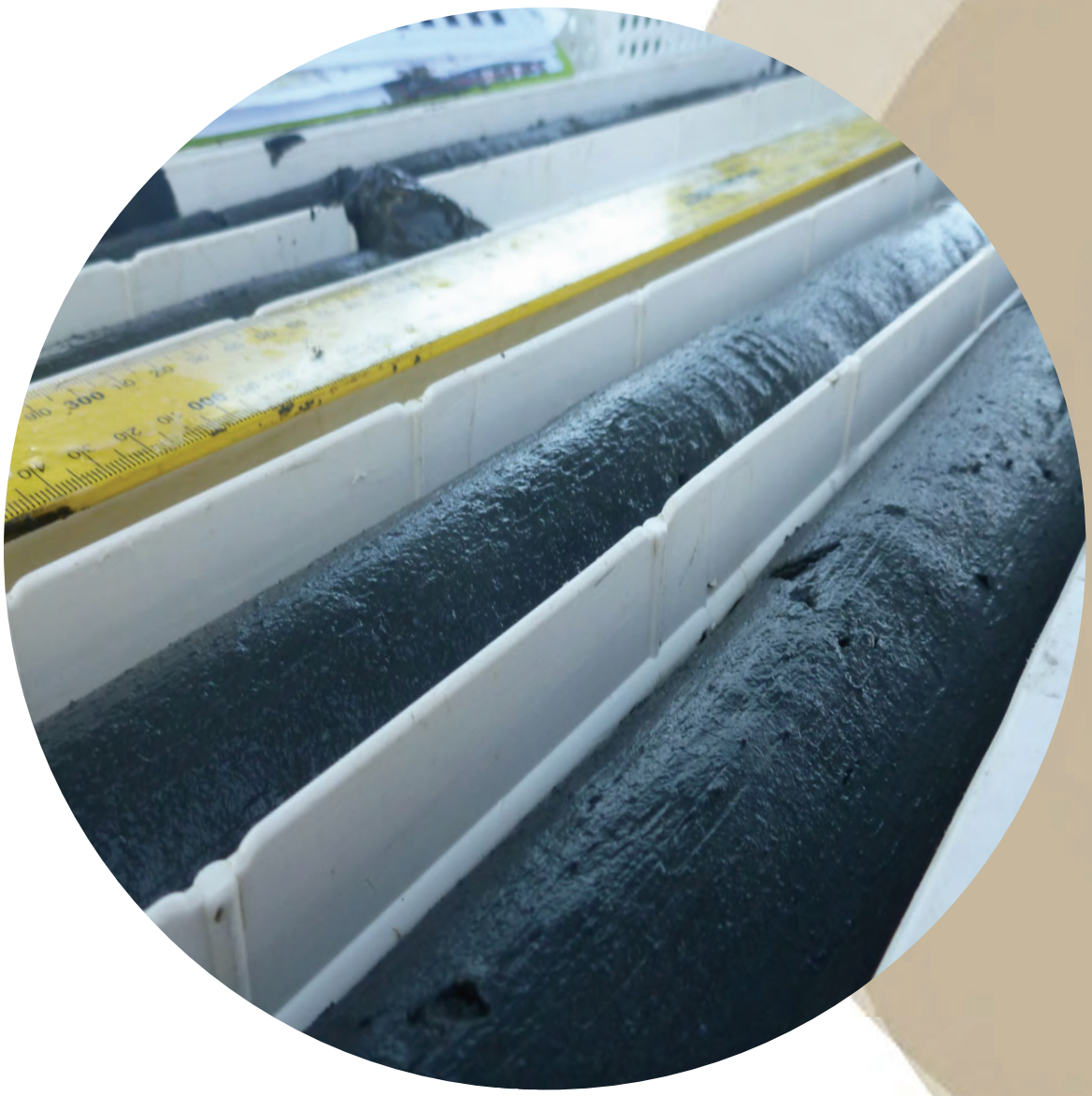
7.6 Sampling Analysis Plan for 2022 to 2032



Port of Cairns Maintenance Dredging

Sediment Sampling and Analysis Plan for 2022 to 2032

Ports North

7 June 2022

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PROJECT 301001-02058-00-EN-RPT-0012 – Port of Cairns Maintenance Dredging: Sediment Sampling and Analysis Plan

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2	Updated – Issued for use				14/04/2022
3	Updated – Issued for use	Alex Kochnieff	Bill Boylson	Bill Boylson	07/06/2022

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1 Introduction

This Sediment Sampling and Analysis Plan (SAP) sets out the proposed sampling and analysis of sediments to be completed within areas proposed to be dredged annually by Ports North (trading name of Far North Queensland Ports Corporation Limited) as part of the routine maintenance dredging at the Port of Cairns. Analysis of sediments pertains to physical and chemical characteristics of the sediments, as well as the presence of any introduced marine pest species.

The approach taken is consistent with the methods outlined within the approved Port of Cairns Long-term Maintenance Dredging Management Plan (LMDMP) (BMT, 2022) submitted in support of the assessment and permit finalisation process. This SAP accommodates the LMDMP and SAP process requirements arising from the review by the determining authority (Great Barrier Reef Marine Park Authority (GBRMPA)), and agreement reached regarding the proposed approach to sediment sampling and analysis within respective dredge areas.

The dredge areas are described as follows:

- Outer Channel (OC)
- Inner Port (IP) wharves 1 to 8, 10 to 12, swing basins and inner channel
- HMAS Cairns Navy Base (NB) (inner and outer)
- Marlin Marina (MM) (northern and southern halves)
- Commercial Fishing Base 1 (CFB1)
- Commercial Fishing Base 2 (CFB2)
- Maritime Safety Queensland (MSQ).

The placement areas are described as follows:

- Dredge Material Placement Area (DMPA) (old) (1990 to 2022)
- Dredge Spoil Disposal Area (DSDA) (new) (2022 onwards)

The DMPA (old) and the approved DSDA (new) are also included as part of this SAP, and whilst not required to be assessed against NAGD guidelines, sampling is to be conducted to assess long-term trends contaminant concentrations, verify past pre-placement assessment and assess the potential presence of marine pests. The introduced marine pests survey is undertaken to assess their potential presence and therefore manage the potential risk to the values of the Great Barrier Reef Marine Park.

This SAP document, which is incorporated into the LMDMP, serves as the master SAP for the 2023 to 2032 period and does not require replication of the administrative stages (SAP drafting, lodgement, and approval) for each of the SAP program sampling events. Given the strong understanding of sediment characteristics within the Port of Cairns, the request from GBRMPA for a single master SAP has been developed for the sampling and analysis associated with routine maintenance dredging at the Port to be undertaken within the ten-year period of the LMDMP. However, in accordance with permit conditions, prior to commencement of each dredging works campaign and associated analysis activities, a campaign-specific SAP will be submitted to GBRMPA for approval. The campaign specific SAP will outline:

- Anticipated dates and locations of the upcoming sampling and dredging activities

- Confirmation of consistency with this document
- Any proposed divergence from this master SAP and justification for this divergence
- Details and analysis of land-use changes and incidents that have occurred that may impact those locations since the previous dredging campaign, including identification of any additional contaminants to be included in sampling and analysis activities
- Details of status regarding marine pest species and any new marine pest species to be included in sampling and analysis activities.

In the event that contingency dredging is required, GBRMPA will be contacted for approval prior to this being undertaken and any written directions provided by GBRMPA will be complied with.

1.1 Objectives

The objectives of the SAP are to:

- Set out the sampling and analysis proposed to be undertaken to facilitate understanding of the quality and contamination status of sediments to be dredged at the Port of Cairns and the presence of introduced marine pests.
- Support Phase II investigations of sediment to be dredged and introduced marine pest survey in alignment with the Department of Environment, Water, Heritage and the Arts (DEWHA) National Assessment Guidelines for Dredging (NAGD) 2009, the Sea Dumping Permit (**SD22/01**), Marine Park Permit (**G22/44236.1**) and the LMDMP.
- Support an understanding of long-term trends in sediment quality within the Port and including at the DSDA.
- Ensure sampling is undertaken consistent with industry best practice with appropriate field protocols in place.
- Support achievement of high quality laboratory analysis results, with appropriate Quality Assurance (QA) / Quality Control (QC) checks (as per NAGD guidance) and through use of recognised and National Association of Testing Authorities (NATA) accredited analytical laboratories with expertise in marine sediment quality assessment applicable to dredge material management.
- Ensure data from sampling is accurately reported, summarised and analysed to provide confidence in the efficacy of the sediment investigations sufficient to make a decision on suitability for dredging and placement of the material under the Sea Dumping Permit (**SD22/01**) and in compliance with the Marine Park Permit (**G22/44236.1**) and the LMDMP.

1.2 Proposed dredging works

To maintain declared depth for vessel access to port facilities maintenance dredging is required throughout various areas within the Port of Cairns limits. The OC and IP wharves 1-8 and 10-12 require the most frequent maintenance, with dredging to be undertaken on an annual basis. Other dredge areas do not typically require annual maintenance and often are dredged every two to three years on an alternating basis. The NB and MM dredge areas are each divided into two portions with each portion typically dredged once every two years e.g. The NB (outer) and MM (northern) portions were dredged in 2017, while NB (inner) and MM (southern) portions were dredged in 2018. The CFB1, CFB2, MSQ, IP swing basins and IP inner channel dredge areas are dredged as needed on an irregular basis.

Maintenance dredge material will be placed at the DSDA (new) commencing with use for the material generated from the 2022 *Trailer Suction Hopper Dredge (TSHD) Brisbane* campaign. This is the new dredge spoil placement facility established in 2022 under **SD22/01** and **G22/44236.1**. Previously dredge spoil was placed at the DMPA also previously known as the Offshore Disposal Site (ODS) established in 1990. The DMPA will be used until 2022 when the final placement of maintenance dredge material (originating from material generated by the *Willunga*) at the site will occur. Dredging will be completed by either a *TSHD Brisbane* or a clam shell dredge (*Willunga*), based on suitability of the dredge for each dredge area. Previous total annual maintenance dredging volumes have ranged between 319,959 and 574,426 in situ cubic metres (m^3).

The largest volume of material to be dredged is from the OC dredge area. Maintenance material across dredge areas is comprised predominantly of fine surface sediments (silt and clay) that have accumulated since previous maintenance dredging. Some coarser sandy material is encountered within a small segment of the OC.

Table 1-1 provides the estimated average dredge material disposal quantities required for the 2022 to 2032 period, while Table 1-2 provides the dredging details for each dredge area, including potential upper bound estimates for volume and quantity. These estimates are based on maximum historical and forecast activity and include provision for a contingency volume of 730,000m^3 in-situ.

Table 1-1: Estimated dredge material disposal quantities under the 10-year LMDMP

Operational case	In-situ (m^3)
Annual average of maintenance dredging	520,000
Annual maximum forecast	730,000
Contingency (spread across the 10-year period)	730,000
Total allowance of maintenance dredge material	5,200,000
Total requirement for 10-year permit duration	5,930,000

Table 1-2: Proposed dredging details

Dredge Area	Dredging volume (*in situ* m^3)**	Dredging frequency	Dredge method	Typical dredge sediment depth
Outer Channel	618,776	Annual	*TSHD Brisbane*	0 – 0.5m
Inner Port: Wharves 1 – 8, 10 – 12	20,558	Annual	*Willunga*	0 – 0.5m
Inner Port: Swing basins	16,749	As required	As required	As required
Inner Port: Inner Channel	10,468	As required	As required	As required
HMAS Cairns Navy Base (Inner)	19,649	Every second year	*Willunga*	*0.5 – 1.5m
HMAS Cairns Navy Base (Outer)	13,122	Every second year	*Willunga*	
Marlin Marina (Northern)	17,070	Every second year	*Willunga*	0 – 1.5m
Marlin Marina (Southern)		Every second year	*Willunga*	
Commercial Fishing Base 1	6,531	Infrequent, as required	*Willunga*	*0.5 – 1.5m
Commercial Fishing Base 2	1,670	Infrequent, as required	*Willunga*	*0.5 – 1.5m
MSQ (adjacent to CFB2)	1,670	Infrequent, as required	*Willunga*	*0.5 – 1.5m

Notes: * the minimum depth of sediment removed from the NB, CFB1, CFB2 and MSQ is 0.5m

2 Compilation and review of existing information

2.1 History of maintenance dredging at the Port of Cairns

Maintenance dredging operations have been an ongoing annual requirement at Port of Cairns, since it was developed over a hundred years ago. Ports North is required under the *Transport Infrastructure Act 1994* to maintain navigable depths within the port navigation areas to ensure effective and efficient port facilities and services. To meet this obligation, Ports North have an augmented maintenance operation where the channel and swing basins are dredged by *TSHD Brisbane*, and the IP wharf areas and smaller, access constrained marinas including the NB, MM, CFB 1 and 2 and MSQ, are dredged using the *Willunga,* a clam shell dredger (i.e. bucket grab dredge and two hopper bottom barges). On occasion, when tides permit safe manoeuvring, the *TSHD Brisbane* may be used to dredge adjacent to the Main Wharf areas into which material from the berth pockets is dragged using a bar leveller.

Ports North undertake annual routine maintenance dredging operations generally within three separate campaigns that differ in dredging volumes, frequency and dredging plant. These separate campaigns include:

- Outer and inner shipping channel and associated swing basins
- IP (main wharves 1 to 8 and 10 to 12), MM, CFB1, CFB2 and MSQ
- NB.

Maintenance dredged material for each campaign is placed at the approved DSDA. Further detail on each of these areas and on the historic dredging volumes at the Port of Cairns is provided in the LMDMP (BMT, 2022).

2.2 Summary of sediment quality

Detailed sediment quality characterisation studies have been undertaken within the Port of Cairns since 1995. A detailed review of physical and chemical characteristics of the dredge material was conducted during development of, and included in, the approved LMDMP. A summary of contaminant issues is provided below, with further information available in the approved LMDMP.

Sediments within the Port of Cairns have been subject to a wide range of contaminant analyses over the years including metals/metalloids, nutrients, Total Petroleum Hydrocarbons (TPHs), Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), Organochlorine/ Organophosphate (OC/OP) pesticides, benzene, toluene, ethylbenzene, and xylenes (BTEX), organotins tributyltin (TBT), dibutyltin (DBT) and monobutyltin (MBT) and volatile chlorinated hydrocarbons, Per-and poly-fluoroalkyl substances (PFAS) and the herbicide, Diuron. An assessment of each parameter is provided in the LMDMP, while a summary is provided below.

Typically, most contaminants analysed in the last 11 years (i.e. 2010 to 2020) have not exceeded relevant NAGD Screening Levels and / or local Screening Levels at the 95% UCL of the mean. In a few instances As, Ni, Ag, Cu, Zn, TBT, and Diuron triggered additional Phase III assessment as the 95% UCLs were greater than the respective NAGD Screening Levels and / or local Screening Levels. The Phase III analysis consistently indicated that contaminants contained within the sediments were below the respective receiving water quality Australia and New Zealand Guidelines for Fresh and Marine Water

Quality (ANZG), 2018 and / or NAGD Screening Levels therefore impacts to water quality, organisms in the water column or benthic communities following and / or during disposal were unlikely. As such, sediments were identified as suitable for unconfined placement within the DMPA used between 1990 through to 2022. This outcome was consistent for each year throughout the entire 2010-2020 period, including capital sediment material sampled by BMT in 2013, and is supported by non-parametric Mann-Kendall (MK) trend analysis which identified *stable* or *probably decreasing* trends for all Phase II contaminants that exceeded NAGD or local Screening Levels except for Diuron in the IP where a *probably increasing* trends was identified.

Stable trends may be perceived as favourable, however, it may also suggest a continuous input of contaminants. For example, the ban on TBT has been in place for decades, yet stable trends have been identified where they may be expected to be decreasing. Stable trends are relevant for many of the contaminants of concern and therefore suggests continued monitoring is required due to a potential continued input of contaminants (natural or anthropogenic). The stable trends suggest the contaminant inputs are low and steady therefore resulting in concentrations in sediment remaining below NAGD and / or local Screening Levels and being suitable for unconfined ocean placement.

3 Sampling and analysis of sediments

3.1 Proposed sediment quality attributes for analysis

3.1.1 Contaminant list

The review of 2012 to 2020 contaminant substances within the approved LMDMP (BMT, 2022) details a two-tier list of contaminants to be monitored within the Port of Cairns; a primary contaminant list and a secondary contaminant list. This two-tier approach is generally consistent with the previous long-term management plan developed by WorleyParsons in 2010. The primary list of contaminants is consistent with previous years and presented in Table 3-1.

While not strictly required under the NAGD, the secondary contaminants list is proposed to include contaminant substances that could be present in dredge sediments at levels of environmental concern although historical sampling indicates this is not likely. This list is proposed to monitor contaminants at an intensity of 20% of sampling locations (with a minimum of three in any one dredge area) within IP, NB and marina areas (including MM, CFB1 and CFB2) during every SAP. This list includes TPH, PAH, Diuron and PFAS. If total concentrations are reported at levels greater than one-tenth of the Screening Levels for the secondary list of contaminants then the hold samples (refer to Section 3.3.6) for the remaining sampling locations within the specific dredge area will be tested. The secondary contaminants identified are presented in Table 3-1.

Consistent with previous years, a miscellaneous list of substances will also be tested (Table 3-1). This includes moisture content, Particle Size Distribution (PSD) and Total Organic Carbon (TOC), nutrients (including Total Nitrogen (TN), Total Kjeldahl Nitrogen (TKN), Nitrate, Nitrite, Nitrite + Nitrate, Total Phosphorus (TP)) and Ammonia (NH_3). However, nutrients and ammonia will be analysed at an intensity of 20% of sampling locations (with a minimum of three in any one dredge area). This may include Phase III analysis of nutrients and ammonia to assess and research potential bioavailability. If required, this would be outside of the process described in Section 3.1.2 and considered a research task to further inform future management, rather than strict compliance against guideline assessment, as there are no NAGD Screening Levels for nutrients and ammonia. The miscellaneous contaminants identified are presented in Table 3-1.

Characterisation of physical properties of sediment will continue as part of the regular evaluation of sediment quality through analysis of particle size distribution and grain size. Detailed geotechnical assessment of maintenance dredge material from port areas was undertaken in 2020/2021. The assessment identified typical physical characteristics of maintenance dredge material at the port with respect to potential reuse. Further detailed geotechnical assessment is not currently planned as the sediment properties identified through the 2020/2021 analysis are considered representative of maintenance dredge material at the port.

In addition to the primary and secondary contaminant lists, the need for additional contaminant analysis will be based on a review of incidents occurring in the port. The review will be undertaken during the preparation of each annual SAP to assess the likelihood of contaminant substances having been released into the respective dredge area. Ports North records all incidents and near miss events of foreign non-sediment material / spills affecting the Port of Cairns in an incident register. Each incident is assigned a ranking aligned with Table 3 in Appendix A of the NAGD, i.e., uncontaminated (minor), significant contamination (moderate) or very significant contamination (major).

In the event of a contaminant release within the port (e.g., oil spill) that is deemed moderate or major, the relevant contaminant parameter will be included in subsequent annual sediment monitoring and laboratory analysis for all dredged areas with a reasonable likelihood of having been impacted. This is to identify whether there has been any impact to sediment quality and confirm suitability for unconfined placement at sea. An extract of the incident register for the relevant prior period will be included in the campaign specific SAP document. Any adjustment to the contaminant list and the list of incidents will also be detailed in the subsequent SAP report.

Table 3-1: Indicative SAP contaminant list

Sampling area	Primary contaminant list *All locations*	Secondary contaminant list *20% of locations (or minimum of three)*	*Miscellaneous list* *All locations*
IP (Wharves 1-8, 10-12, swing basins and inner channel) MM NB CFB 1 CFB 2 DMPA (old) DSDA (new)	Metals and metalloids: Sb, As, Cd, Cr, Cu, Hg, Ni, Pb, Ag, Zn	TPH	Moisture content PSD TOC
		PAH	
		Diuron	
		PFAS	
	Organotins	Nutrients (TN, TKN, nitrate, nitrite, TP, NH_3*)	
OC	Metals and metalloids: Sb, As, Cd, Cr, Cu, Hg, Ni, Pb, Ag, Zn	-	
	Organotins	-	
* Phase III testing at a single location in each dredge area to assess bioavailability if required			

3.1.2 Elutriate, Dilute Acid Extraction and Porewater Analysis

If Screening Level assessment identify contaminants above the NAGD Screening Level or local Screening Levels at the 95%UCL of the mean, then further testing will be required according to the NAGD framework for the assessment of potential contaminants and the clarification of the NAGD, 2009 decision tree and explanatory note for assessment of TBT in dredge spoil (DAWE, 2021). If further sampling and analysis is required, a request to GBRMPA will then be made for consideration of the initial results, this SAP document, and for provision of comment or approval prior to conduct of any further sampling and analysis.

The SAP reports will include the initial results, and outcomes of any additional phases of sampling and laboratory analysis that may be needed to evaluate the suitability of material for dredging.

3.2 Frequency and timing of sampling

Sampling and analysis will be undertaken prior to each proposed dredge campaign for each dredge area. The frequency of requirement for maintenance dredging varies for each dredge area at the Port of Cairns. Maintenance dredging is required annually at the OC and IP dredge areas, and therefore it is anticipated that sampling and analysis will be undertaken annually for these areas, while maintenance dredging is required on alternate years at the NB (inner/outer) and MM (northern/southern) dredge areas and therefore it is anticipated that sampling and analysis will be undertaken every second year for these areas. Maintenance dredging is required less frequently at the CFB1, CFB2 and MSQ dredge areas, typically on a three-to-four-year cycle (as required) and sampling and analysis will mirror the frequency of dredging for these areas.

The anticipated schedule with the corresponding contaminant list is presented in Table 3-2. If maintenance dredging requirements do not align with this schedule (e.g., are required more frequently) then SAP implementation will be adjusted to ensure it is undertaken prior to each dredging campaign consistent with permit conditions. This adjustment be outlined in the campaign specific SAPs submitted to GBRMPA for approval.

Although not required for disposal assessment against NAGD, evaluation of contaminant status at the DSDA will be implemented each year to ensure data continuity for comparison of long-term trends. Sampling at the former DMPA will be undertaken infrequently.

The timing of each sampling and analysis program will depend on the dredging schedule as informed by siltation patterns, hydrographic survey program and operational requirements. Typically, Port of Cairns sampling and analysis programs have occurred in the first quarter of the year, toward the end of wet season, and when there is a higher likelihood of contaminants to be present due to catchment runoff. Due to the required lead time for implementation of the SAP process, a second period of fieldwork may be required in the second half of the year for continuity with the proposed maintenance dredging schedule and any dredging works to be done in the first half of the subsequent year.

Due to the number of dredge areas to be sampled, the timeframe for fieldwork collection of sediment will be approximately one to two weeks.

Table 3-2: Anticipated SAP implementation schedule

Dredge area	Year										
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
OC	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM
IP (Wharves 1 – 8, 10 – 12, swing basins, inner channel)	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM
NB (inner)	PSM		PSM		PSM		PSM		PSM		PSM
NB (outer)		PSM		PSM		PSM		PSM		PSM	
MM (northern)	PSM		PSM		PSM		PSM		PSM		PSM
MM (southern)		PSM		PSM		PSM		PSM		PSM	
CFB1		PSM			PSM			PSM			PSM
CFB2		PSM			PSM			PSM			PSM
MSQ											
DSDA	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM	PSM
DMPA	PSM					PSM*					PSM*

Notes: P – Primary list; S – Secondary list; M – Miscellaneous list; * Sampling at DMPA subject to future technical review

This table reflects the anticipated SAP implementation schedule. If maintenance dredging requirements do not align with this (e.g., are required more frequent), then the SAP implementation will be adjusted to ensure it is undertaken prior to each dredging campaign consistent with permit conditions. Any adjustment to the anticipated schedule will be reflected in the campaign specific SAPs.

3.3 Sampling design

3.3.1 Sample grids

Sampling within the Port of Cairns is undertaken using predetermined grid cells historically approved by GBRMPA. In all maintenance dredging areas (except NB outer dredge area where grid squares would be impractically small) the number of predetermined grids is greater than the minimum number required as per the method in Appendix D of the NAGD, 2009. Appendix D of the NAGD, 2009 indicates that the minimum number of sample grids is determined by five times the number of sampling locations presented in Table 6 of the NAGD, 2009. The number of sample grids will be maintained as per the previous years' sediment characterisation investigations (with previous approval by GBRMPA) as the number of grids exceeds the minimum requirement, and the dredge volumes for each area are typically consistent. This has been a consistent and accepted approach for maintenance dredge sampling at the Port of Cairns. .

3.3.2 Number of sampling locations

Due to the availability of good quality data with a currency of five-years or better, the number of sampling locations for the OC has been halved from the number included in the NAGD Table 6 for conservative estimates of dredge volume of potentially contaminated dredge material. This has been the approach for the OC in past years and supported by GBRMPA approved SAPs and a technical data review completed by Advisian, 2020. This approach is proposed to continue unless a change in volume or contaminant risk is identified.

The number of sampling locations for the remaining dredge areas will be consistent with, or exceed the NAGD Table 6 guidance. The summary number of grid sampling locations is provided in Table 3-3. The proposed sampling numbers will reflect the anticipated dredging need with any variations to Table 3-3 presented in annual campaign SAPs.

3.3.3 Sampling location selection

Each sampling location will be randomly selected from the approved sampling grid cells. The grid cells used for random selection are only those where more than half the cell is contained within the bounds of dredging. Where sampling grids partially overlap, such as that of the NB outer dredge area and IP main wharf dredge area, then that portion will be included for sampling in only one of the two areas.

Each year the selection of sampling grids will be undertaken using random number generation in Microsoft Excel. The sites selected and their central coordinates for sediment collection will be identified in each annual campaign specific SAP.

In the field, the grids will be located using either an on-board GPS or hand-held GPS that is reliably accurate to at least ± 5m or through positioning relative to dominant structures in the case of marina berths or wharf berth chainage. From time to time, site-specific hazards preclude sampling in the predetermined grids, for example, a berthed vessel may be located within the grid. In these scenarios, a new grid, generally the grid adjacent, is to be selected for sampling. Grid locations may also be adjusted to ensure areas of the greatest sediment deposition (determined through Ports North's hydrographic survey program) are sampled. In any case, deviation from the proposed grids presented in the campaign specific SAP will be identified and described in the subsequent SAP report.

Note that six sampling sites within and adjacent to the DSDA (new) have been established in a similar orientation to that used in the DMPA (old). These locations are fixed, not random and will be sampled in each year to enable periodic comparison of long-term sediment quality trends.

An overview of all the grids and their interactions is provided below in Figure 3-1, while a more detailed view and individual dredge areas are presented as Figure 3-2 to Figure 3-8.

Table 3-3: Summary of typical sediment collection program for all dredge areas – to be updated as applicable in each campaign specific SAP

Dredge Area	Typical dredging volume (*in situ* m^3)**	NAGD Table 6 Minimum number of sampling locations	Number of sampling locations proposed	Number of Sample Grids*
Outer Channel	618,776	28	14	264
Inner Port: Wharves 1 – 8, 10 – 12	20,558	8	8	124
Inner Port: Swing basins	16,749	7	7	
Inner Port: Inner Channel	10,468	7	7	
HMAS Cairns Navy Base (Inner)	19,649	8	8	45
HMAS Cairns Navy Base (Outer)	13,122	7	7	35
Marlin Marina (Northern)	10,000	6	6	48
Marlin Marina (Southern)	7,070	6	6	92
Commercial Fishing Base 1	6,531	6	6	120
Commercial Fishing Base 2	1,670	6	6	89
Dredge Material Placement Area	Not applicable	Not applicable	6	6
Dredge Spoil Disposal Area	Not applicable	Not applicable	6	6
MSQ (part of CFB2)	1,670	6	6	30

* In all dredging areas (except NB outer) the number of sample grids exceeds the minimum number required as per the method in Appendix D of the NAGD, 2009. Appendix D of the NAGD, 2009 indicates that the minimum number of sample grids is determined by five times the number of sampling locations presented in Table 6 of the NAGD, 2009. The number of sample grids will be maintained as per the previous years' sediment characterisation investigations (with previous approval by GBRMPA) as the number of grids exceeds the minimum requirement, and the dredge volumes for each area are typically consistent..

** Forecast volume and quantity based on 2010 to 2019 averages including increased volume arising from the CSDP's influence on dredge area footprint and resultant siltation, as well as annual variability of each dredge area. As such the volumes presented above are estimates and are likely to change from year to year. Up to date volume estimates and associated sampling locations will be reflected in campaign specific yearly SAPs.

Note that the Inner Port Inner Channel and Swing Basins do not regularly require maintenance dredging as sediments do not generally deposit within these dredge areas due to significant current velocities. As such, sampling and analysis of maintenance sediments in these dredge areas is rarely required.

Table 3-4: Example sample locations from the 2022 sediment characterisation

Sampling Site ID	Port Area	Easting (GDA94z55)	Northing (GDA94z55)	Sampling Site ID	Port Area	Easting (GDA94z55)	Northing (GDA94z55)	Sampling Site ID	Port Area	Easting (GDA94z55)	Northing (GDA94z55)
OC10-b	OC	374754.4941	8137227.86	01-b	IP	370467.5904	8128064.912	I-06	NB - I	369985.4015	8127146.121
OC11-c	OC	374568.5548	8137056.294	100-c	IP	370182.9337	8127231.077	I-09	NB - I	369993.677	8127090.17
OC13-b	OC	374522.761	8136807.501	71-a	IP	370415.7859	8128898.502	I-15	NB - I	370010.2305	8126978.268
OC18-a	OC	374066.4627	8136145.532	77-b	IP	370265.1254	8128605.075	I-24	NB - I	369988.4116	8126996.926
OC1-c	OC	375340.9955	8138457.468	79-d	IP	370210.5551	8128371.37	I-27	NB - I	369950.0441	8127127.478
OC23-b	OC	373750.3075	8135406.326	80-b	IP	370348.17	8128257.093	I-30	NB - I	369958.323	8127071.519
OC30-b	OC	373209.6004	8134425.511	84-d	IP	370257.2183	8127867.572	I-36	NB - I	369933.7417	8127108.818
OC35-b	OC	372823.3759	8133724.918	85-b	IP	370119.6075	8127981.849	I-45	NB - I	369892.872	8127127.477
OC41-d	OC	372321.2802	8132814.163	88-a	IP	370124.7488	8127652.036	1-d	MM - N	370213.2669	8129169.315
OC46-c	OC	371864.988	8132152.185	90-b	IP	370129.9376	8127356.892	2-c	MM - N	370185.5269	8129110.558
OC4-d	OC	375179.3364	8137998.501	93-d	IP	370098.6755	8126827.999	21-d	MM - N	370327.3121	8129118.613
OC56-a	OC	371131.1629	8130821.065	97-a	IP	370165.403	8126991.731	30-c	MM - N	370354.4781	8129174.261
OC62-c	OC	370652.2345	8129911.248	98-a	IP	370336.6566	8127139.615	32-d	MM - N	370384.7065	8129064.521
OC68-b	OC	370530.1052	8129036.135	105-a	Smiths Creek Swing Basin (SCk)	370166.4971	8126521.996	34-c	MM - N	370358.5647	8128953.724
DMPA-01	DMPA	374606.2786	8141612.02	104-d	Smiths Creek Swing Basin (SCk)	370406.4971	8126601.996	DSDA-1	DSDA	374976.6643	8145038.247
DMPA-02	DMPA	373886.6105	8142495.73					DSDA-2	DSDA	374499.0757	8144675.193
DMPA-03	DMPA	373669.6517	8143755.15					DSDA-3	DSDA	374374.7877	8145334.347
DMPA-04	DMPA	373209.2758	8143199.523					DSDA-4	DSDA	375100.9172	8144379.14
DMPA-05	DMPA	373008.1921	8143786.9					DSDA-5	DSDA	373618.2981	8146329.492
DMPA-06	DMPA	372336.1491	8144723.526					DSDA-6	DSDA	375857.4414	8143383.949

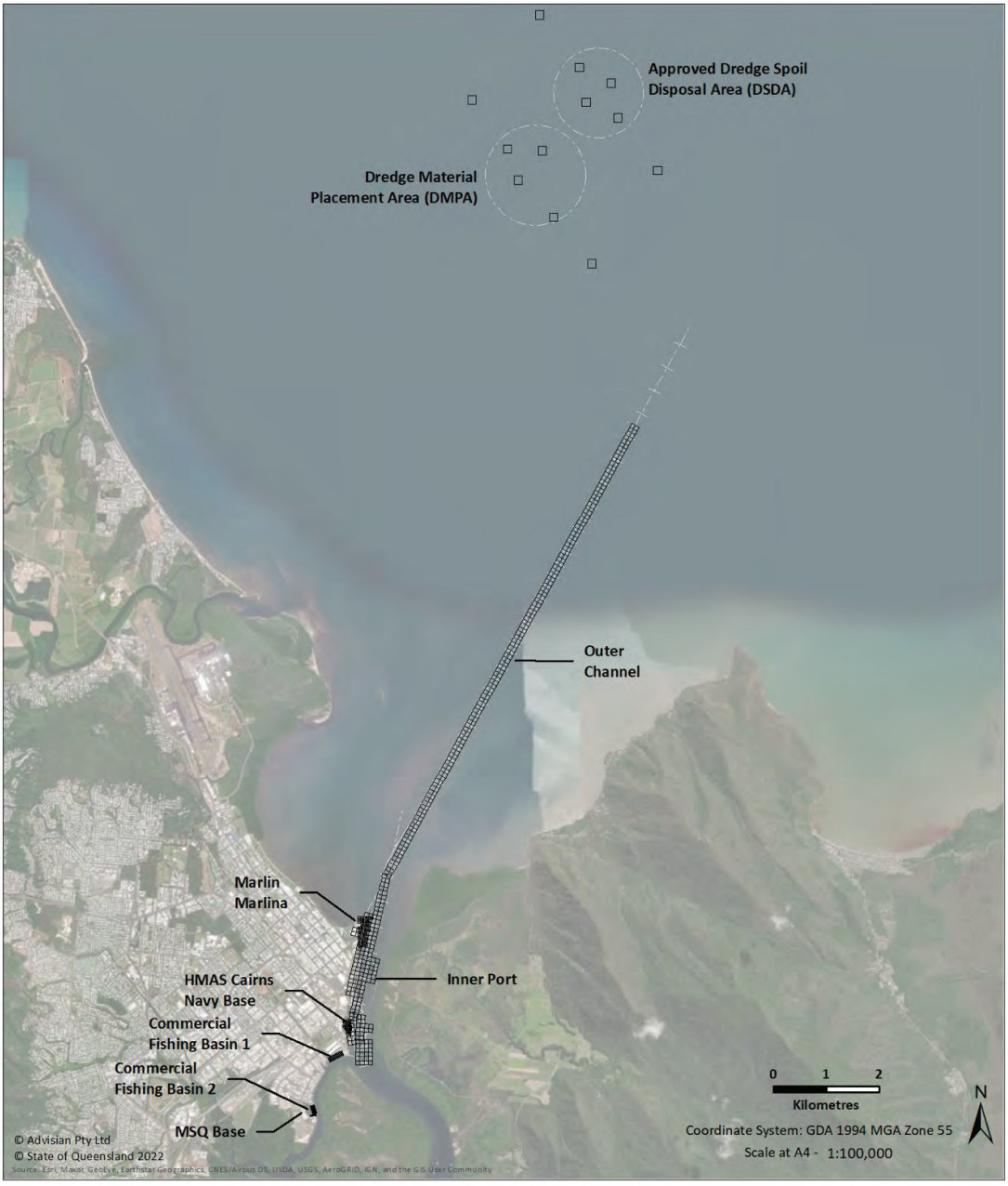
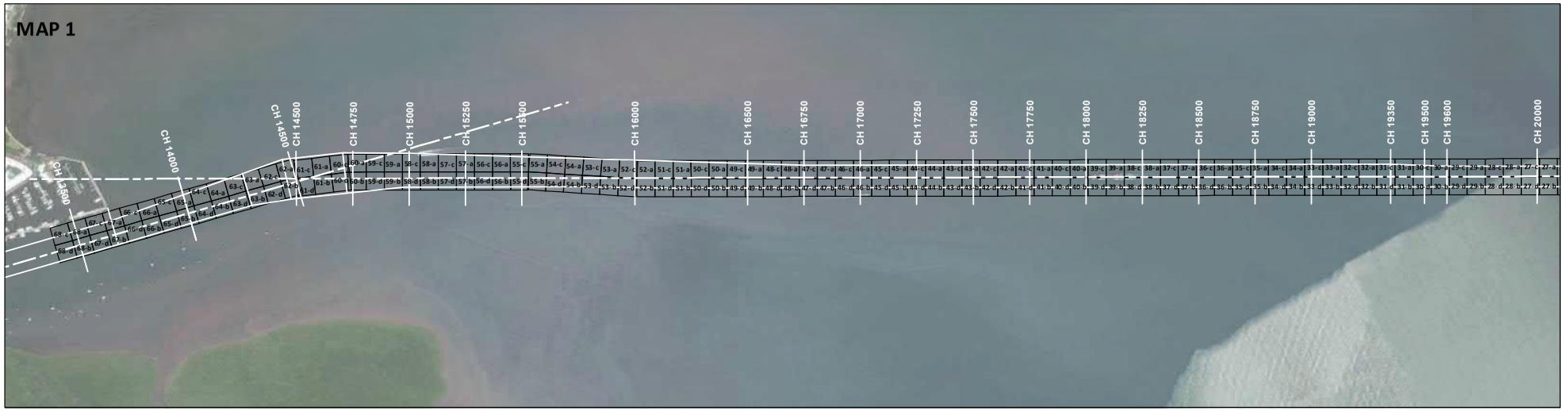
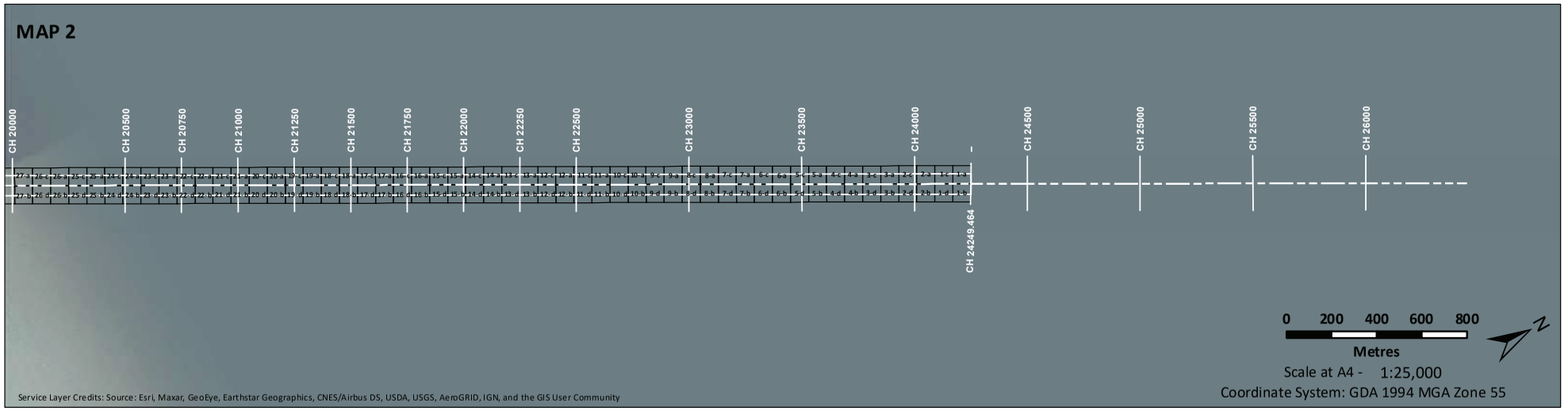
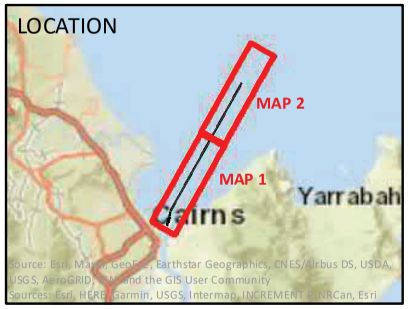


Figure 3-1: Port of Cairns SAP grids







LEGEND

Sampling grid

Figure 3-2 – Outer Channel - SAP Sampling Grids

14/04/2022 | Rev: D ISSUED FOR INFORMATION Org: KM Chk: AK |
G:\301001\02058 PROJ - Cairns SAP 2018-2019\10.0 Engineering\10 GM-Geomatics\PCR06_LTMP Chapters\Output\301001-02058-00-GM-SKT-2008-D (CairnsLTMP SamplingGrid Outer Channel).mxd

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LEGEND

Sampling grid

Areas not sampled as part of the Inner Port maintenance dredging program

Shaded grids indicate areas not sampled as part of the Inner Port maintenance dredging program as these areas are located within other discrete dredge areas where specific sampling grids have been applied.
These areas include the Outer Channel, Marlin Marina and HMAS Cairns Navy Base.
These areas and their specific sampling grids are presented on Figures 3-2, 3-4 and 3-5.

Figure 3-3 - Inner Port – SAP Sampling Grids

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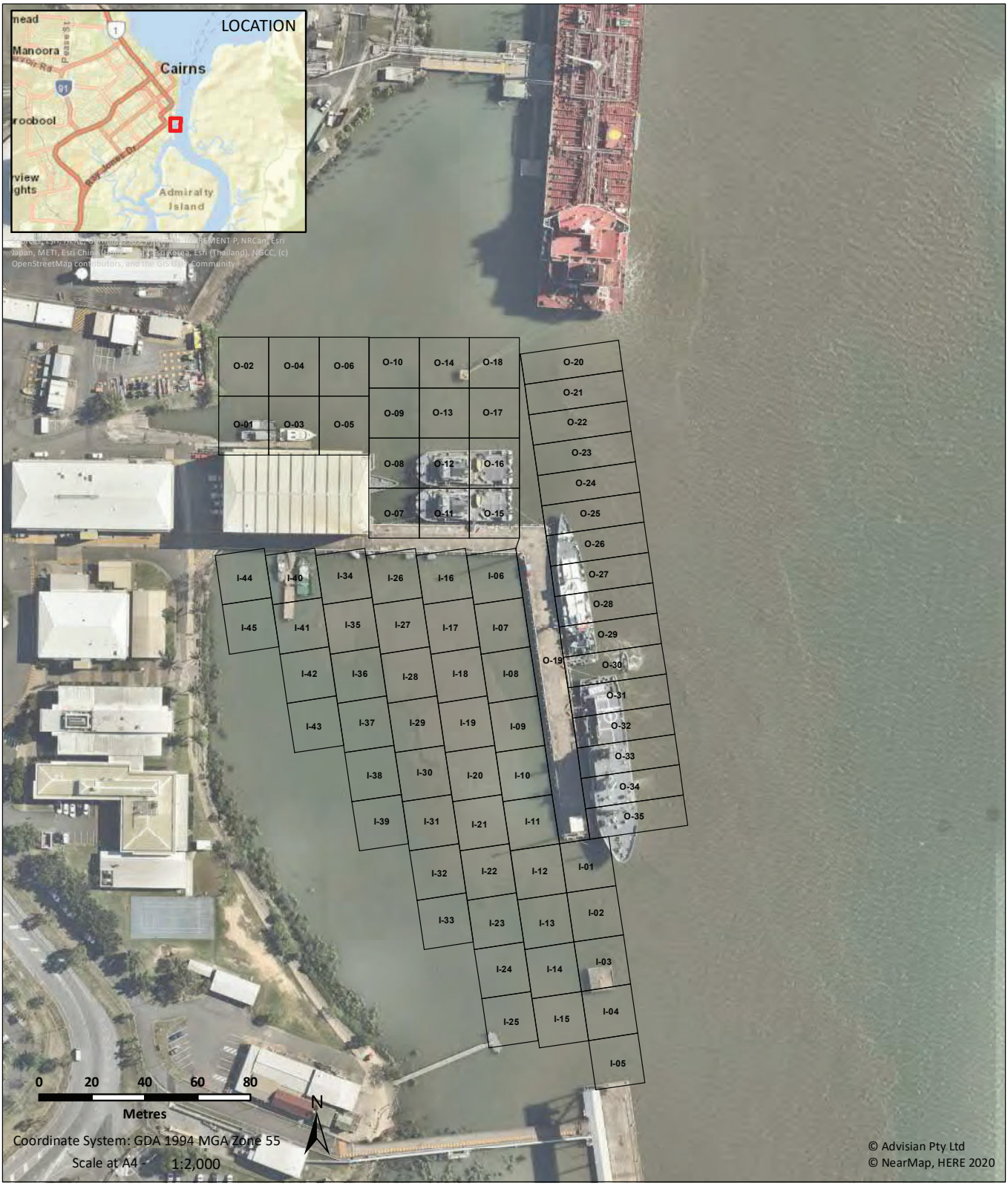
G:\301001\02058 PROJ - Cairns SAP 2018-2019\10.0 Engineering\10 GM-Geomatics\PCR06_LTMP Chapters\Output\301001-02058-00-GM-SKT-2010-F (CairnsLTMP SamplingGrid Inner Port).mxd



LEGEND

Sampling grid

Figure 3-5 - HMAS Cairns Navy Base – SAP Sampling Grids

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G:\301001\02058 PROJ - Cairns SAP 2018-2019\10.0 Engineering\10 GM-Geomatics\PCR06_LTMP Chapters\Output\301001-02058-00-GM-SKT-2011-C (CairnsLTMP SamplingGrid Navy Base).mxd

LEGEND

Sampling grid

Figure 3-4 - Marlin Marina– SAP Sampling Grids

LEGEND

Sampling grid

Figure 3-6 –
Commercial Fishing Berth 1 - SAP Sampling Grids

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G:\301001\02058 PROJ - Cairns SAP 2018-2019\10.0 Engineering\10 GM-Geomatics\PCR06_LTMP Chapters\Output\301001-02058-00-GM-SKT-2013-C (CairnsLTMP SamplingGrid CFB1).mxd

LEGEND

Sampling grid

Figure 3-7 –
Commercial Fishing Berth 2 - SAP Sampling Grids

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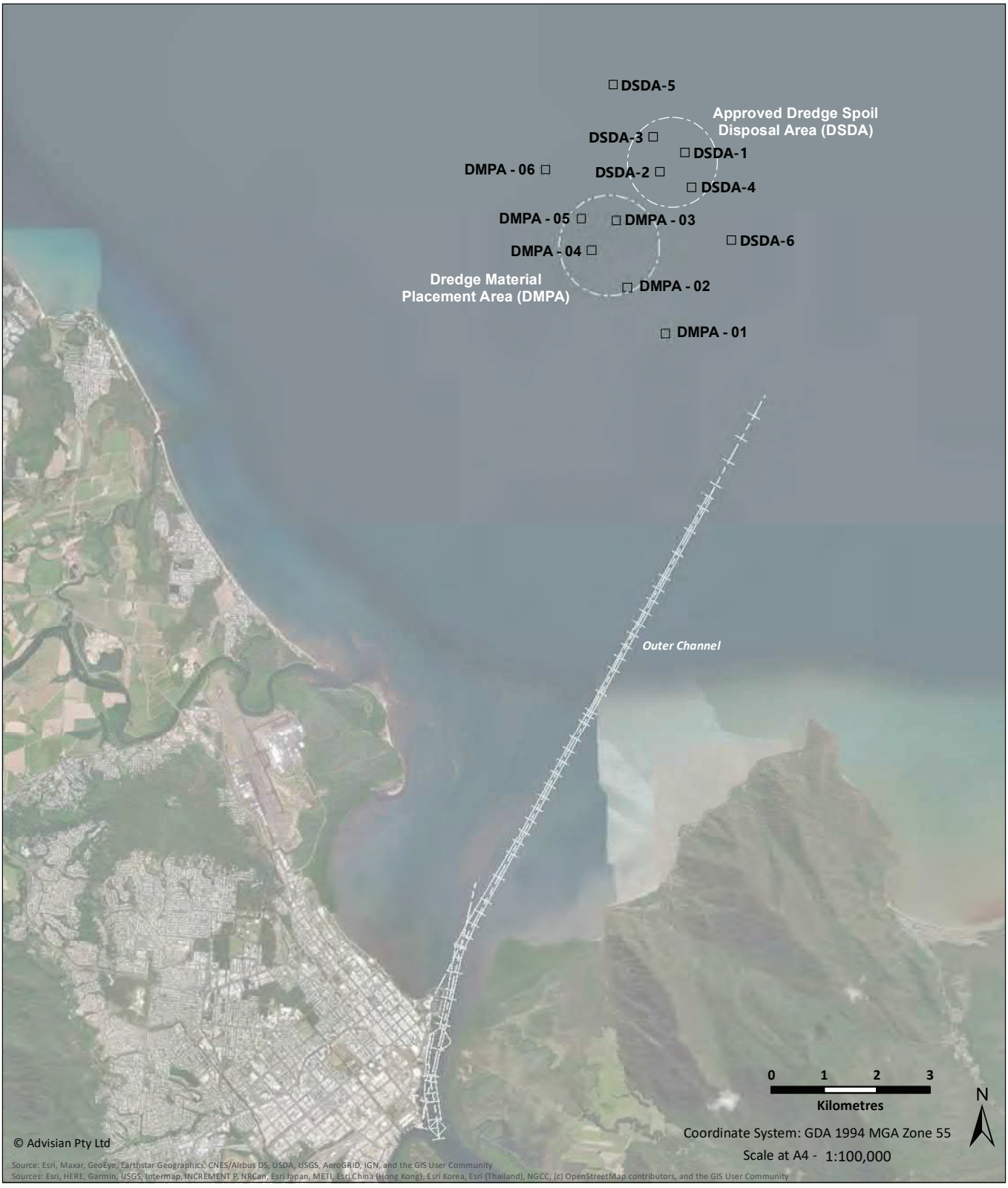

LEGEND

Sampling Areas

Figure 3-8: Dredge Material Placement Area (old) and Dredge Spoil Disposal Area (new) - SAP sampling grids

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G:\301001\02058 PROJ - Cairns SAP 2018-2019\10.0 Engineering\10 GM-Geomatics\PCR06_LTMP Chapters\Output\301001-02058-00-GM-SKT-2009-E (CairnsLTMP SamplingGrid Disposal Site).mxd

3.3.4 Sample collection methods and sampling horizons

The selection of primary sampling methods within each dredge area is based on the review of historic depths of dredging undertaken in those areas, consideration of practical sampling constraints and knowledge of sediment characteristics, as set out in Table 3-5. Demonstration of the typical depths of dredging is provided by differential survey plots for each of the dredge areas.

Volumes and areas proposed for dredging are evaluated on a regular basis (at least annually) under Ports North's hydrographic survey program, with most areas exhibiting consistent and predictable sedimentation and hence there is confidence that the sampling methods employed under this SAP are sound.

Sampling is to be undertaken using a stainless steel Van Veen grab and a 2.2m piston corer, depending on the anticipated depth of material and practical consideration of achieving core penetration and depth of water overlying the sediments to be sampled.

Table 3-5: Typical sediment dredge depth and collection method for dredge areas

Dredge Area	Typical Dredge Sediment Depth (m)	Sediment Grab	Piston Coring (Horizons)
OC	0 – 0.5	✓	Surface
IP (main wharves, inner shipping channel and swing basins)	0 – 0.5	✓	Surface
MM (northern / southern)	0 – 1.5		✓ (0-0.5m; 0.5-1.0m; 1.0-2.0m)
NB (Inner / Outer)	*0.5 – 1.5	✓**	✓ (0-0.5m; 0.5-1.0m; 1.0-2.0m)
CFB 1	*0.5 – 1.5		✓ (0-0.5m; 0.5-1.0m; 1.0-2.0m)
CFB 2, including MSQ	*0.5 – 1.5		✓ (0-0.5m; 0.5-1.0m; 1.0-2.0m)
Notes: * the minimum depth of sediment removed from the NB, CFB1, CFB2 and MSQ is 0.5m; ** Due to the water depth some locations at the NB outer dredge area may require grab sampling			

The sampling will be led by a suitably qualified environmental professional with experience in the application of the NAGD Guidelines to sediment quality assessment.

All working areas of the sampling vessel will be thoroughly checked, cleaned and prepared for sediment sampling activities prior to each day's sampling.

Specific forms (Appendix A) will be completed in the field (one for each sampling site) to document both collection details and sediment description for later compilation onto a standardised core description log. Photographs will be taken of samples obtained at each sampling location.

3.3.5 Sample processing

Sample handling onboard the vessel will include sediment description logging, sample homogenisation and containerisation for dispatch to analytical laboratories under chain of custody documentation.

Samples will be placed/extruded into large stainless-steel mixing bowls and homogenised using gloved hands (powderless latex gloves) or small stainless-steel sample scoop. Once homogenised, samples will be placed in containers supplied by the analytical laboratory. The laboratory will be NATA accredited for the analyses to be undertaken. A description of typical laboratory supplied sampling containers is provided in Table 3-6. Sample containers will be appropriately labelled using indelible ink to write the sample site number and date on both the label and lid of the container or pre-printed labels that will be stuck onto each container.

Samples will be stored either in refrigerators or in eskies with ice packs. Samples will remain in refrigerated condition until dispatched to the analytical testing laboratory, where they will be maintained at 4°C. If samples are to be frozen to extend hold times to minimise the need to recollect material for further analyses, sediments for organic contaminants or mercury assessment are to be stored at -10°C or below.

To allow for longer hold times of up to eight weeks during these surveys and to minimise resampling, an additional hold sample will be retained for each sampling location and stored at -10°C (or below) within 12 hours of sampling. If the 95% UCL of the initial results are at levels greater than the Screening Levels, then the remaining hold samples for the specific dredge area may be tested as part of the Phase III analysis.

All sample material held at the analytical laboratory is to be retained for at least one month or longer from the date of submission, to be available for repeat/verification testing as may be required.

Table 3-6: Sample containers

Analyte	Containers per sample
TOC, Trace metals, nutrients, hydrocarbons and organics.	2 x 250 ml solvent washed, acid rinsed glass jar with a Teflon lined lid
PFAS	1 x 200 ml plastic jar
Hold samples	1 to 3 x 250 ml solvent washed, acid rinsed glass jar with a Teflon lined lid
Particle size	1 x plastic bag to hold a minimum of 500 g sample
Elutriates (hold sample unless Phase III sampling is required)	2 x 5 L of seawater in clean plastic containers

3.3.6 Hold samples

Hold samples (i.e. small duplicate splits taken from the homogenised sample material for each horizon of each of the sampling locations) are submitted to the analytical laboratory and stored under appropriate conditions for further analysis or re-analysis, if required.

At least two five litre containers of seawater (each) from the DSDA will also be collected for holding in the event that Phase III testing is required.

3.3.7 Summary of sampling and analysis

An example summary of the proposed sampling scheme is presented in Table 3-7. The example is taken from the 2022 SAP. The table includes those samples to be analysed for field quality control/quality assurance purposes as identified in Section 3.5.

The need to update this sampling scheme will be assessed on an annual basis as discussed in Section 3.1.1. Identified changes will be outlined in each annual SAP prior to submission to GBRMPA for approval.

3.3.8 Sampling design content in campaign SAPs

Due to the likely variability in the maintenance dredging scheduled over the term of the LMDMP and potential variations in maintenance dredging volumes the pre-campaign SAPs will include:

- Updated version of Table 3-3 comprising forecast dredge volumes and number of proposed sampling locations, noting that the number of grids will remain consistent for each dredge area.
- Review of potential contaminant inputs associated with environmental incidents and subsequent consideration of change to the frequency or type of contaminant analysis.
- Detail on any need for targeted or increased frequency of sampling responding to potential areas of concern.
- Sampling scheme for sites and the relevant primary, secondary and miscellaneous contaminant analytes (example shown in Table 3-7).
- Figures showing grid overlay and campaign specific random sampling locations (i.e., relevant cells to be shade / hatched on Figure 3-2 to Figure 3-8 as applicable to the campaign).
- Detail of any proposed variations to the method outlined in this document.

Table 3-7: Example - Year 2022 - Proposed sample locations and samples analysed for various sediment quality attributes for each dredge area

	Grid No.	# horizons	Sample type	Miscellaneous			Primary		Secondary analytes				
				Moisture	PSD	TOC	Metals	Organotins	TPH	PAH	Nutrients	Diuron	PFAS
Outer Channel	OC10-b	1	G	1	1	1	1	1					
	OC11-c	1	G	1	1	1	1	1					
	OC 13-b (T1)	1	G	1	1	1	1	1					
	OC 13-b (T2)	1	G	1		1	1	1					
	OC 13-b (T3)	1	G	1		1	1	1					
	OC18-a	1	G	1	1	1	1	1					
	OC1-c	1	G	1	1	1	1	1					
	OC23-b	1	G	1	1	1	1	1					
	OC30-b	1	G	1	1	1	1	1					
	OC 35-b (T1)	1	G	1	1	1	1	1					
	OC 35-b (T2)	1	G	1		1	1	1					
	OC 35-b (T3)	1	G	1		1	1	1					
	OC41-d	1	G	1	1	1	1	1					
	OC46-c	1	G	1	1	1	1	1					
	OC4-d	1	G	1	1	1	1	1					
	OC 56-a	1	G	1	1	1	1	1					
	OC 56-a (D1)	1	G	1		1	1	1					
	OC 56-a (D2)	1	G	1		1	1	1					
	OC62-c	1	G	1	1	1	1	1					
	OC68-b	1	G	1	1	1	1	1					
Dredge Spoil Disposal Area	DSDA 1	1	G	1	1	1	1	1					
	DSDA 2	1	G	1	1	1	1	1	1	1	1	1	1
	DSDA 3	1	G	1	1	1	1	1	1	1	1	1	1
	DSDA 4	1	G	1	1	1	1	1	1	1	1	1	1
	DSDA 5	1	G	1	1	1	1	1					
	DSDA 6	1	G	1	1	1	1	1					
			Total	26	20	26	26	26	3	3	3	3	3

	Grid No.	# horizons	Sample type	Miscellaneous			Primary		Secondary analytes				
				Moisture	PSD	TOC	Metals	Organotins	TPH	PAH	Nutrients	Diuron	PFAS
Inner Port	IP 01-b	1	G	1	1	1	1	1					
	IP 100-c	1	G	1	1	1	1	1					
	IP 71-a	1	G	1	1	1	1	1					
	IP 77-b (T1)	1	G	1	1	1	1	1	1	1	1	1	1
	IP 77-b (T2)	1	G	1		1	1	1				1	1
	IP 77-b (T3)	1	G	1		1	1	1				1	1
	IP 79-d	1	G	1	1	1	1	1					
	IP 80-b	1	G	1	1	1	1	1					
	IP 84-d	1	G	1	1	1	1	1					
	IP 85-b	1	G	1	1	1	1	1	1	1	1	1	1
	IP 85-b (D3)	1	G	1		1	1	1				1	1
	IP 85-b (D4)	1	G	1		1	1	1				1	1
	IP 88-a	1	G	1	1	1	1	1					
	IP 90-b	1	G	1	1	1	1	1					
	IP 93-d (T1)	1	G	1	1	1	1	1	1	1	1	1	1
	IP 93-d (T2)	1	G	1		1	1	1				1	1
	IP 93-d (T3)	1	G	1		1	1	1				1	1
	IP 97-a	1	G	1	1	1	1	1					
	IP 98-a	1	G	1	1	1	1	1					
	IP 105-a	1	G	1	1	1	1	1					
	IP 104-d	1	G	1	1	1	1	1					
			Total	21	15	21	21	21	3	3	3	9	9

	Grid No.	# horizons	Sample type	Miscellaneous			Primary		Secondary analytes				
				Moisture	PSD	TOC	Metals	Organotins	TPH	PAH	Nutrients	Diuron	PFAS
Navy Base - Inner	NB I-06	3	PC	1	1	1	1	1					
	NB I-09	3	PC	1	1	1	1	1	1	1	1	1	1
	NB I-09 (D5)	3	PC	1		1	1	1				1	1
	NB I-09 (D6)	3	PC	1		1	1	1				1	1
	NB I-15 (T1)	3	PC	1	1	1	1	1	1	1	1	1	1
	NB I-15 (T2)	3	PC	1		1	1	1				1	1
	NB I-15 (T3)	3	PC	1		1	1	1				1	1
	NB I-24	3	PC	1	1	1	1	1	1	1	1	1	1
	NB I-27	3	PC	1	1	1	1	1					
	NB I-30	3	PC	1	1	1	1	1					
	NB I-36	3	PC	1	1	1	1	1					
	NB I-45	3	PC	1	1	1	1	1					
Marlin Marina - North	MM-N 1-d	3	PC	1	1	1	1	1					
	MM-N 2-c	3	PC	1	1	1	1	1	1	1	1	1	1
	MM-N 2-c (D7)	3	PC	1		1	1	1				1	1
	MM-N 2-c (D8)	3	PC	1		1	1	1				1	1
	MM-N 21-d (T1)	3	PC	1	1	1	1	1	1	1	1	1	1
	MM-N 21-d (T2)	3	PC	1		1	1	1				1	1
	MM-N 21-d (T3)	3	PC	1		1	1	1				1	1
	MM-N 30-c	3	PC	1	1	1	1	1	1	1	1	1	1
	MM-N 32-d	3	PC	1	1	1	1	1					
	MM-N 34-c	3	PC	1	1	1	1	1					
			Total	22	14	22	22	22	6	6	6	14	14

Notes

G: Grab (sample depth 0.1m)

PC: 2m Piston Corer (sample depths of 0-0.5m; 0.5-1m; 1-2m

Normal samples

Triplicate samples

Triplicate split

Nutrients include TN, TKN, nitrate, nitrite, TP, ammonia

3.4 Laboratory analysis

Laboratory analyses will be undertaken by reputable NATA accredited analytical laboratories consistent with the NAGD requirements and with experience in marine sediment analysis. Proactive engagement with the laboratories will be enacted to ensure laboratories are aware of the required LOR's, sample anomalies and to ensure the need for re-analysis or clarifications are minimised.

3.5 Field Quality Assurance / Quality Control

Field and laboratory quality assurance and quality control are to be undertaken in compliance with NAGD requirements. Primary and secondary laboratories to be used will be NATA accredited for the testing to be undertaken. If a laboratory has alternative quality control criteria, then these will be reported. Alternative criteria are often employed on a sliding scale dependent on the magnitude of the results in comparison to the level of reporting and should be reported where applicable.

3.5.1 Quality Control – field sampling

QC during sampling is to include:

- Using suitably qualified environmental staff experienced in sediment sampling, field supervision and sediment logging
- Using a surveyed vessel which is thoroughly inspected and washed down
- Containing samples in appropriately cleaned, pre-treated and labelled sample containers
- Keeping samples cool (4°C) after sampling and during transport where they would be stored in eskies with pre-frozen ice bricks
- Transportation of samples under chain of custody documentation
- Generating additional QC samples in accordance with the NAGD (refer Section 3.5.2 below)
- 'Blind labelling' all field QC duplicate/triplicate samples in the field with QC field numbers which do not relate to sampling location names
- Decontaminating all sampling equipment, including mixing bowls etc., between sampling locations via a decontamination procedure involving a wash with ambient sea water and a laboratory grade detergent, and successive rinsing with deionised water; or by a similarly acceptable method.

3.5.2 Quality Control – analysis

The NAGD (Appendix F) specifies that field quality control samples should include (per batch of 20 or fewer):

- *In cases where volatile substances such as some chlorinated organics are being determined, one container (trip) blank filled with inert material, for example chromatographic sand*
- *On 10 per cent of locations, one field triplicate (that is three separate samples taken at the same location) to determine the variability of the sediment physical and chemical characteristics*
- *On five per cent of locations, samples should be thoroughly mixed then split into three containers to assess laboratory variation, with one of the three samples sent to a second (reference) laboratory for analyses.*

- *One sample that has been analysed in a previous batch (if more than one batch is sent) to determine the analytical variation between batches.*

In consideration of this, the following Quality Assurance Quality Control (QAQC) protocol has been developed for this SAP:

- Trip blanks will be taken and analysed as volatile organic carbon compounds will be assessed
- The total number of field replicate samples that will be collected within the study area is calculated based on total number of sample locations within each of the dredge areas
- One of each split triplicate sample will be sent to a secondary (reference laboratory) for analysis
- Samples from each dredge area will be sent to the laboratory as a single batch, so no inter-batch samples are required.

The primary laboratory for the sediment characterisation program will need to comply with the laboratory and quality assurance procedures specified in Appendix F of the NAGD, which require:

The laboratory quality assurance program should include the following quality control samples to be analysed in each batch (10-20 samples). This is in addition to its own internal procedures to ensure analytical procedures are conducted properly and produce reliable results:

- *One laboratory blank sample*
- *For metals, one Standard Reference Material (SRM), that is, a sample of certified composition such as MESS-1 or BCSS-1, or BEST-1 (for mercury), or a suitable internal laboratory standard calibrated against an SRM. The laboratory standard should be a ground sediment sample, not a liquid sample, to test both the recovery of the extraction procedure and the analysis*
- *For organics, one sample spiked with the parameters being determined (or a surrogate spike for certain organics) at a concentration within the linear range of the method being employed – this will determine whether the recovery rate of the analytical method is adequate or not (that is, that all the chemicals present in the sample are actually being found in the analysis)*
- *One replicate sample to determine the precision of the analysis; the standard deviation and coefficient of variation should be documented.*

Details of the laboratory analytical methods and associated detection limits will be presented within each SAP report.

A validation of the analytical data obtained will be undertaken in accordance with Appendix F of the NAGD to confirm it is of a quality suitable for undertaking an assessment of dredge material suitability for sea disposal. This validation will include a consideration of results for blanks, standards and spikes, and replicate and duplicate samples. The relative percent differences and relative standard deviations between quality control duplicate and triplicate samples will be compared against relevant criteria.

3.6 Analysis of results

3.6.1 Phase II – Sediment analysis for total sediment concentrations

Contaminant levels for sediments will be compared against the Screening Levels listed in Table 2 of Appendix A of the NAGD, local Screening Levels and Heads of Environmental Protection Agency's (HEPA) Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) National Environmental Management Plan

(NEPM). These Screening Levels will be used to assess whether the material from each dredge area is suitable for placement at sea; or if further testing is required (e.g. elutriate, bioavailability and/or toxicity assessment).

It is understood that guidance on PFAS is presently in development by DAWE for use within the NAGD framework. Once this new guidance becomes available, it will replace the guidance from the NEMP described above and will be included within this SAP and associated future annual SAPs.

Each sample will be compared against the adopted screening levels described above and assessed for hot spots. A hot spot is a cluster of two or more samples exceeding the NAGD Screening Level. If present, the area may be treated as a separate unit and selectively dredged.

Following the assessment of individual samples to the adopted screening levels, a comparison of mean contaminant concentrations at the upper 95% confidence level (95%UCL) of the mean will be undertaken. A minimum of 10 samples are required for accurate calculation of 95%UCL, however, it can be calculated with fewer samples. Using fewer samples sometimes results in a 95%UCL value that is higher than the highest concentration detected. In this instance the highest value will be adopted as the 95%UCL.

For the purposes of calculation of 95% UCLs, values below detection limit will be set to one-half of the LOR in accordance with NAGD recommendations. Results for organic parameters are normalised to 1% TOC where the recorded value is within the range of 0.2 – 10%. If TOC values are outside this range, then the highest or lowest of the 0.2 – 10% range is adopted as appropriate. For example, for concentrations of TOC less than 0.2%, a value of five times the determine TBT concentration must be used. Mean, standard deviation and the 95%UCL's will be calculated for each dredge area and the DMPA (old) and DSDA (new).

Means standard deviation and 95% UCL's will not be calculated for contaminant groups that were found to have concentrations below the LOR at all sampling locations.

The methods proposed to be used to calculate the 95% UCLs are based on the methods recommended in Appendix A of the NAGD (P38, Comparison of Data to Screening Levels). Normality of datasets will be determined using Shapiro-Wilks test in ProUCL Version 5 (5.0) developed by the US EPA. Datasets will be determined as being either *normal*, *log-normal* or *other* in their distributions. Normal datasets will be analysed using the 1-tailed student's t UCL. Log-normal and other datasets were analysed using non-parametric bootstrap analysis. The H-Lands UCL will not be used for the analysis of log-normal data as this method is only appropriate for datasets of more than 30 samples, which is significantly more than the number of samples for respective dredge areas being assessed.

Should a contaminant be found to exceed the screening level assessment process and Phase III testing is triggered on additional samples collected during initial field program, a request to GBRMPA will then be made to consider the initial results, this SAP, proposed sampling and analysis and provide comment or approval prior to the conduct of further testing.

Under the NAGD, if the 95%UCL values for all substances are below relevant Screening Levels, it is considered unlikely that sediment contaminants will have adverse effects on organisms living in or on that sediment. The sediment is therefore considered non-toxic and there are no chemical obstacles to unconfined placement at sea in the approved DSDA (new).

3.6.2 Phase III – Elutriate analysis

If required, under the NAGD framework, elutriate analyses will be undertaken using sediments prepared in a 1:4 suspension of Port of Cairns DSDA seawater, collected whilst the vessel is in the vicinity of the site for the sediment sampling. A dilution correction factor will then be applied to the 1:4 result as described in the NAGD. That is, the 1:4 elutriate concentration may be divided by at least 100 then assessed against the marine water quality guideline values as described below.

To assess potential impacts on water column organisms during disposal corrected elutriate concentrations will be compared to the 99% species protection marine water quality guideline values / toxicant trigger level published by ANZG, 2018, NEMP guidelines or future DAWE guidance on PFAS, following the procedures outlined in Appendix A of the NAGD and the clarification of the NAGD, 2009 decision tree and explanatory note for assessment of TBT in dredge spoil (DAWE, 2021). Where more specific local water quality management triggers exist for contaminants these will also be applied at the 99% species protection level.

3.6.3 Phase III – Bioavailability and toxicity analyses

If required, assessment of the bioavailability of metals and metalloids will be via the dilute acid extraction (DAE) method, which uses a weak acid (1M HCl) to extract the metals and metalloids, rather than using strong acid as used in total metals and metalloid analysis. Statistical analysis of DAE results will be as described in Section 3.6.1 for total metal contaminants. The statistical results will be compared against the values in Table 2 of Appendix A of the NAGD.

For organic contaminants and where the type of sediment material is suitable, collected sediment samples will be pressure squeezed to provide the chemical laboratory with porewater for chemical analysis. In previous years, porewater analysis could not be completed on clays from the CFB1 as sufficient porewater volume could not be extracted for analysis. However, where data is obtained, and following the procedures outlined in Appendix A of the NAGD, porewater concentrations will be compared to the 99% species protection marine water quality guideline values / toxicant trigger level published by ANZG, 2018, NEMP guidelines or future DAWE guidance on PFAS. Where more specific local water quality management triggers exist for contaminants these will also be applied at the 99% species protection level.

If pore water cannot be obtained, such as the case has been for sediments previously collected at CFB1, elutriate data can be used to estimate pore water concentrations. However, for TBT data, the marine water quality guideline value is compared to the undiluted elutriate data. If the data is above the marine water quality guideline value the spoil is unacceptable for sea disposal and treatment, confined disposal options or on-land disposal will need investigation.

If the TBT data for porewater (or elutriate water) is below the relevant marine water quality guideline values, but greater than the sediment quality high value for TBT of 70 μg Sn/L, bioaccumulation testing is required in Phase IV.

3.6.4 Phase IV – assess TBT bioaccumulation

Historically Phase IV testing has not been required for the Port of Cairns maintenance sediments as no values have exceeded the sediment quality high values. It is therefore considered unlikely that Phase IV testing would be required. However, if Phase IV testing is required, the detail in the NAGD at Section

4.2.4 (page 14), Appendix A (page 43 to 46) Appendix D (page 62-63) and Simpson *et al*., 2013 will be adopted.

3.6.5 Phase V – Assess Weight of Evidence

Historically Phase V testing has not been required for the Port of Cairns maintenance sediments. However, if Phase V testing is required, the detail in the NAGD at Section 4.2.4 (page 15), Appendix A (page 48), Table 3 (page 46) and Simpson *et al*., 2013 will be adopted.

4 Introduced marine pest survey

4.1 Sampling design and method

4.1.1 Species targeted

Historical marine pest monitoring of Port of Cairns, or detections on the hulls of slipped vessels, has identified three species, the Asian green mussel (*Perna viridis*), Caribbean tube worm (*Hydroides sanctaecrucis*) and Asian bag mussel (*Musculista senhousia*). Therefore, annual surveys will focus on these three species previously recorded from the Port area as a priority, and also aim to identify the presence of any specimens that appear as suspect marine macro-invertebrate pest species. This sampling will complement the e-DNA settlement plate and plankton sampling program enacted by Ports North in partnership with Biosecurity Queensland (BQ).

4.1.2 Sampling location and methods

4.1.2.1 Outer channel

Sediments located within the OC dredge area will be sampled for marine pest species using a benthic sled at 12 pre-determined locations (refer to Table 4-1). The benthic sled will sample sediments to 10cm depth below the seabed surface using a 600 mm x 250 mm collection bag. At each of the 12 sampling locations, which replicate those surveyed from 2008 - 2020, the sled will be deployed from the rear of the sampling vessel and towed at a speed of <2 knots for approximately 100 m. On completion of each transect the sled will be retrieved and the contents will be transferred to a sorting tray for initial screening.

Field notes will describe the biota contained within each sample and any suspect individuals or other relevant data. Each sample will be photographed to provide a permanent record. Where confirmed, or possible live marine pests are present (i.e. containing Mytillid mussel shells), the samples will be preserved in 10% formalin solution and sent to a qualified taxonomy specialist for formal species identification. Coordinates for sled sites are provided in Table 4-1.

4.1.2.2 Inner Port (Wharves 1-8 and 10-12)

Towed sled sampling will also be undertaken as far as practicable along the wharf faces of the IP, provided vessels and other obstacles do not preclude reasonable access for the towing vessel and sufficient room to maneuver while towing the sled. Optimally, sled tows will be undertaken along the following wharf faces:

- Wharves 1 - 8
- Wharves 10 - 12.

On completion of each transect, the sled will be retrieved, and the contents of the sample bag will be transferred to a sorting tray for field processing. Sample processing (sample photograph, description, preservation and identification) will be consistent with that described for the OC (Section 4.1.2.1).

In addition to towed sledding, six replicate grab samples will be taken from the sediment sampling locations and processed according to the methods for marinas (Section 4.1.2.3). The timing of the grab sample will be undertaken prior to any sediment sampling to minimise potential sediment disturbance.

Where grab samples are collected, each sample will be washed using a deck hose and 2 mm sieve before being transferred to a sorting tray. Sample processing and recording will similarly be undertaken as for towed sled samples. Coordinates for grab sampling sites are the same as sediment sampling sites.

4.1.2.3 Marinas (NB, MM, CFB1, CFB2, MSQ)

Due to spatial restrictions, the various marina maintenance dredge sediments will be sampled for marine pest species using a van Veen grab. Marine pest sampling sites will be identical to those sampled as part of the sediment sampling program. Six grab samples will be taken and composited to form each sample. Each sample will be washed using a deck hose and 2 mm sieve before being transferred to a sorting tray for species screening. Sample processing and recording will be consistent with that described for the OC (Section 4.1.2.1).

4.1.2.4 Dredge Material Placement Area and Dredge Spoil Disposal Area

A 100 m towed sled survey of four sample locations within the DMPA and four locations within the DSDA will be undertaken (refer to Table 4-1). On completion of each transect, the sled will be retrieved, and the contents transferred to a sorting tray for field processing. Sample processing and recording will be consistent with that described for the OC (Section 4.1.2.1).

Table 4-1: GPS coordinates of pre-determined marine pest sampling locations for OC, DMPA and DSDA

Sampling Site ID	Port Area	Easting (GDA94z55)	Northing (GDA94z55)
OCP-01	OC	375240.8538	8138192.958
OCP-02	OC	374931.8765	8137632.49
OCP-03	OC	374700.1474	8137212.139
OCP-04	OC	374236.6805	8136371.431
OCP-05	OC	374004.9388	8135951.08
OCP-06	OC	373618.7188	8135250.488
OCP-07	OC	373386.9817	8134830.138
OCP-09	OC	372923.518	8133989.434
OCP-09	OC	372382.8023	8133008.614
OCP-10	OC	371533.1135	8131467.322
OCP-11	OC	371301.3808	8131046.973
OCP-12	OC	370627.541	8129629.504
DMPA-02*	DMPA	373886.6105	8142495.73
DMPA-03*	DMPA	373669.6517	8143755.15
DMPA-04*	DMPA	373209.2758	8143199.523
DMPA-05*	DMPA	373008.1921	8143786.9
DSDA-1*	DSDA	374976.6643	8145038.247
DSDA-2*	DSDA	374499.0757	8144675.193
DSDA-3*	DSDA	374374.7877	8145334.347
DSDA-4*	DSDA	375100.9172	8144379.14
Notes: * indicates sites that have the same coordinates as sediment sampling locations			

5 Reporting

SAP reports will be prepared consistent with the requirements of Appendix B of the NAGD. Depending on the staging of dredging, reporting of dredge areas may be undertaken separately. Reports will contain the following information:

- Executive Summary
- Introduction and description of the study area
- Details of the sampling methodology, including any deviations from the approved SAP
- Figures showing precise locations of the sampling points (based upon GPS sampling coordinates)
- Physical descriptions of the samples, based upon the photos and core logs;
- Descriptions of any observations or anomalies during sampling and/or analysis
- Table of laboratories used and the analytical methods employed
- Quality Assurance/Quality Control procedures and results
- Summary table of results for each parameter analysed
- Comparison and interpretation of the results
- Conclusions regarding the acceptability or not of dredge material for unconfined sea disposal
- Recommendations as to further testing required
- Appendices containing all raw data and quality assurance and quality control analyses.

The reports will provide summary data tables with highlighted exceedance results for any parameters for which the Screening Levels or appropriate indicator criteria are exceeded. The original laboratory reports will be provided as appendices. Mapping will be undertaken for all parameters where the Screening Level is exceeded.

Once reports are finalized, they will be submitted to the Determining Authority (GBRMPA) for review and comment or approval for continuation of sea dumping activity. Written approval is required from the Determining Authority for respective dredge areas prior to dredging and disposal activities commencing.

6 References

Advisian, 2021. Technical Memorandum – Long-term Maintenance Dredging and Management Plan – Port of Cairns – Maintenance Dredge Spoil Characteristics, document number 301001-02058-00-EN-MEM-0005 Rev 1. Advisian, Brisbane.

ANZECC/ARMCANZ, 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. National Water Quality Strategy. Australian and New Zealand Environment Conservation Council and Agricultural Resource Management Council of Australia and New Zealand.

Australian Government Department of Agriculture, Water and the Environment (DAWE), 2021. Clarification of the National Assessment Guidelines for Dredging 2009 – Decision tree and explanatory note for assessment of tributyltin (TBT) in dredge spoil. DAWE.

BMT, 2022. Port of Cairns Long-term Maintenance Dredging Management Plan 2021-2031, document number R.B24065.001.02 Revision 2. BMT, Brisbane.

Commonwealth of Australia, 2002. *National Ocean Disposal Guidelines for Dredged Material*. Commonwealth of Australia, Canberra.

Commonwealth of Australia, 2009. *National Assessment Guidelines for Dredging*. Commonwealth of Australia, Canberra.

National Chemicals Working Group of the Head of EPAs Australia and New Zealand (HEPA), 2020. PFAS National Environmental Management Plan (NEPM), Version 2.0 January 2020. Commonwealth of Australia.

Appendix A
Example core/sampling sheet log

Cairns Port 2022 to 2032 SAP

Sediment Description

Sample Location	
Date / Sample Time	
Depth retained	

Strata Change (m)	Colour* (refer AS1726)	Field texture**	Moist.	Consist	Sand grain size	Plasticity	% stones	Shell/grit and/or biota	Odour

* Colour: black, white, grey, red, brown, orange, yellow, green, blue. Pale, dark, mottled. *e.g. grey mottled red-brown clay.*

**Field Texture: clay, silt, sand, gravel, etc