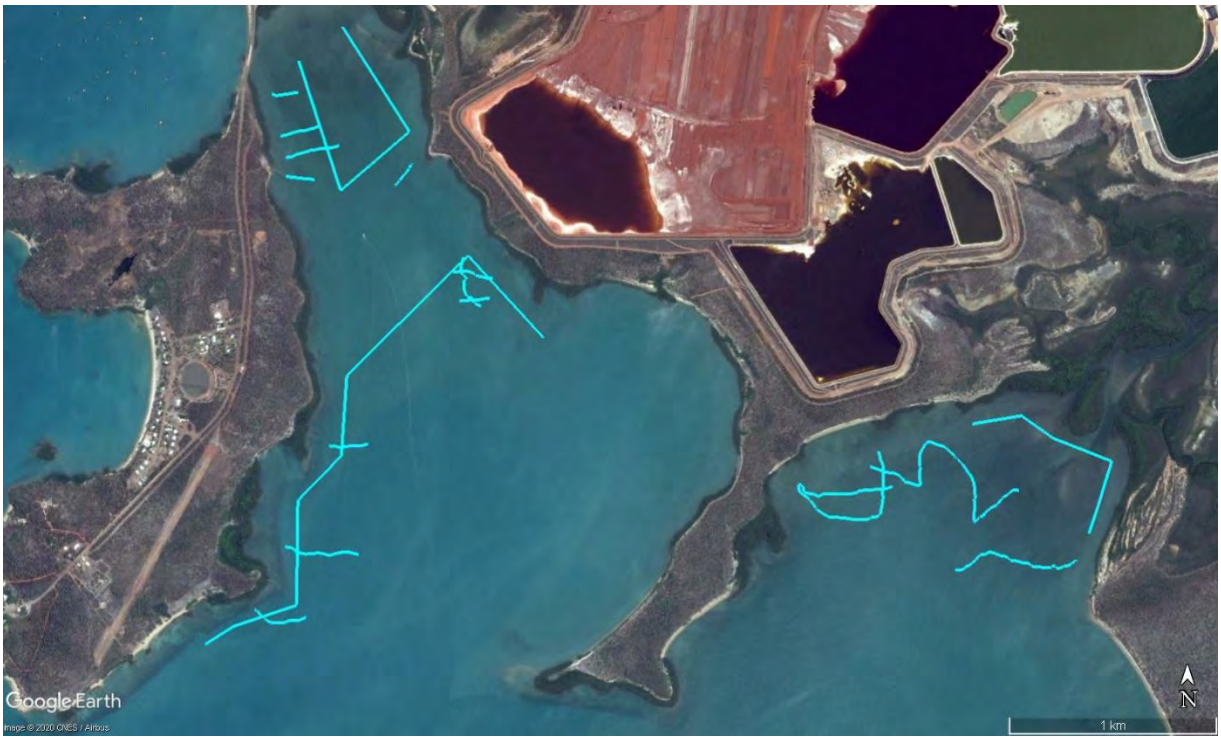


Figure 2: The transect lines (blue lines) for AIMS's slow video surveys 2008, 2018, 2019, 2020 and 2021 for Whatta (No Name) and Drimmie Arm.

The slow-video system comprises of a towed camera platform (tow body) that sends forward-facing live camera feed to the operator on the small vessel (AIMS Capricornus). The operator manually maintains the tow body at ~50 cm off the seabed, assisted by a pulley on a davit arm. Forward video imagery will be captured using either a GoPro camera or the in-built video system. A downward-facing high resolution still camera and strobe system will capture images of the seabed at fixed time intervals of three seconds and towed at 1-2 knots (1.5 nominal) until the transect is completed. For longer transects, surveys will be completed in sections and data post-consolidated. Real-time survey transect tracks will be logged at an interval of one second using a Garmin handheld GPS. At the completion of each towed video transect, the tow body will be retrieved to the vessel deck, still camera images and HD video recordings downloaded, and the camera systems prepared for the next transect.

ROV transects will be operated using the same methodology as Slow-Video transects and utilise the same forward-facing video and downward still camera arrangement. Use of the BlueROV allows for finer depth control (and collision avoidance), and slower (safer) transects through sections of complex bathymetry or high relief reef. If possible ultra-short baseline (USBL) positioning system will be used to provide more accurate positioning of the ROV and

resultant imagery.

The forward-facing video from Northern Beaches will be scored by a trained benthic ecologist in the office prior to classifying the still images. Still images from all locations will be assessed and scored by a trained AIMS benthic ecologist using the AIMS Image Classifier program, which uses a five-point intercept method [11] to quantify benthic community cover (coral, sponges and seagrass) and species composition. The occurrence of habitat groups in Drimmie Arm, Whatta (No Name) Bay and Northern Beaches will be presented in georeferenced maps and the distribution compared to previous studies.

DELIVERABLES

Reports to Rio Tinto Gove Operations will include the following:

1. Distribution of benthic communities (coral, sponges and seagrass) in Drimmie Arm, Whatta (No Name) Bay and Northern Beaches;
2. Comparison of benthic communities to previous surveys in Drimmie Arm and Whatta (No Name) Bay e.g. 2018, 2019 and 2020; and
3. Where possible comparison of the benthic communities at Northern Beaches to previous surveys e.g. 2018 and 2020.

The ability to undertake the surveys is dependent on weather conditions being suitable to obtain images of sufficient quality to identify subtidal fauna and flora. This may result in surveys being cancelled and/or survey data not being of sufficient quality to allow the required level of analysis.

RTA Gove is evaluating reports from previous years monitoring to inform decision for future benthic communities monitoring in Drimmie Arm and Whatta (No Name) Bay.

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