APPENDIX C

Port of Hay Point – Sediment Analysis Plan

Maintenance Dredging Sampling and Analysis Plan

Port of Hay Point

15/12/17

Level 31, 12 Creek St
Brisbane QLD 4000
Australia

301001-02018-EN-PLN-0001

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WorleyParsons Group

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Project No: 301001-02018-EN-PLN-0001 – Maintenance Dredging Sampling and Analysis Plan: Port of Hay Point

Rev	Description	Author	Review	Advisian Approval	Date
2	For Client Use	S Neale	B Boylson	B Boylson	15/12/17

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1 Introduction

1.1 Scope

This Sampling and Analysis Plan (SAP) describes the dredging proposal and outlines the proposed design and scope of sediment characterisation investigations for the existing navigational areas within the Port of Hay Point. Sediment characterisation investigations are required in order to determine the suitability of the maintenance dredge sediment for unconfined disposal to sea (into an approved dredge material relocation ground).

This SAP has been developed in accordance with the requirements outlined within the National Assessment Guidelines for Dredging (NAGD) (Commonwealth of Australia, 2009). As part of the dredging permit process, prior to field sediment characterisation, the SAP is required to be approved by the determining authority, the Great Barrier Reef Marine Park Authority (GBRMPA).

All issues on the SAP identified by a GBRMPA review process have been addressed in this revision of the SAP.

1.2 Background

The Port of Hay Point is located within central Queensland, 40km south of Mackay, and is one of the largest coal export ports in the world (Figure 1-1). North Queensland Bulk Ports Corporation Limited (NQBP) is the port authority for the Port. The port facilities consist of two terminals, Dalrymple Bay Coal Terminal (DBCT) and the Hay Point Coal Terminal (HPCT). Both terminals are serviced by an Apron Area for manoeuvring ships, and a Departure Path (inner and outer path) that facilitates the movement of loaded ships between the berth areas of each terminal and the offshore area. Tugs which service the operations at the Port are moored within the adjacent Half Tide Tug Harbour (HTTH).

The HPCT is owned by BHP Mitsubishi Alliance (BMA). The HPCT commenced operations in 1971. The HPCT wharf is 1.8 km long and has three berths (Berths 1, 2 and 3). Operations at DBCT commenced at Berth 1 in 1983, while Berth 2, Berth 3 and Berth 4 commenced operations in 1994, 2003 and 2008 respectively.

Sedimentation of the navigational facilities within the Port of Hay Point occurs naturally and is caused by the transportation of sediment from ocean currents, swell and tides, and cyclonic activity. These sediments require periodic removal from the navigational areas to maintain safe and efficient operational depths.

The areas of interest for this SAP are the four berths associated with the DBCT terminal, one berth (HPCT Berth 3) associated with the HPCT terminal, the Apron Area, Departure Path (inner and outer path), HTTH and the public boat ramp. The two other HPCT berths (HPCT Berth 1 and HPCT Berth 2) are not included in this SAP, as there are no immediate needs for maintenance dredging.

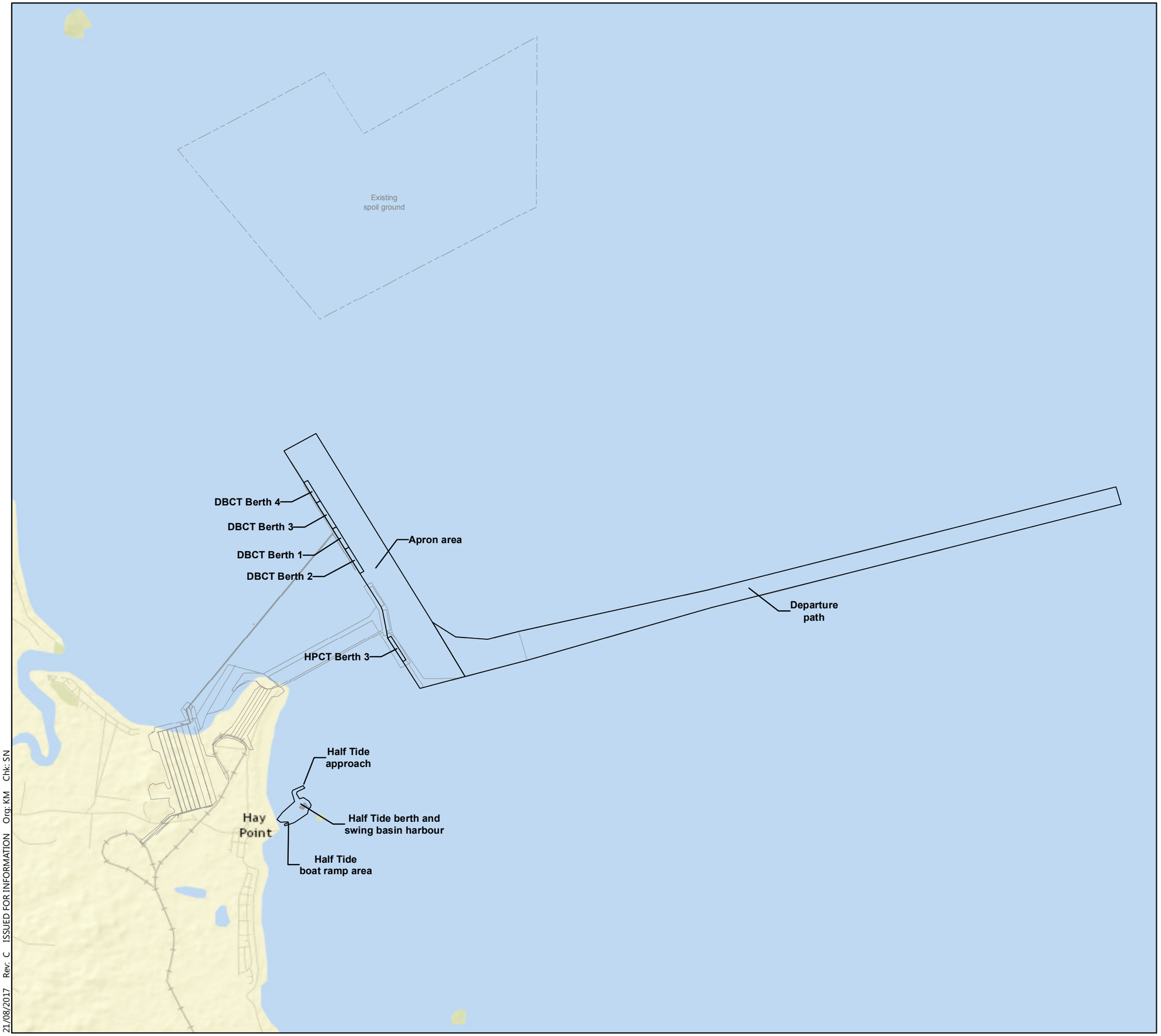
1.3 Objectives

This SAP is developed based on the requirements as set out in the NAGD (Commonwealth of Australia, 2009). The primary objectives of the SAP are to:

- Provide a description of the dredging and placement footprint (**Section 2.4**)
- Define existing and historical land uses which may influence the contamination potential of the sediment to be dredged (**Section 3**)
- Identify contaminants required for analysis based on potential contaminant sources and results of recent testing (**Section 3.3** and **Section 3.4**)
- Determine the location and number of samples required to provide an adequate dataset for calculating the upper 95 percentile confidence limit of the mean to compare to screening levels of contaminants (**Section 4**)
- Define the types of analysis required for sediments (**Section 4.5**)
- Present the protocols for collection and handling of sediment samples (**Section 5**)
- Present the quality assurance and quality control procedures for sample collection, handling and laboratory analysis (**Section 5.1.3** and **Section 5.2.1**)
- Define the statistical techniques used to determine the status of potential contamination within the sediment to be dredged (**Section 5.3**)
- Present the reporting framework for the presentation of data, results and conclusions to address the needs of NQBP and GBRMPA (**Section 5.4**).

Port of Hay Point Sediment Investigation 2017

Figure 1-1
Location of the Port of Hay Point and the navigational areas associated with the Port



LEGEND

- Existing infrastructure
- Existing spoil ground
- Port areas

Source Information:
Infrastructure
Extracted from drawing 223510-A20-DW-M-001(M) supplied by Aurecon 2012/09/26
HTTH Boat Ramp Access Channel and Dredge Area
Coordinates extracted from client supplied Map - NQBP2014-028

0 500 1,000 1,500 2,000
Metres

Coordinate System: GCS GDA 1994
Datum: GDA 1994
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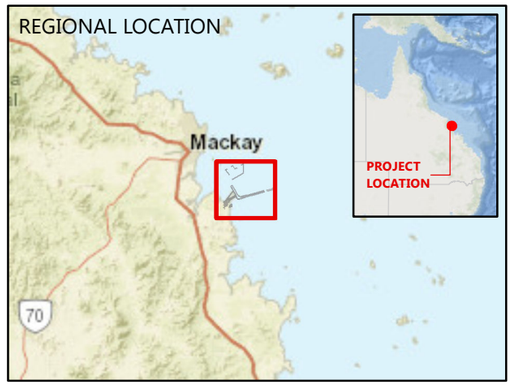

Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

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2 Proposed Maintenance Dredging

The NAGD requires proponents to define the location and estimated volume of dredging and dredge sediment relocation, along with the proposed methods to be utilised. Proponents are also required to provide an indication of the timing/schedule of activities. The following sections address these requirements.

2.1 Previous maintenance dredging

In 2010, approximately 216,000 cubic meters (m^3) of unconsolidated sediment was removed by the Trailing Suction Hopper Dredge (TSHD) Brisbane and relocated to the current dredge sediment relocation ground located to the north of the DBCT berth pockets (Figure 1-1). Dredging commenced on August 30, 2010 and ceased on September 7, 2010. The areas dredged included parts of the Departure Path and Apron Area. No maintenance dredging has occurred since 2010.

2.2 Dredge volumes and footprint

To ensure continued safe and efficient port operations maintenance dredging is proposed for all navigational areas apart from HPCT Berth 1 and Berth 2. The estimated volume of sediment in each of the navigational areas was ascertained from bathymetric survey undertaken in August 2017 (Table 2-1). The total volume of sediment to be removed including a 10% over dredge volume is estimated as **355,834**m^3.

The maintenance dredging footprint applicable to this SAP includes those areas shown in Figure 1-1 (except for HPCT Berth 1 and 2). The proposed management areas for the SAP, along with the design depth and estimated volume of sediment to be dredged from each area, are set out in Table 2-1.

Table 2-1 Management areas and volume of sediment to be dredged

Management Area	Location	Estimated Volume (m^3)	Design Depth (mLAT)
Area 1	HTTH	22,624	HTTH approaches -5.6
			HTTH berths -6.1
	Hay Point Boat Ramp	5,837	-0.5 Area
			-1.0 Area
Area 2	DBCT Berth 1	57076	-19.6
Area 3	DBCT Berth 2	62,323	-19.6
	DBCT Berth 3	47,226	-19.0
	DBCT Berth 4	53,852	-19.0
Area 4	Apron Area	56,887	-14.9
Area 5	Inner Channel	7,597	-14.9
	Outer Channel	2,866	-14.9
Area 6	HPCT Berth 3	7,197	-19.0
Volume		323,485	
10% over dredge		32,349	
Total Volume		**355,834**	

2.3 Type of sediments to be dredged

The sediments within the berth pockets are dominated by fine fraction silts and clays (average 60%, but as high as 74%) with sands and minor gravels making up the remainder; sediments in the apron and departure path areas are generally have higher sand fractions (WorleyParsons 2013c). Sediments in the navigational areas of the Port are generally unconsolidated resulting from siltation and migration of sediments over time from periodic extreme metocean events such as cyclones.

2.4 Dredging methods

It is proposed to utilise the 'Brisbane' or a similar TSHD as the primary dredging and dredge sediment relocation equipment for the Port of Hay Point maintenance dredging.

2.4.1 Trailing suction hopper dredge

Depending on the ongoing viability and availability of the 'Brisbane' other TSHDs may be used for dredging from time to time. However, for the purposes of this SAP, the specifications and operational characteristics of the 'Brisbane' will form the baseline for dredge specification and operational environmental management.

Sediment to be dredged is removed through two suction heads, which are lowered into position on either side of the vessel. As the vessel steams slowly at around 1 – 3 knots, large pumps draw water through the heads, which entrain the sediment and transport the water/sediment mixture aboard into a central collection hopper. Each extraction run takes approximately 1 hour to complete within about a three-hour dredge cycle (depending upon the relocation ground location).

The sediment/water ratio of sediment delivered to the central hopper of the 'Brisbane' is typically quite low. Whilst it varies depending on the type of sediment being dredged, the sediment concentration is generally in the order of 10 – 30 % solids. To maximise dredge sediment capacity, these large volumes of water are managed using a central column weir, which is incorporated into the hopper. This arrangement allows excess water to decant from the sediment and overflow to discharge. Overflow occurs only toward the very end of the dredging run as the hopper nears capacity (typically the last ten minutes of a one hour dredging run). The capacity of the hopper is dependent on the sediment type – with volumes (including both sediment and water) approximating 2,800 m^3 for fine silts and 1,700 m^3 for sands (of a maximum hopper capacity of 2,900m^3). Considering that more water is held in the silt matrix than sands, the dry weight cubic metres of sand able to be practically collected in each load is therefore generally greater than that in silts.

Once the dredge has filled its hopper, the vessel will then relocate the sediment to the designated dredge sediment relocation ground. Dredged sediment is discharged below keel level to minimise turbidity generation. Each dredged sediment placement is manually logged using both satellite navigation and standard bridge equipment, and is electronically fixed using a differentially corrected global positioning system (GPS). The electronic track plot marks the start of the placement process (hopper open), and the end of the process (hopper closed). This track usually shows an arc, which the dredge follows to ensure that all dredged sediment is placed within the designated dredge sediment relocation ground boundary. The time taken to place sediment over the dredge sediment relocation ground is typically about 15 minutes out of the approximately 3-hour dredge cycle.

During the dredging works, electronic logs of each dredge sediment relocation event will be maintained. At the completion of each dredge campaign, these logs will be available to the relevant government agencies to demonstrate compliance with permit conditions.

The TSHD undertaking dredging works at the Port of Hay Point will include the following minimum specifications to minimise environmental impact from dredging and dredge sediment relocation:

- Central weir discharge system
- Below keel discharge point
- Low wash hull design

- Electronic positioning system.

An Environmental Management Plan (EMP) will be developed by the dredging contractor, and implemented for maintenance dredging campaigns. The dredge disposal procedures, any associated monitoring arrangements and corrective actions are incorporated into the EMP. Implementation of the EMP is audited by NQBP environmental staff.

2.5 Dredged sediment relocation

2.5.1 Dredge sediment relocation ground

The dredged sediment from the maintenance dredging is expected to be placed at the existing dredge sediment relocation ground located two kilometres to the north of the DBCT berths, (see Figure 1-1).

The continued use of the dredge sediment relocation ground mitigates impacts from smothering through preventing the need to place dredged sediment in an area that has not been disturbed previously. The seabed of the existing ground is relatively flat and featureless and consists of silty sands. The geomorphic features of the ground have been altered through its historical use. The ground is not an area of high productivity leading to significant ecological or biological processes.

The coral communities of Round Top Island are the closest natural habitat to the dredge sediment relocation ground that provides some biological diversity. These communities may potentially be impacted by dredge plumes; however, previous studies have shown these impacts to be minimal and of short duration (WorleyParsons 2013c). Seagrass and macroalgal communities within the ground have been identified as highly dynamic and influenced by seasonal changes (WorleyParsons 2013c).

2.5.2 Uniform dredge sediment deposition

Impacts to the dredge sediment relocation ground and adjacent areas will be minimised through relocation of the dredge sediment in such a manner as to uniformly spread it over the ground. This is achieved through deposition patterns that vary with the prevailing current direction. When currents are minimal, deposition will occur relatively uniformly over the dredge sediment relocation ground area in arc patterns (refer Figure 2-1 left). When currents are present, deposition will occur in arcs in the up-current portion of the dredge sediment relocation ground to consider drift of sediment as it settles (refer Figure 2-1).

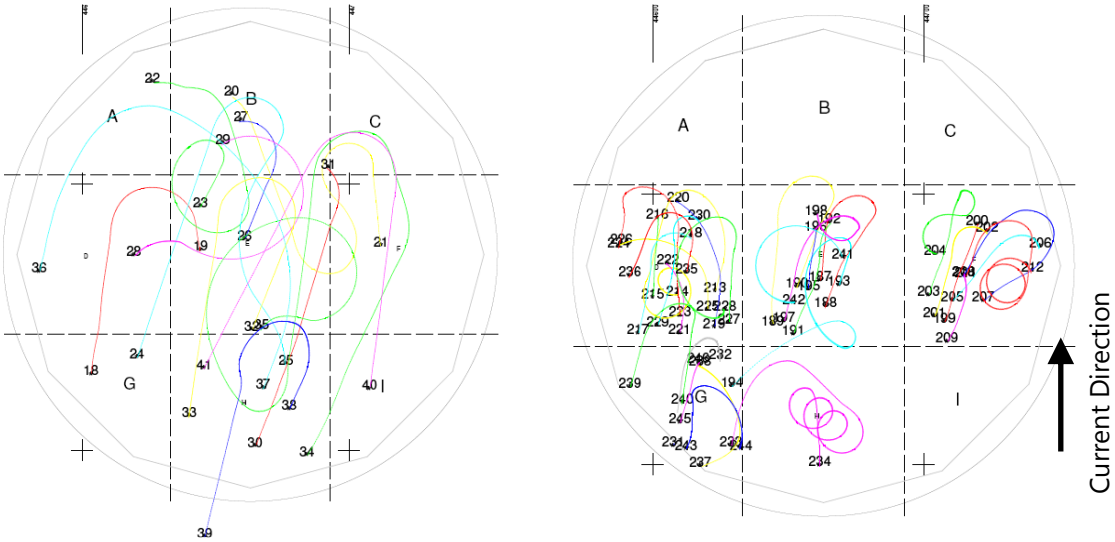

Figure 2-1 Example of dump plot showing deposition during periods of low current (left) and high current (right)

2.6 Timing

Maintenance dredging of the existing material above design depth will occur in 2018. The current schedule of the TSHD Brisbane would allow this to occur in either March / April or September / October, but will be dependent on the maintenance needs of other ports following the 2018 wet season.

2.7 Alternatives to disposal at sea

2.7.1 Previous investigations

Alternatives to ocean relocation for capital and maintenance dredge sediment extracted from the Port of Hay Point have been examined exhaustively. Reports reviewed as part of this investigation included:

- Strategic assessment of future developments that could affect the World Heritage Area:
  - Literature Review and Cost Analysis of Land-based Dredge Material Re-use and Disposal Options, Revision 2.4, 15 July 2013, SKM 2013 for GBRMPA.
- Port of Hay Point investigations for dredge and dredge sediment relocation areas:
  - Port of Hay Point Apron Area and Departure Path Capital Dredging Environmental Impact Statement (GHD 2006).
  - Spoil Ground Site Selection Port of Hay Point (WBM 2004a).
  - Assessment for Land Disposal Options for Dredge Spoil at the Port of Hay Point (WBM 2004b).
  - Dredge Spoil Disposal Options Assessment Hay Point Coal Terminal Expansion BM Alliance Coal Operations Pty Ltd (Connell Hatch 2009).

The most recent and comprehensive assessment of alternative uses of dredged sediment for the Port of Hay Point is the *Comprehensive Beneficial Reuse Assessment – Port of Hay Point – Sustainable Sediment Management Assessment for Navigational Maintenance (Advisian, 2016)*.

2.7.2 Beneficial reuse assessment

As part of a long-term strategic assessment for ongoing management of marine sediments at the Port of Hay Point, NQBP commissioned Advisian to undertake a comprehensive investigation of options for the beneficial reuse of marine sediments that naturally accumulate in the navigational areas of the Port of Hay Point. The investigation incorporated targeted sampling and analysis of maintenance dredge sediment at the Port of Hay Point, with analysis of sediment properties focussed on potential beneficial reuse options (e.g. sediment type, plasticity, moisture content, compressibility). Potential beneficial reuse opportunities were identified and analysed, with key considerations including the sediment properties, the local context and dredge method. The investigations concluded (detailed in Advisian, 2016) that there is no beneficial reuse option for maintenance dredge sediment from the Port with a clear existing demand and requiring minimal infrastructure development. As such, for the Port there is no current definitive alternative to placement of maintenance dredge sediment at sea.

3 Existing Information

3.1 General

The Port of Hay Point is located within the Great Barrier Reef World Heritage Area (GBRWHA) and adjacent to the Great Barrier Reef Marine Park (GBRMP). The shoreline at Hay Point is dominated by a combination of revetments and natural rocky shores. Sandy beaches and mangrove habitats extend both to the north and south of Hay Point. Nearby fringing coral communities are located within the shallow areas between the two wharves, to the south at Victor Islet and to the north at Round Top Island and Flat Top Island.

3.2 Site history and land use

As described previously, port infrastructure includes two coal terminals, HPCT and DBCT and supporting infrastructure such the HTTH. HPCT commenced operations during 1971 exporting coal from one berth (HPCT Berth 1); the jetty associated with this terminal is 2.2km long. An additional berth (HBCT berth 3) was constructed to the south of the existing two berths and commenced operations in 2015. The DBCT consists of 4 berths and commenced operations in 1983. The HTTH was developed (including development of the breakwater and wharf structures) in 1986 when capital dredging for DBCT (Berth 1) was completed (PaCE 2013).

Agricultural land uses (primarily sugar cane production) are located several kilometres to the west of the terminals and minor residential land uses border the facilities to the north and south and are adjacent to the HTTH. The nearest major urban and industrial areas (apart from the coal terminals) with the potential to introduce contaminants into the Port of Hay Point are located in the city of Mackay located 15km to the north.

The Reef Catchments Water Quality Improvement Plan 2014-2021 states that Alligator Creek, which is adjacent to the dredge area, has pesticides and herbicides commonly used in sugar cane production (e.g. Diuron, Ametryn, Hexazinone) levels that are either just below or above the trigger values set out in The Water Quality Guidelines for the GBRMP (2010). The berths (both DBCT and HPCT), apron areas and departure path are located 1.8 to 3 km from shore in an open water environment where organic rich sediments which have the potential to be contaminated are unlikely to accumulate.

Stormwater from both terminals is collected, treated in sedimentation ponds to remove coal and sediment and then stored in large dams for reuse onsite such as for dust suppression (Jacobs 2016).

Port activities have potential to introduce contaminants to the marine sediments in the Hay Point area. These activities include stockpiling, chemical and fuel storages, sewage treatment, abrasive blasting and metal coating processes that are required for operations and maintenance of the port facilities. Dust emissions from the coal terminals are continuously monitored. With respect HTTH and the boat ramp, the primary potential sources of contaminants are from chemical and fuel storage (and potential spills) associated with the operation of the Tug facilities and the use of the boat ramp.

3.3 Previous sediment investigations

The most recent studies which characterise the sediments found in the navigational areas of the Port of Hay Point and relevant to this SAP include:

- Advisian (2016). Comprehensive Beneficial Reuse Assessment – Port of Hay Point – Sustainable Sediment Management Assessment for Navigational Maintenance, report 301310-09537-002, Advisian, Brisbane.
- BMT WBM (2011). Half Tide Boat Ramp Sediment Characterisation Report. June 2011. Report prepared for Queensland Department of Transport
- GHD (2005). Port of Hay Point – Capital Dredging Departure Path and Apron Areas. Sediment sampling and analysis report. Report prepared for the Ports Corporation of Queensland.
- GHD (2011). DRAFT Report for Berths 1 and 2 Maintenance Dredging Sediment Sampling and Analysis Plan, June 2011. Report prepared for Dalrymple Bay Coal Terminal.
- Ports and Coastal Environmental Pty Ltd (PaCE) (2013). Port of Hay Point, Sediment Characterisation Report - 2013. No. 2012001-001. Ormeau, Queensland.
- Ports and Coastal Environmental Pty Ltd (PaCE) (2014). Port of Hay Point, DBCT Berths 1 and 2 - Sediment Characterisation Report. No. 2014002 – 002. PaCE, Brisbane.
- WorleyParsons (2013b). Dudgeon Point Coal Terminals Project – Sediment Characterisation Report for Marine Support Facilities – Revision C, report – 301001-01385-00-PM-REP-0004-069. WorleyParsons 12 April 201

The main findings from each of the studies, including whether the sediments were considered suitable for unconfined ocean disposal are summarised in Table 3-1 below.

Additional background reference documents relevant to the current environmental values of the Port of Hay Point area and the management of any potential impacts from maintenance dredging on these are:

- Jacobs (2016). Port of Hay Point - Environmental Values Assessment – Revision 2. Report prepared by Jacobs on behalf of North Queensland Bulk Ports, September 2016.
- WorleyParsons (2013c). Port of Hay Point Maintenance Dredging Management Plan, report 301001-01665 – 000-EN-REP-002. WorleyParsons, Brisbane.

Table 3-1 Historical sediment investigations of the Port of Hay Point navigational areas

Location	Sub-location (where applicable)	Recent Studies	Findings	Suitability for Placement at Sea
Half Tide Tug Harbour (HTTH)	Approaches and Berths	WorleyParsons (2013b)	▪ With the exception of arsenic, all metals analytes remained below the NAGD screening criteria at the 95% Upper Confidence Limit (UCL) of the mean ▪ TBT, DBT and MBT remained below the Limit of Reporting (LOR) at all sample locations ▪ TPH and BTEX remained below the LOR at all sample locations ▪ PAH analytes reported minor concentrations above the LOR. Total PAHs remained below the NAGD screening level of 10,000µg/kg at all locations. The 95% UCL of the mean also remained below the NAGD screening Level ▪ All Organochlorin, Organophosphorus (OC/Ops) and Polychlorinated Biphenyl (PCB) concentrations were below the LOR at all sample locations ▪ Dioxin concentrations were between 0.23 and 6.86pg/g, well below the NAGD PQLs (20,000 pg/g).	Yes
		PACE (2013)	▪ All analytes reported a 95% UCL below the NAGD guidelines screening criteria, with the exception of arsenic at one sample in the berth area (21.8mg/kg) which was marginally above the NAGD criteria of 20mg/kg.	Yes
HTTH Public Boat Ramp		BMT WBM (2011)	▪ Arsenic (23mg/kg) was the only analyte reporting an individual sample concentration above the NAGD screening criteria (20mg/kg) ▪ TBT and PAH concentrations were above the LOR at some sites, but were below the NAGD screening criteria ▪ Concentrations of TPH, BTEX, OC/OP pesticides, phenolic compounds and volatile chlorinated hydrocarbons were all below the LOR	Yes
Hay Point Coal Terminal (HPCT)	Berth 3	No studies of Maintenance sediments undertaken at this stage	No studies of Maintenance sediment undertaken at this stage	Unknown
Dalrymple Bay Coal Terminal (DBCT)	Berth 1 and Berth 2	PACE (2014)	▪ All concentrations of metals, TPH, BTEX, PAHs, DBT, MBT and nutrients were below the NAGD screening criteria ▪ TBT concentrations at 5 sites in Berth 1 and one site in Berth 2 were above the NAGD screening level. The 95% UCL of the mean TBT concentrations were below the NAGD screening criteria	Yes
	Berth 3 and Berth 4	PACE (2013)	▪ All concentrations of metals, TPH, BTEX, PAHs, TBT, DBT and MBT were below the NAGD screening criteria.	Yes
		Advisian (2016)	▪ Metals and metalloid concentrations were detected in all samples, with the exception of antimony, cadmium and silver which were below the LOR, which is below the respective NAGD screening criteria. The 95%UCL of the mean for each metal and metalloid was below respective NAGD screening criteria. ▪ Low level concentrations of organotin compounds (monobutyltin, dibutyltin and tributyltin) were detected in four samples, all of which were below the NAGD screening level of 9 µg Sn/kg for TBT. Once concentrations were normalized, values remained below the NAGD screening level. All remaining samples had concentrations of organotin compounds below LOR. The 95% UCL of the mean for tributyltin was also below the NAGD screening level. ▪ Concentrations of TPH and BTEX in all samples analysed were below the LOR and therefore below the NAGD screening of 550 mg/kg for TPH.	Yes

Location	Sub-location (where applicable)	Recent Studies	Findings	Suitability for Placement at Sea
			▪ Concentrations of PAHs were detected in most samples with the exception of three samples. These concentrations, when summed and normalized, are below the NAGD screening criteria of 10000 µg/kg for total PAH. The 95% UCL of the mean for PAHs was also below the NAGD screening level. ▪ Statistical analysis indicated that all nutrient data was normally distributed. Note there are no NAGD screening levels for comparison for nutrients.	
Departure Path and Apron Areas		GHD (2005)	▪ Nine samples returned TBT concentration above the LOR and one above the NAGD screening levels. The 95% UCL concentrations of TBT across all sites were below the NAGD screening level ▪ The concentrations of two metals (Nickel and Arsenic) were above the NAGD screening levels. The 95% UCL concentrations of these metals across all sites were below the NAGD screening level ▪ Two samples recorded PAH concentrations above the lab LOR but below the NAGD screening levels. ▪ OC/Ops, TPH and BTEX concentrations were all below the laboratory LOR for all samples	Yes
Apron		PACE (2013)	▪ TBT concentrations were detected, but well below the NAGD screening criteria ▪ Metal concentrations measured at all sites were below the NAGD screening criteria ▪ BTEX and TPH concentrations were primarily below the laboratory LOR. When detected the concentrations were below the NAGD screening criteria ▪ PAH concentrations were primarily below the laboratory LOR. When detected the concentrations were below the NAGD screening criteria	Yes
Departure Path (inner and outer path)		PACE (2013)	▪ All TBT concentrations were below the LOR at all sites ▪ Metal concentrations measured at all sites were below the NAGD screening criteria ▪ BTEX and TPH concentrations were primarily below the laboratory LOR. When detected the concentrations were below the NAGD screening criteria ▪ PAH concentrations were primarily below the laboratory LOR. When detected the concentrations were below the NAGD screening criteria	Yes

3.4 Contamination status

A summary of contamination status based on previous investigations is provided in Table 3-2.

Table 3-2 Historical Contamination status of dredge sediments from each location

Management Area	Location	Suitability for Ocean Placement
Area 1	HTTH	suitable
	HP Boat Ramp	suitable
Area 2	DBCT Berth 1	suitable
Area 3	DBCT Berth 2	suitable
	DBCT Berth 3	suitable
	DBCT Berth 4	suitable
Area 4	Apron Area	suitable
Area 5	Inner Channel	suitable
	Outer Channel	suitable
Area 6	HPCT Berth 3	Unknown, yet to be characterised

3.4.1 Containments of concern

The following list of contaminants together with the NAGD Practical Quantitation Limit (PQL), the laboratory LOR, NAGD Screening level and potential sources are summarised in Table 3-3. The potential contaminants have been identified from the site history, nearby land use and previous sediment characterisation data summarised in Section 3.3.

Of the contaminants identified, Organotin (TBT, DBT and MBT) is considered to have the greatest potential (despite its use being banned for the last decade) to be present in sediments in the Port of Hay Point and will be sampled from each management area and sampling location to the full depth of maintenance dredging. Metals were not identified as a contaminant of concern, but will be adopted as an indicator analyte in this SAP. PAH, TPH and BTEX are proposed for all management areas including HTTH. Total organic carbon and moisture content will also be assessed for all samples. Herbicides (Ametryn and Hexazinone) and pesticides (Diuron) historically used in the adjacent cane farms may wash down from the catchment areas into the nearshore marine environment. Note the HPCT and DBCT berth pockets are located several kilometres out to sea and the open and exposed nature of the marine environment at this location does not lend itself to accumulation. It is proposed that concentrations of pesticides and herbicides be examined from 50% of the sites in each management area. Physical sediment characteristics including nutrients, particle size, settling velocity and bulk density will also be examined at 50% of the sites in each management area.

Table 3-3 Proposed contaminants for laboratory analysis

Contaminants	NAGD PQL	Laboratory LOR	NAGD Screening	Known or likely sources	Sampling regime
Aluminium	200mg/kg	5mg/kg	None Available (NA)	Antifouling paints Coal residues Stormwater runoff Facility maintenance	100% of locations and horizons
Antimony	0.5mg/kg	0.5mg/kg	2mg/kg	As above	100% of locations and horizons
Arsenic	1mg/kg	0.1mg/kg	20mg/kg	As above	100% of locations and horizons
Barium	0.1mg/kg	0.1mg/kg	NA	As above	100% of locations and horizons
Cadmium	0.1mg/kg	0.1mg/kg	1.5mg/kg	As above	100% of locations and horizons
Chromium	1mg/kg	0.1mg/kg	80mg/kg	As above	100% of locations and horizons
Cobalt	0.5mg/kg	0.1mg/kg	NA	As above	100% of locations and horizons
Copper	1mg/kg	0.1mg/kg	65mg/kg	As above	100% of locations and horizons
Iron	100mg/kg	5mg/kg	NA	As above	100% of locations and horizons
Lead	1mg/kg	0.1mg/kg	50mg/kg	As above	100% of locations and horizons
Manganese	10mg/kg	0.1 - 5mg/kg	NA	As above	100% of locations and horizons
Nickel	1mg/kg	0.1mg/kg	21mg/kg	As above	100% of locations and horizons

Contaminants	NAGD PQL	Laboratory LOR	NAGD Screening	Known or likely sources	Sampling regime
Selenium	0.1mg/kg	0.1mg/kg	NA	As above	100% of locations and horizons
Silver	0.1mg/kg	0.1 - 5mg/kg	1mg/kg	As above	100% of locations and horizons
Vanadium	2mg/kg	2mg/kg	NA	As above	100% of locations and horizons
Zinc	1mg/kg	0.1mg/kg	200mg/kg	As above	100% of locations and horizons
Mercury	0.01mg/kg	0.01mg/kg	0.15mg/kg	As above	100% of locations and horizons
Organotins (Tributyltin(TBT), Dibutyltin (DBT), Monobutyltin (MBT)	1µgSn/kg	0.5µgSn/kg	9µgSn/kg	Antifouling Paints	100% of locations and horizons
Total Petroleum Hydrocarbons (TPH)	100mg/kg	10 – 50mg/kg	550mg/kg	Vessel operations Bilge discharges Accidental fuel spills	100% of locations and horizons
Polycyclic Aromatic Hydrocarbons (PAH)	5µg/kg	5µg/kg	NA	Vessel operations Exhaust and bilge discharges Coal residues Accidental fuel spills	100% of locations and horizons

Contaminants	NAGD PQL	Laboratory LOR	NAGD Screening	Known or likely sources	Sampling regime
Sum of PAH	100µg/kg	100µg/kg	10,000µg/kg	As above	100% of locations and horizons
Benzene, Toluene, Ethyl-Benzene and Xylene (BTEX)	200µg/kg	200µg/kg	NA	Vessel operations Bilge discharges Accidental fuel spills	100% of locations and horizons
Total Nitrogen	0.1mg/kg	20mg/kg	NA	Agricultural practices in the catchment. Recent and historical flooding in the catchment may be considered a potential source. Capture of fine sediment within berth pockets due to infilling by tidal currents and waves and climatic events such as storms and cyclones	100% of locations and horizons
Total Kjeldahl nitrogen	0.1mg/kg	20mg/kg	NA	As above	100% of locations and horizons
Nitrate as N	0.1mg/kg	0.1mg/kg	NA	As above	100% of locations and horizons
Nitrite as N	0.1mg/kg	0.1mg/kg	NA	As above	100% of locations and horizons
Total Phosphorus,	0.1mg/kg	1mg/kg	NA	As above	100% of locations and horizons

Contaminants	NAGD PQL	Laboratory LOR	NAGD Screening	Known or likely sources	Sampling regime
Reactive Phosphorus	0.1mg/kg	0.1mg/kg	NA	As above	100% of locations and horizons
Ammonia as N	0.1mg/kg	0.1mg/kg	NA	As above	100% of locations and horizons
Multiresidue Screen (75 pesticides including 21 Ops, includes Ametryn and Hexazinone)	-	1 -10µg/kg	Various	Agricultural practices in the catchment. Recent and historical flooding in the catchment may be considered a potential source. Capture of fine sediment within berth pockets due to infilling by tidal currents and waves and climatic events such as storms and cyclones	50% of locations and horizons
Diuron	-	1µg/kg	2µg/kg	As above	50% of locations and horizons
Total Organic Carbon (TOC)	0.1%	0.01%	NA	Applied to the analysis of TBT and physical characteristics	100% of locations and horizons
Moisture content	0.1%	0.1%	NA	Physical characteristics	100% of locations and horizons

Contaminants	NAGD PQL	Laboratory LOR	NAGD Screening	Known or likely sources	Sampling regime
Particle size distribution (PSD) Bulk density Settling velocity	Not Applicable			Physical characteristics	50% of locations and horizons

3.4.2 Exemption from testing

The NAGD states that exemptions from some or all sediment testing requirements are possible under certain circumstances, subject to approval by the determining authority. The following exemptions from testing for this SAP (in alignment with those previously requested and agreed) are requested because prior sediment characterisations, existing port operations and the absence of sources from the local catchments indicate that the current sediments are highly unlikely to be contaminated with these analytes. These exemptions have been approved previously by GBRMPA for all navigational areas of Hay Point.

- **Polychlorinated biphenyls (PCBs):** No significant catchment based sources of PCBs exist within the vicinity of the Port of Hay Point. Results of sampling from the tug harbour, berth pockets, apron and channel have confirmed an absence of PCBs at concentrations which may define these sediments as contaminated. With minor exception in one sample (Koskela 2008), the remainder of analytical results for PCBs have been reported below the limits of laboratory detection (Koskela Group, 2008, Koskela Group 2010, BMT WBM Pty Ltd, 2011, WorleyParsons, 2013b). Exemption of PCBs analysis is requested for all areas described in this SAP.
- **Organochlorine and Organophosphates pesticides (OC/OPs):** The presence of OC/OPs is predominately associated with industrial or agricultural activities involving use or manufacture of herbicides and pesticides. OC/OPs concentration have been reported below the limits of laboratory detection by several sampling programs since 2005, including studies from the Departure Path and Apron (GHD, 2005), Half Tide Tug Harbour (BMT WBM Pty Ltd, 2011, WorleyParsons, 2013b) and berth pockets (Koskela Group, 2008, Koskela Group 2010, GHD, 2011 and WorleyParsons, 2013b). Exemption of OC/OP analysis is requested for all areas described in this SAP.
- **Dioxins**: Dioxins are predominately related to the manufacturing of pesticides, paper, operation of cement kilns and waste incineration. Such operations are not present within the Port of Hay Point or broader catchment. Dioxins have been analysed from the tug harbour and the proposed Dudgeon Point areas (WorleyParsons, 2013b). Reported concentrations (maximum ~6.8 pg/g) well below the NAGD PQLs of 20,000 pg/g. Exemption of dioxin analysis is requested for all areas described in this SAP.

4 Sampling and Analysis of Sediments

4.1 Rationale

The sampling and analysis of sediments as proposed in this SAP complies with the requirements for maintenance dredging projects as outlined in Appendix D of the NAGD. The program is designed to conduct Phase II testing during the initial field investigations. Should these results from Phase II show elevations above the screening criteria within the dredge areas (95%UCL) then Phase III sampling would be carried out on a separate occasion. The diagrammatical process for the assessment of potential contaminants as set out in section 4.2 of the NAGD (2009) is provided for reference in Figure 4-1 below.

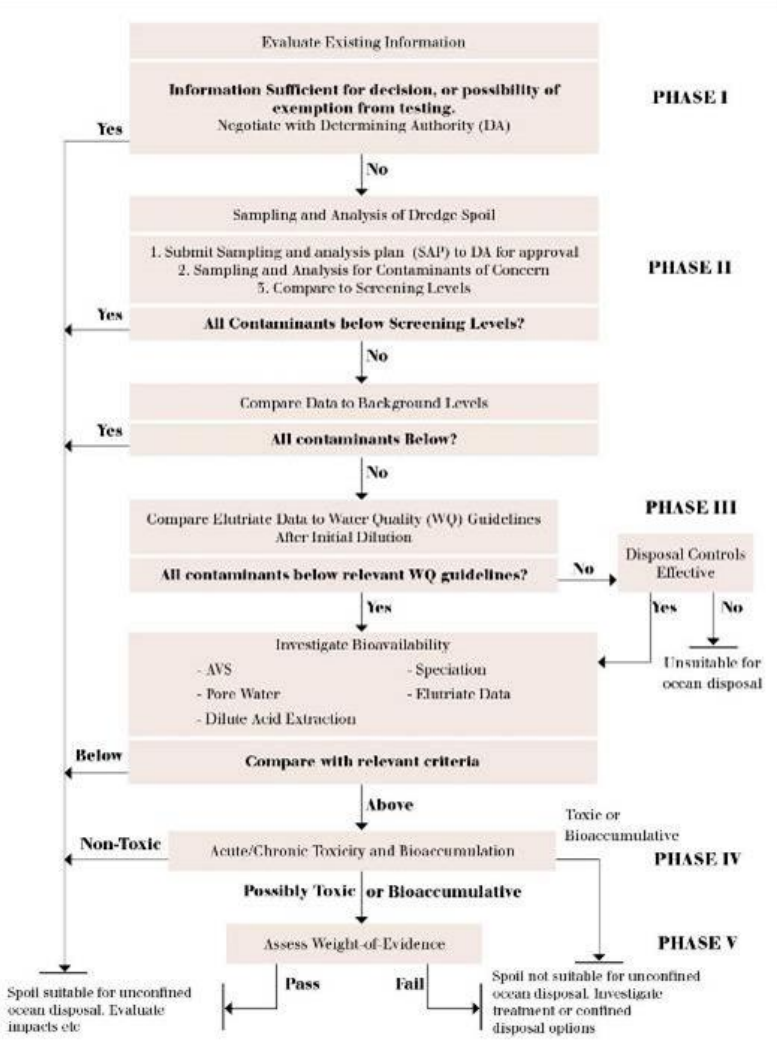

Figure 4-1 Process undertaken for the assessment of potential contaminants (NAGD 2009)

4.2 Phase II - Sampling locations and intensity

According to p.58 of the NAGD, the proposed dredging would be defined as a medium sized maintenance dredging project. Based on a review of all available data, the dredge area is defined as "probably clean" as we have good quality data for the site that supports this classification.

As per the NAGD (2009), if there is existing information on the sediment characteristics of an area to be dredged that is less than five years old, the number of sampling sites for any new study in the same area may be halved. To ensure a robust dataset for calculating the upper 95 percentile confidence limit of the mean to compare to screening levels of contaminants the number of sampling sites in each area is set at a minimum of six sites. Table 4-1 sets out the sampling site requirements for each of management areas, including identification of the management areas for which reduced sampling intensity may be acceptable based on availability and currency of existing information. The total number of sampling sites proposed is 42.

Table 4-1 Description of the areas to be dredged and site requirements as per NAGD (2009)

Management Area	Location	Estimated Volume	Sites required as per NADG (2009)	Sites with currency from previous work	Revised number of sites required
Area 1	HTTH	22,624	9	Yes[1]	6
	HP Boat Ramp	5,837			
Area 2	DBCT Berth 1	57,076	13	Yes[1,2]	7
Area 3	DBCT Berth 2	62,323	20	Yes[1,2]	10
	DBCT Berth 3	47,226		Yes[3]	
	DBCT Berth 4	53,852			
Area 4	Apron Area	56,887	13	Yes[1]	7
Area 5	Inner Channel	7,597	7	Yes[1]	6
	Outer Channel	2,886			
Area 6	HPCT Berth 3	7,197	6	No	6
Total number of sampling sites					**42**

[1] (PACE) (2013)
[2] (PACE) (2014)
[3] Advisian (2016)

Sample locations have been haphazardly assigned to each management areas following the methods outlined within the NAGD (Appendix D, p61). The specific sampling locations in each Management Area are presented in Figure 4-3 (Management Area 1), Figure 4-4 (Management Area 2 and 3), Figure 4-5 (Management Area 4 and 5) and Figure 4-6 (Management Area 6).

4.2.1 Dredged Sediment Relocation Ground Sampling

To examine the existing level of contamination from previous dredging activities, representative sediment grabs will be taken from five sites spaced across the existing sediment relocation ground (Figure 4-2). The samples will be analysed for contaminants as per all other sample locations as listed in Table 3-3.

Figure 4-2 Grab sampling locations in the existing sediment relocation ground

4.3 Sampling horizons

The bathymetric data collected in May 2017 indicates that target sampling depths vary between each management area and within each management area. The maximum depth of sediments (~2m) to be removed is found in the DBCT Berths, whilst other areas have a maximum of 1m of sediment to be removed or less. In the event the sampling depth is 10cm beyond a certain horizon (for e.g. 1.6m or 2.1m) this sediment will be incorporated into the previous horizon. If sampling depth is >10cm beyond a certain horizon, this sediment will be sampled separately into a new horizon.

Sampling horizons will therefore include where applicable:

- 0.0m to 0.5m
- 0.5m to 1.0m (where required)
- 1.0m to 1.5m (where required)
- 1.5m to 2.0m (where required).
- 2.0m to 2.5m (where required)

Table 4-2 provides the proposed breakdown of sampling horizons at each sampling site based on bathymetric data collected in May 2017.

4.3.1 Sample processing

Sample handling onboard the vessel will include sediment description logging, sample homogenisation and containerization for dispatch to analytical laboratories under chain of custody documentation. Detailed descriptions on the methods are outlined in Section 5.1.

4.3.2 Hold Samples

A 250mL hold sample (i.e. a small duplicate split taken from the homogenised sample material for each horizon at each sampling location) will be submitted to the analytical laboratory, to be stored under appropriate conditions, for re-analysis if deemed necessary.

4.4 Phase III Sampling

If screening level assessment (Phase II) identifies contaminants above the NAGD Screening Level at the 95%UCL of the mean, then further testing (Phase III) will be required according to the NAGD framework for the assessment of potential contaminants. Phase III testing typically includes Dilute Acid Extraction (DAE) for metals; porewater and elutriate analysis for organics.

If this analysis is required, the number of sampling locations analysed would be in accordance with Table 7, Appendix D of the NAGD and ensure sites are representative of contamination levels from each management area. A site location figure, including analytical results would be developed prior to sampling.

In management areas where the dredge volume is <50,000m^3 (Area 1, Area 5 and Area 6), 3 sample locations (plus replicates) are required as a minimum. In management areas where the dredge volume is 50 000m^3 to 10 000m^3 (Area 2 and Area 4), 4 sample locations (plus replicates) are required as a minimum. In management areas where the dredge volume is 100 000m3 to 200 000m^3(Area 3), 5 sample locations (plus replicates) are required as a minimum. However, depending on the distribution of contaminants identified in Phase II analysis it may be possible to isolate a 'potentially contaminated' area. This would allow the number of samples required to be reduced based on the site of the target area. Potential hot spots (sites) identified in the Phase II analysis would be targeted for sampling with cores or grabs taken in triplicate at and surrounding the contaminated site.

If there is no discernable pattern in the distribution of contamination, then sites would be randomly allocated within the area to be dredged based on the requirements in the NAGD as outline above. Sampling at each random site would also be in triplicate.

4.5 Proposed analytical parameters

It is proposed to test for the parameters described in Section 4.5. A summary showing the proposed analysis suites, target depths and the number of Quality Assurance and Quality Control (QA/QC) replicates is provided in Table 4-2.

Previous sediment analysis found high TOC in some samples, reducing the confidence of the normalised data results. To alleviate this, all TOC samples will be sieved in the laboratory to remove coarse (>0.4mm) organic and coal material.

Table 4-2 Sampling sites, target depths, sampling horizons, number of samples collected for each parameters to be tested

Management Area	Dredge Area	Site ID	Design Depth (-mLAT)	Survey Depth (-mLAT)	Sampling Depth (m)	Sampling Horizons (m)	Method	Metal suite	Organotins	PAH	TPH, BTEX	Nutrients	Multiresidue Screen for Pesticides (50% of sites)	Diuron (50% of sites)	TOC and Moisture content	QA/QC Triplicate (10% of sites)	QAQC Split Triplicate (5% of sites)	Particle size distribution (PSD) Bulk density Settling velocity (50% of sites)
Area 1	HTTH – berth pockets	A1-4	6.1	5.8	0.2	0 - 0.5	grab	3	3	3	3	3	3	3	3	√		3
		A1-7	6.0	4.7	1.3	0 – 0.5	core	1	1	1	1	1			1			
						0.5-1.0	core	1	1	1	1	1			1			
						1.0-1.5	core	1	1	1	1	1			1			
	HTTH - approaches	A1-5	5.6	5.5	0.1	0 - 0.5	grab	1	1	1	1	1			1			
		A1-6	5.6	5.8	0	0 - 0.5	grab	1	1	1	1	1			1			
	HP Boat Ramp	A1-1	0.5	+1.3	1.8	0 - 0.5	core	1	1	1	1	1			1			
						0.5-1.0	core	1	1	1	1	1			1			
						1.0-1.5	core	1	1	1	1	1			1			
						1.5-1.8	core	1	1	1	1	1			1			
		A1-2	1.0	1.0	0	0 - 0.5	grab	3	3	3	3	3	3	3	3		√	3
		A1-3	1.0	0.8	0.2	0 – 0.5	grab	1	1	1	1	1	1	1	1			1
Area 2	DBCT Berth 1	A2-1	19.6	17.5	2.1	0 - 0.5	core	1	1	1	1	1	1	1	1			1
						0.5 – 1.0	core	1	1	1	1	1	1	1	1			1
						1.0 – 1.5	core	1	1	1	1	1	1	1	1			1
						1.5 – 2.1	core	1	1	1	1	1	1	1	1			1
		A2-2	19.6	17.5	2.1	0 - 0.5	core	3	3	3	3	3			3		√	
						0.5 – 1.0	core	3	3	3	3	3			3		√	

Management Area	Dredge Area	Site ID	Design Depth (-mLAT)	Survey Depth (-mLAT)	Sampling Depth (m)	Sampling Horizons (m)	Method	Metal suite	Organotins	PAH	TPH, BTEX	Nutrients	Multiresidue Screen for Pesticides (50% of sites)	Diuron (50% of sites)	TOC and Moisture content	QA/QC Triplicate (10% of sites)	QAQC Split Triplicate (5% of sites)	Particle size distribution (PSD) Bulk density Settling velocity (50% of sites)
						1.0 – 1.5	core	3	3	3	3	3			3		√	
						1.5 – 2.1	core	3	3	3	3	3			3		√	
		A2-3	19.6	17.5	2.1	0 - 0.5	core	1	1	1	1	1	1	1	1			1
						0.5 – 1.0	core	1	1	1	1	1	1	1	1			1
						1.0 – 1.5	core	1	1	1	1	1	1	1	1			1
						1.5 – 2.1	core	1	1	1	1	1	1	1	1			1
		A2-4	19.6	17.5	2.1	0 - 0.5	core	3	3	3	3	3	3	3	3	√		3
						0.5 – 1.0	core	3	3	3	3	3	3	3	3	√		3
						1.0 – 1.5	core	3	3	3	3	3	3	3	3	√		3
						1.5 – 2.1	core	3	3	3	3	3	3	3	3	√		3
		A2-5	19.6	17.5	2.1	0 - 0.5	core	1	1	1	1	1			1			
						0.5 – 1.0	core	1	1	1	1	1			1			
						1.0 – 1.5	core	1	1	1	1	1			1			
						1.5 – 2.1	core	1	1	1	1	1			1			
		A2-6	19.6	17.5	2.1	0 - 0.5	core	1	1	1	1	1			1			
						0.5 – 1.0	core	1	1	1	1	1			1			
						1.0 – 1.5	core	1	1	1	1	1			1			
						1.5 – 2.1	core	1	1	1	1	1			1			
		A2-7	19.6	17.5	2.1	0 - 0.5	core	1	1	1	1	1	1	1	1			1
						0.5 – 1.0	core	1	1	1	1	1	1	1	1			1

Management Area	Dredge Area	Site ID	Design Depth (-mLAT)	Survey Depth (-mLAT)	Sampling Depth (m)	Sampling Horizons (m)	Method	Metal suite	Organotins	PAH	TPH, BTEX	Nutrients	Multiresidue Screen for Pesticides (50% of sites)	Diuron (50% of sites)	TOC and Moisture content	QA/QC Triplicate (10% of sites)	QAQC Split Triplicate (5% of sites)	Particle size distribution (PSD) Bulk density Settling velocity (50% of sites)
						1.0 – 1.5	core	1	1	1	1	1	1	1	1			1
						1.5 – 2.1	core	1	1	1	1	1	1	1	1			1
		A3-1	19.6	17.9	1.7	0 - 0.5	core	1	1	1	1	1			1			
						0.5 – 1.0	core	1	1	1	1	1			1			
						1.0 – 1.5	core	1	1	1	1	1			1			
						1.5 – 1.7	core	1	1	1	1	1			1			
		A3-2	19.6	17.5	2.1	0 - 0.5	core	3	3	3	3	3	3	3	3	√		3
						0.5 – 1.0	core	3	3	3	3	3	3	3	3	√		3
	DBCT Berth 2					1.0 – 1.5	core	3	3	3	3	3	3	3	3	√		3
						1.5 – 2.1	core	3	3	3	3	3	3	3	3	√		3
		A3-3	19.6	17.5	2.1	0 - 0.5	core	1	1	1	1	1			1			
Area 3						0.5 – 1.0	core	1	1	1	1	1			1			
						1.0 – 1.5	core	1	1	1	1	1			1			
						1.5 – 2.1	core	1	1	1	1	1			1			
		A3-4	19.0	17.4	1.6	0 - 0.5	core	1	1	1	1	1	1	1	1			1
						0.5 – 1.0	core	1	1	1	1	1	1	1	1			1
						1.0 – 1.6	core	1	1	1	1	1	1	1	1			1
	DBCT Berth 3	A3-5	19.0	17.4	1.6	0 - 0.5	core	3	3	3	3	3	3	3	3		√	3
						0.5 – 1.0	core	3	3	3	3	3	3	3	3		√	3
						1.0 – 1.6	core	3	3	3	3	3	3	3	3		√	3

Management Area	Dredge Area	Site ID	Design Depth (-mLAT)	Survey Depth (-mLAT)	Sampling Depth (m)	Sampling Horizons (m)	Method	Metal suite	Organotins	PAH	TPH, BTEX	Nutrients	Multiresidue Screen for Pesticides (50% of sites)	Diuron (50% of sites)	TOC and Moisture content	QA/QC Triplicate (10% of sites)	QAQC Split Triplicate (5% of sites)	Particle size distribution (PSD) Bulk density Settling velocity (50% of sites)
		A3-6	19.0	17.4	1.6	0 - 0.5	core	1	1	1	1	1	1	1	1			1
						0.5 – 1.0	core	1	1	1	1	1	1	1	1			1
						1.0 – 1.6	core	1	1	1	1	1	1	1	1			1
		A3-7	19.0	17.3	1.7	0 - 0.5	core	1	1	1	1	1			1			
						0.5 – 1.0	core	1	1	1	1	1			1			
						1.0 – 1.5	core	1	1	1	1	1			1			
						1.5 – 1.7	core	1	1	1	1	1			1			
		A3-8	19.0	17.1	1.9	0 - 0.5	core	1	1	1	1	1	1	1	1			1
						0.5 – 1.0	core	1	1	1	1	1	1	1	1			1
						1.0 – 1.5	core	1	1	1	1	1	1	1	1			1
						1.5 – 1.9	core	1	1	1	1	1	1	1	1			1
		A3-9	19.0	17.6	1.4	0 - 0.5	core	1	1	1	1	1			1			
	DBCT Berth 4					0.5 – 1.0	core	1	1	1	1	1			1			
						1.0 – 1.4	core	1	1	1	1	1			1			
		A3-10	19.0	17.0	2.0	0 - 0.5	core	1	1	1	1	1			1			
						0.5 – 1.0	core	1	1	1	1	1			1			
						1.0 – 1.5	core	1	1	1	1	1			1			
						1.5 - 2.0	core	1	1	1	1	1			1			
Area 4	**Apron**	A4-1	14.9	14.4	0.5	0 - 0.5	grab	3	3	3	3	3	3	3	3	√		3
		A4-2	14.9	14.7	0.2	0 - 0.5	grab	1	1	1	1	1			1			

Management Area	Dredge Area	Site ID	Design Depth (-mLAT)	Survey Depth (-mLAT)	Sampling Depth (m)	Sampling Horizons (m)	Method	Metal suite	Organotins	PAH	TPH, BTEX	Nutrients	Multiresidue Screen for Pesticides (50% of sites)	Diuron (50% of sites)	TOC and Moisture content	QA/QC Triplicate (10% of sites)	QAQC Split Triplicate (5% of sites)	Particle size distribution (PSD) Bulk density Settling velocity (50% of sites)
		A4-3	14.9	14.7	0.2	0 - 0.5	grab	1	1	1	1	1	1	1	1			1
		A4-4	14.9	14.6	0.3	0 - 0.5	grab	1	1	1	1	1			1			
		A4-5	14.9	14.6	0.3	0 - 0.5	grab	1	1	1	1	1			1			
		A4-6	14.9	14.8	0.1	0 - 0.5	grab	3	3	3	3	3	3	3	3		√	3
		A4-7	14.9	14.8	0.1	0 - 0.5	grab	1	1	1	1	1			1			
Area 5	**Departure Path**	A5-1	14.9	14.8	0.1	0 - 0.5	grab	1	1	1	1	1			1			
		A5-2	14.9	14.8	0.1	0 - 0.5	grab	3	3	3	3	3	3	3	3	√		3
		A5-3	14.9	14.8	0.1	0 - 0.5	grab	1	1	1	1	1			1			
		A5-4	14.9	14.7	0.2	0 - 0.5	grab	1	1	1	1	1	1	1	1			1
		A5-5	14.9	14.8	0.1	0 - 0.5	grab	1	1	1	1	1			1			
		A5-6	14.9	14.8	0.1	0 - 0.5	grab	3	3	3	3	3	3	3	3		√	3
Area 6	**HPCT Berth 3**	A6-1	18.6	18.5	0.1	0 - 0.5	grab	1	1	1	1	1			1			
		A6-2	18.6	18.4	0.2	0 - 0.5	grab	3	3	3	3	3	3	3	3		√	3
		A6-3	18.6	18.4	0.2	0 - 0.5	grab	1	1	1	1	1			1			
		A6-4	18.6	18.5	0.2	0 - 0.5	grab	1	1	1	1	1			1			
		A6-5	18.6	18.6	0	0 - 0.5	grab	3	3	3	3	3	3	3	3	√		3
		A6-6	18.6	18.6	0	0 - 0.5	grab	1	1	1	1	1	1	1	1			1
Dredge Sediment Relocation Ground		S-1	-	-	0	0 - 0.5	grab	1	1	1	1	1	1	1	1			1
		S-2	-	-	0	0 - 0.5	grab	1	1	1	1	1			1			
		S-3	-	-	0	0 - 0.5	grab	3	3	3	3	3	3	3	3	√		3

Management Area	Dredge Area	Site ID	Design Depth (-mLAT)	Survey Depth (-mLAT)	Sampling Depth (m)	Sampling Horizons (m)	Method	Metal suite	Organotins	PAH	TPH, BTEX	Nutrients	Multiresidue Screen for Pesticides (50% of sites)	Diuron (50% of sites)	TOC and Moisture content	QA/QC Triplicate (10% of sites)	QAQC Split Triplicate (5% of sites)	Particle size distribution (PSD) Bulk density Settling velocity (50% of sites)
		S-4	-	-	0	0 - 0.5	grab	1	1	1	1	1			1			
		S-5	-	-	0	0 - 0.5	grab	1	1	1	1	1	1	1	1			1
Total Samples								148	148	148	148	148	88	88	148			88

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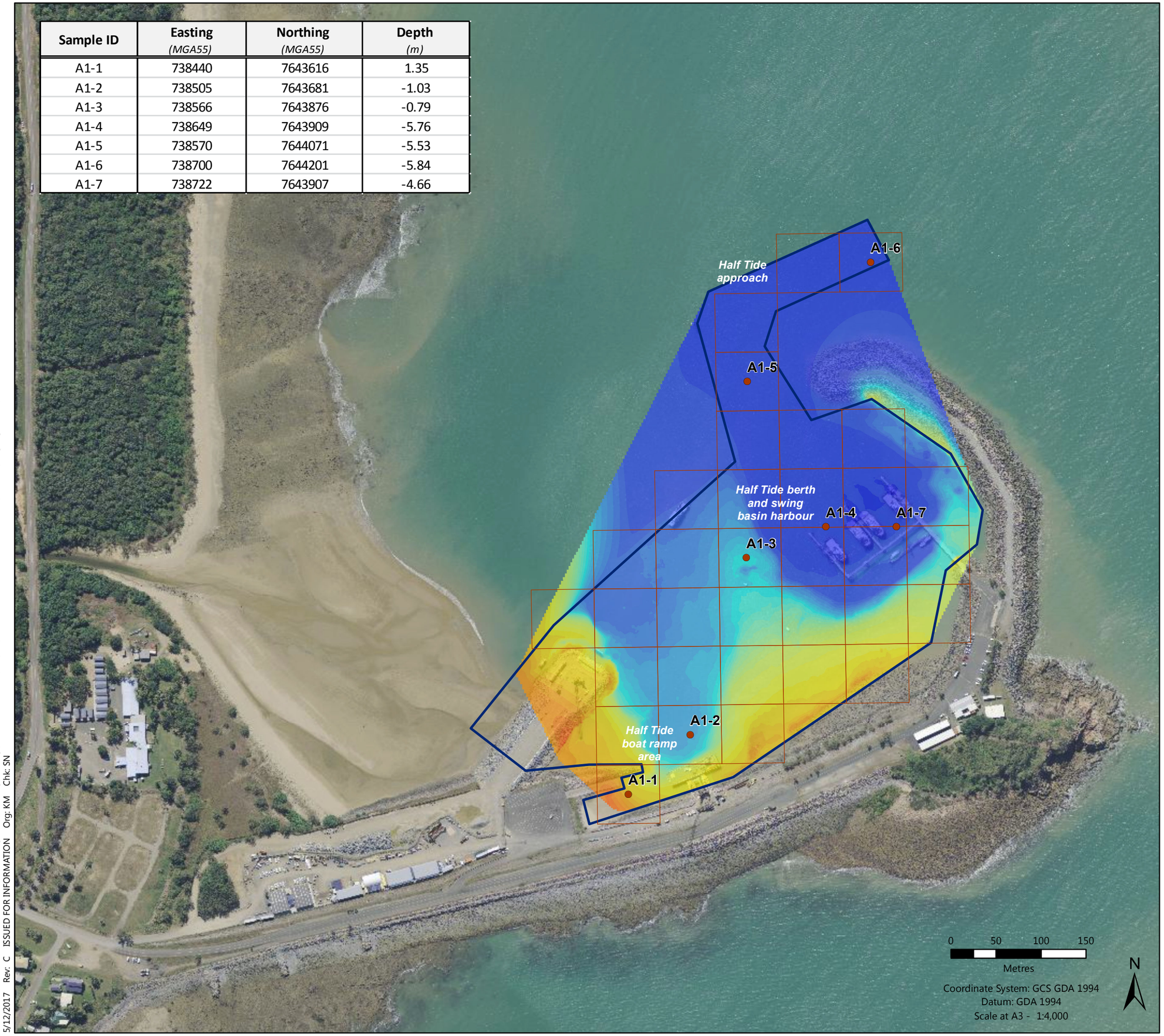
Figure 4-3

Proposed sediment sampling locations in Management Area 1

Sample ID	Easting (MGA55)	Northing (MGA55)	Depth (m)
A1-1	738440	7643616	1.35
A1-2	738505	7643681	-1.03
A1-3	738566	7643876	-0.79
A1-4	738649	7643909	-5.76
A1-5	738570	7644071	-5.53
A1-6	738700	7644201	-5.84
A1-7	738722	7643907	-4.66



LEGEND

- Sampling grid
- Management areas

Depth (m)

2.81 - 2.85	0.41 - 0.6	-0.89 - -0.8
2.61 - 2.8	0.21 - 0.4	-0.99 - -0.9
2.41 - 2.6	0.01 - 0.2	-1.19 - -1
2.21 - 2.4	-0.09 - 0	-1.39 - -1.2
2.01 - 2.2	-0.19 - -0.1	-1.59 - -1.4
1.81 - 2	-0.29 - -0.2	-1.79 - -1.6
1.61 - 1.8	-0.39 - -0.3	-1.99 - -1.8
1.41 - 1.6	-0.49 - -0.4	-3.99 - -2
1.21 - 1.4	-0.59 - -0.5	-5.99 - -4
0.81 - 1.2	-0.69 - -0.6	-6.42 - -6
0.61 - 0.8	-0.79 - -0.7	

Infrastructure
Extracted from drawing 223510-A20-DW-M-001(M) supplied by Aurecon 2012/09/26
HTTH Boat Ramp Access Channel and Dredge Area
Coordinates extracted from client supplied Map - NQBP2014-028
Bathymetry
HTTH_PreSurvey_2017_50cm_Avg_ENH_SSV
Supplied by NQBP 17/08/2017, interpolated using nearest neighbour method by Advisian

REGIONAL LOCATION

Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

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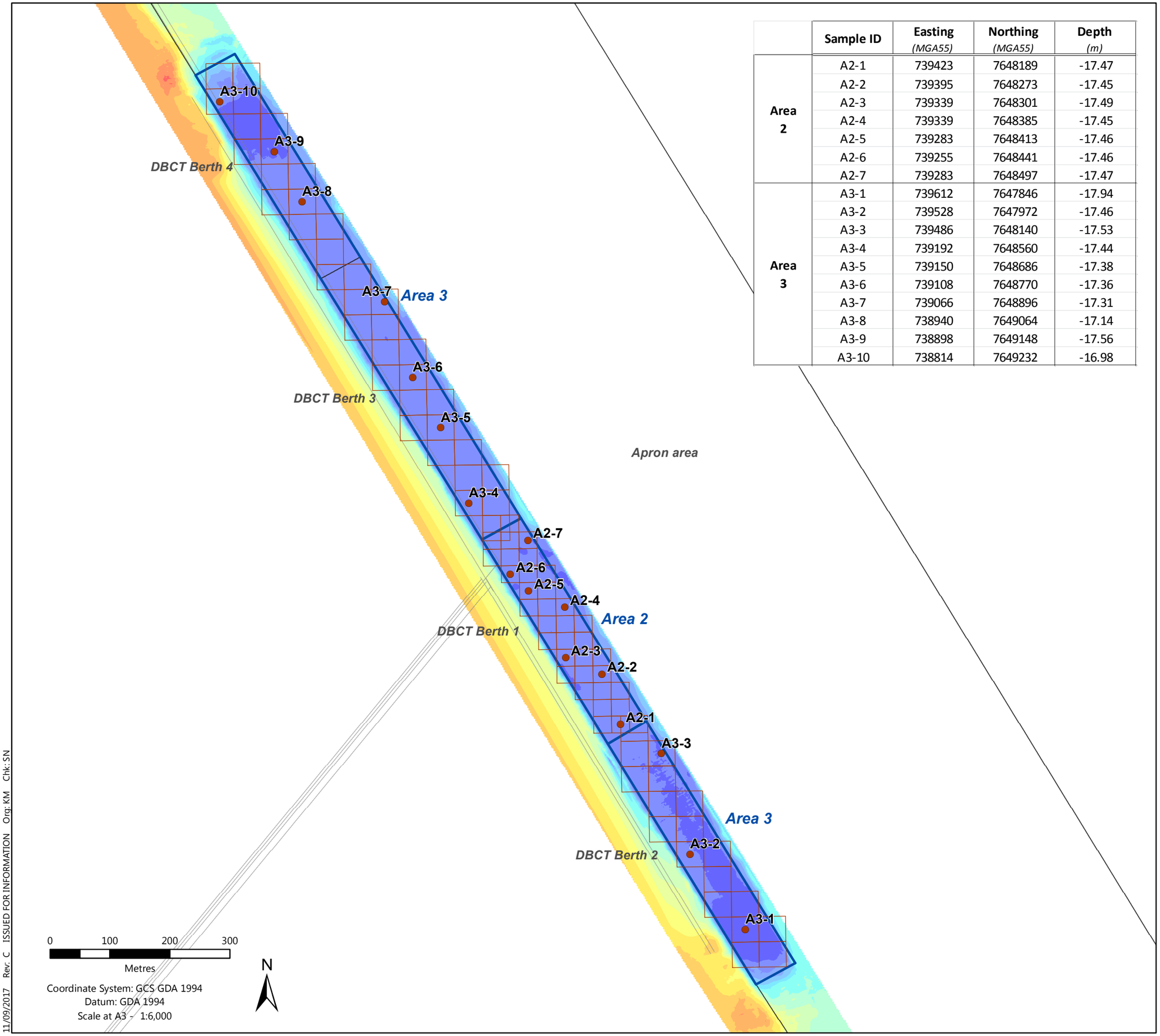
5/12/2017 Rev: C ISSUED FOR INFORMATION Org: KM Chk: SN

Port of Hay Point Sediment Investigation 2017

Figure 4-4

Proposed sediment sampling locations in Management Area 2 and 3



	Sample ID	Easting (MGA55)	Northing (MGA55)	Depth (m)
Area 2	A2-1	739423	7648189	-17.47
	A2-2	739395	7648273	-17.45
	A2-3	739339	7648301	-17.49
	A2-4	739339	7648385	-17.45
	A2-5	739283	7648413	-17.46
	A2-6	739255	7648441	-17.46
	A2-7	739283	7648497	-17.47
Area 3	A3-1	739612	7647846	-17.94
	A3-2	739528	7647972	-17.46
	A3-3	739486	7648140	-17.53
	A3-4	739192	7648560	-17.44
	A3-5	739150	7648686	-17.38
	A3-6	739108	7648770	-17.36
	A3-7	739066	7648896	-17.31
	A3-8	738940	7649064	-17.14
	A3-9	738898	7649148	-17.56
	A3-10	738814	7649232	-16.98

LEGEND

- 2017 sediment sampling location
- Existing infrastructure
- Sampling grid
- Port areas
- Management areas

Depth (m)

- -10.9 - -10.9
- -11.4 - -11
- -11.9 - -11.5
- -12.4 - -12
- -12.9 - -12.5
- -13.4 - -13
- -13.9 - -13.5
- -14.4 - -14
- -14.9 - -14.5
- -15.4 - -15
- -15.9 - -15.5
- -16.4 - -16
- -16.9 - -16.5
- -17.4 - -17
- -18 - -17.5

Source Information:
Infrastructure
Extracted from drawing 223510-A20-DW-M-001(M) supplied by Aurecon 2012/09/26
Bathymetry
DBCT Berths 07/06/2017 supplied by NQBP

Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

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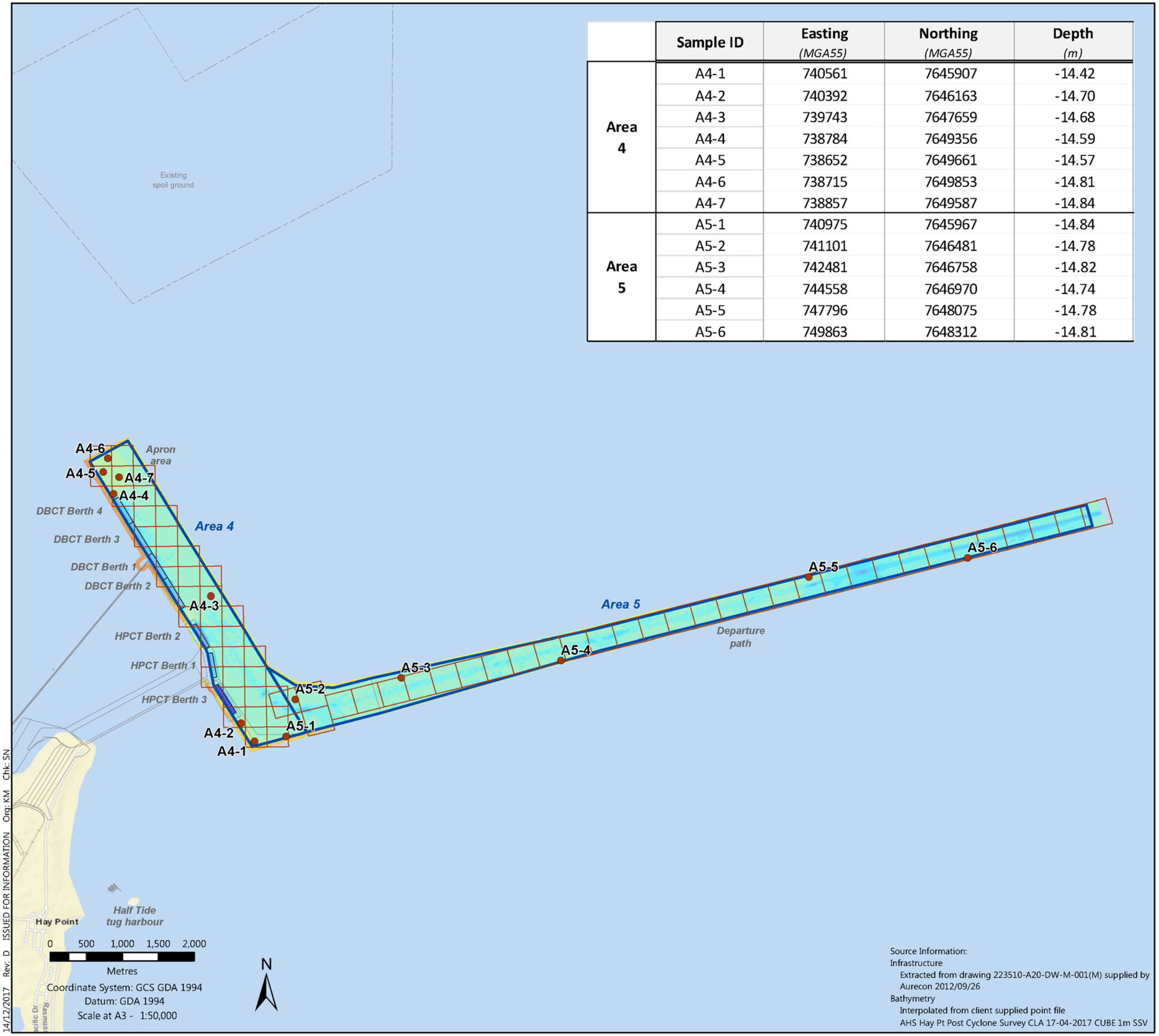
11/09/2017 Rev: C ISSUED FOR INFORMATION Org: KM Chk: SN

Port of Hay Point Sediment Investigation 2017

Figure 4-5
Proposed sediment sampling locations in Management Area 4 and 5

	Sample ID	Easting (MGA55)	Northing (MGA55)	Depth (m)
Area 4	A4-1	740561	7645907	-14.42
	A4-2	740392	7646163	-14.70
	A4-3	739743	7647659	-14.68
	A4-4	738784	7649356	-14.59
	A4-5	738652	7649661	-14.57
	A4-6	738715	7649853	-14.81
	A4-7	738857	7649587	-14.84
Area 5	A5-1	740975	7645967	-14.84
	A5-2	741101	7646481	-14.78
	A5-3	742481	7646758	-14.82
	A5-4	744558	7646970	-14.74
	A5-5	747796	7648075	-14.78
	A5-6	749863	7648312	-14.81



Source Information:
Infrastructure
Extracted from drawing 223510-A20-DW-M-001(M) supplied by Aurecon 2012/09/26
Bathymetry
Interpolated from client supplied point file
AHS Hay Pt Post Cyclone Survey CLA 17-04-2017 CUBE 1m SSV

LEGEND

- 2017 sediment sampling location
- Existing infrastructure
- Existing spoil ground
- Sampling grid
- Port areas
- Management areas

Depth (m)

- -10.9 - -10.5
- -11.4 - -11
- -11.9 - -11.5
- -12.4 - -12
- -12.9 - -12.5
- -13.4 - -13
- -13.9 - -13.5
- -14.4 - -14
- -14.9 - -14.5
- -15.4 - -15
- -15.9 - -15.5
- -16.4 - -16
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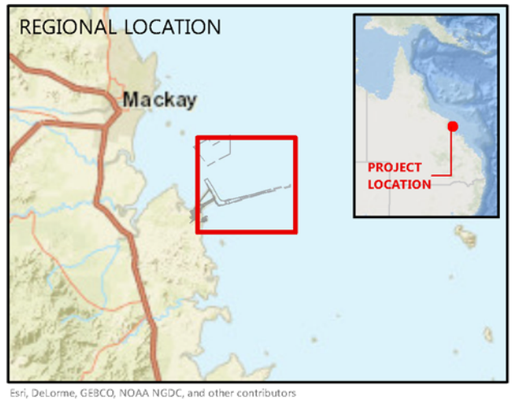
- -17.4 - -17
- -17.9 - -17.5
- -18.4 - -18
- -18.8 - -18.5



Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

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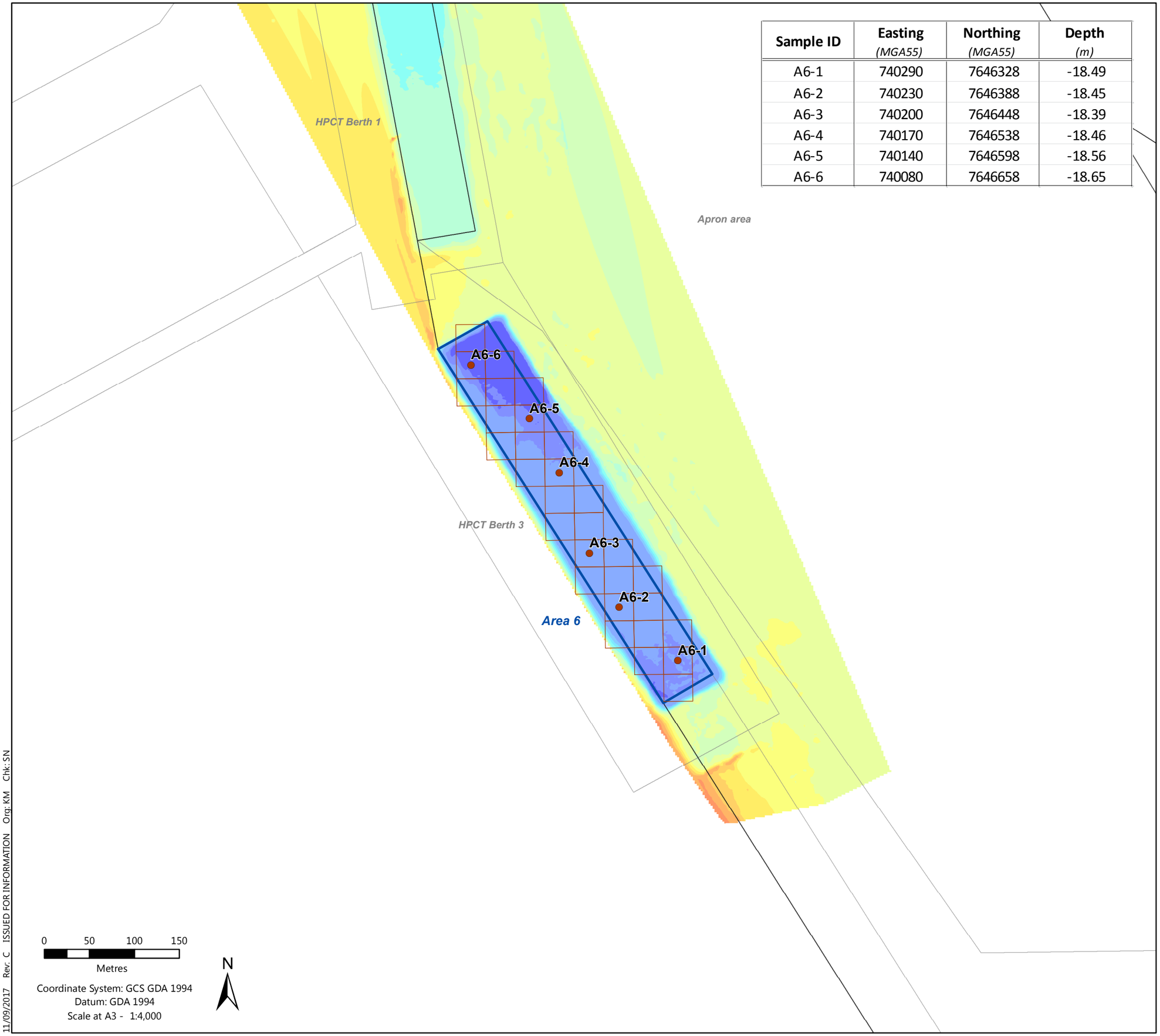
Port of Hay Point Sediment Investigation 2017

Figure 4-6
Proposed sediment sampling locations in Management Area 6

Sample ID	Easting (MGA55)	Northing (MGA55)	Depth (m)
A6-1	740290	7646328	-18.49
A6-2	740230	7646388	-18.45
A6-3	740200	7646448	-18.39
A6-4	740170	7646538	-18.46
A6-5	740140	7646598	-18.56
A6-6	740080	7646658	-18.65



LEGEND

- 2017 sediment sampling location
- Existing infrastructure
- Sampling grid
- Port areas
- Management areas

Depth (m)

- -12.4 - -12.3
- -12.9 - -12.5
- -13.4 - -13
- -13.9 - -13.5
- -14.4 - -14
- -14.9 - -14.5
- -15.4 - -15
- -15.9 - -15.5
- -16.4 - -16
- -16.9 - -16.5
- -17.4 - -17
- -17.9 - -17.5
- -18.4 - -18
- -18.5 - -18.5
- -18.9 - -18.6

Source Information:
Infrastructure
Extracted from drawing 223510-A20-DW-M-001(M) supplied by Aurecon 2012/09/26
Tug Harbor infrastructure extracted from drawing 223510-A06-DW-MA-079(H) supplied by Aurecon 2012/10/29.
Bathymetry
Port of Hay Point - Post Cyclone Debbie Surveys - 15 May 2017 supplied by NQBP

Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China

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5 Methodology

5.1 Field

Field sampling procedures, conforming to *Appendix F Field and laboratory quality assurance and quality control* of NAGD, 2009 and Advisian's Quality Assurance / Quality Control (QA/QC) protocols, will be carried out to minimise the potential for cross contamination and preserve the sample integrity. Table 5-1 provides a summary of the sediment sampling activities to be undertaken.

Table 5-1 Sampling activities

Activity	Details
Sampling locations	The co-ordinates of the sampling locations will be uploaded onto a Garmin 76CSx Global Positioning System (GPS) unit with an accuracy of +/-5m. The Garmin will be used to navigate to the locations and if required, also re-position the locations due to site conditions.
Sediment sampling	Samples will be collected using two methods: 1) a diver operated piston corer from the sea floor and 2) a boat deployed grab sampler. **Piston coring:** Depending upon the depth of sediment to be collected piston corers of two different lengths will be used (1.2m and 2.2m); both operate in an identical manner. The piston corers are constructed of stainless steel, has an internal barrel lengths of 1.2m or 2.2m and an internal diameter of 62mm. The corer is lowered over the side of the vessel to the seabed where a commercial diver would receive the piston corer and use it to collect a sediment core to a depth of at least 1 m or 2m depending upon the sampling location. Once a sediment core had been collected, the piston corer is retrieved by rope from the surface and the sediment core extruded into a plastic core tray for logging and processing. **Grab Sampling:** The grab sampler is constructed of stainless steel and has an approximate grab payload of 10kg. Using a pulley system, the grab sampler is deployed from the boat and lowered to the sea floor where it would trigger shut and capture sediments. The grab sampler is then lifted back to the surface where it is opened and sediments placed directly into steel mixing bowls
Sediment logging	The following information is recorded at each sampling location: ▪ Name of client ▪ Sampling date ▪ General location of sample collection ▪ Sample identifiers assigned ▪ Name of the sample collector ▪ Type of sampler used

Activity	Details
	▪ Weather conditions at the time of sampling ▪ Sea state at time of sampling ▪ General comments (e.g. Wind speed, level of shipping etc.) ▪ GPS location (easting and northing) ▪ Time of sampling ▪ Water depth ▪ Photograph of sediment sample The sediment log for each core is recorded on separate field data sheets, which describe each sample according to the following information: ▪ Colour ▪ Field texture ▪ Observed sand grain size ▪ Plasticity ▪ Moisture content of sample (e.g. Wet, moist, dry) ▪ % stones ▪ Presence of shell/shell grit ▪ Odour (e.g. marine, sulphurous).
Sediment sampling & storage	Once logging is completed the core was split into two horizons (0.0-0.5m and 0.5-1.0m) and placed separately into stainless steel mixing bowls, where samples will be homogenized using powderless nitrile gloves. Homogenised sediment material is then placed into laboratory supplied 250 ml and 125 ml glass jars leaving zero head space and into zip lock bags. Label information is completed on each sample container and the containers will be stored on ice in eskies.
Labelling	Sample bags and jars will be labelled with the date, the abbreviated project location (Hay Pt), the location number / depth, sampler's initials and date of sampling. For instance, a sample collected at 4-1 at a depth of 0.0-0.5m is labelled as follows: 4-1/0.0-0.5 (sample I.D) SN (initials of sampler) 14/10/17 (date sampled)
Decontamination	Decontamination between samples included washing of all sampling equipment with ambient sea water and a laboratory grade detergent (Decon 90), and successive rinsing with deionised water.
Dispatch	All samples collected will be delivered to TNT or TOLL courier depots daily. Samples will be transported under chain of custody documentation to Advanced Analytical Australia's (AAA) Sydney laboratory (via AAA Brisbane). Here, samples will be logged into their system and stored in refrigerated storage until the sample is analysed. All testing will occur within recommended holding times. Triplicate split samples collected in the field will

Activity	Details
	be dispatched by AAA to Australian Laboratory Services (ALS) in Brisbane so that inter-laboratory QC analysis can be assessed.

5.1.1 Sampling Schedule

It is proposed that field sampling will be initiated once approval of the SAP is received and a calm weather window occurs. A minimum of 10 days to sample all sites is required.

5.1.2 Contingency Plan

There are important considerations to consider when sediment sampling at the Port of Hay Point:

- Sea conditions – To minimise the potential of an aborted survey and the need for re-mobilisation, sea state forecasts will be closely considered prior to mobilising to the field.
- Tidal conditions – The tides at Hay Point generate strong current flow and there can be very high tidal ranges (up to 6m during spring tides). Ideally Neap tidal period will be targeted to minimise difficulties associated with positioning the vessel and retrieving the cores.
- Priority locations – Sampling in the berth pockets will be undertaken as a priority while vessels are absent from the selected berth or during shutdown periods. Sampling in the Departure Path or Apron or HTTH will be undertaken whilst vessels are at berth.

5.1.3 QA/QC

The methods to be employed in field sampling quality assurance to ensure validity of the analyses results is ensured by:

- Using suitably qualified environmental staff and support personnel experienced in piston coring, field supervision and sediment logging
- Samples will be contained in appropriately cleaned, pre-treated and labelled sample containers that are provided by the analytical laboratory
- Samples will be kept cool (4°C) after sampling and during transport, stored in eskies with ice packs
- Transportation of samples under chain of custody documentation
- On 10% of locations within each management area one field triplicate (i.e. three separate samples taken at the same location) is collected to determine the variability of the sediment chemical and physical characteristics (refer to Table 5-1)
- On 5% of locations samples will be thoroughly mixed then split into three different containers to access laboratory variation, with one of the three (triplicate) samples sent to a second (reference) laboratory for analysis (refer to Table 5-1). All field triplicate (split) samples will be 'blind' labelled in the field with QC field numbers, which do not relate to sampling location names
- All sampling equipment, including mixing bowls etc. will be decontaminated between samples and sampling locations via a decontamination procedure involving a wash with ambient sea

water and a laboratory grade detergent (Decon 90), and successive rinsing with deionised water.

5.2 Laboratory

Samples will be analysed for the physical characteristics and contaminant substances of concern as identified in Table 3-3. Detailed descriptions of these analyses by the primary laboratory (AAA) are provided in Table 5-2.

Table 5-2 AAA laboratory analysis methodology

Analysis	AAA Laboratory method code	Laboratory method
Moisture Content	04-004 Moisture by gravimetric %	Determination of Total Solids and Moisture Content in Solid and Semisolid Matrices. Total Solids The amount of solid material (or dry matter) remaining after removing moisture from a sample at 105^{0}C. This is usually expressed as a percentage of the as received or wet weight. Moisture content The amount of water lost from soil upon drying to a constant weight. This is usually expressed as a percentage of the as received or wet weight. Moisture content plus Total Solids equals one hundred percent. The method is adapted from USEPA Method 200.7 Appendix A. "Total solids in solid and semisolid matrices". Approximately 10g of sample is added to a pre-weighed dish. The dish and sample are accurately weighed to 2 decimal places and recorded on the worksheet. The dish is then placed in a 105 ^{0}C oven for at least 12 hours so the moisture is evaporated. The sample is then removed from the oven and allowed to reach ambient temperature before reweighing. The total solids and moisture content is calculated and reported as a percentage of the wet sample weight.
Total Organic Carbon (TOC)	In house method	Samples are first sieved to retain sediments <400µm. Soil sample is heated to high temperature until the organic carbon is combusted and driven by Nitrogen carrier gas to be read by Infra-red detector.
Particle size distribution (PSD) and settling velocity	X-ray sedimentation by Sedigraph 5100	For dry powders a representative 10-20g subsample is taken and dispersed in approximately 75mL of 1000ppm sodium hexametaphosphate (Calgon) using a Cole-Palmer 8851 (or equivalent) ultrasonic bath for 15 minutes. Some powders may require the addition of a wetting agent to enable full dispersion. In this instance, Alcopol "O" is used. For slurry samples a representative subsample is taken and dispersed in 1000ppm sodium hexametaphosphate (using the

Analysis	AAA Laboratory method code	Laboratory method
		same bath) for 10 minutes. The resulting slurry is then homogenised before being dispensed into the sample loading chamber. The sample concentration may have to be adjusted to give an appropriate full scale X-ray attenuation line once the sample is loaded into the instrument. The density, used in the Micromeritics software to calculate the size distribution of the material, is set at an appropriate value for the supplied sample. The sample is run in the sedimentation system for a time dependant on the size distribution range requested. Any material greater than 106 µm in size has to be manually screened out of the sample, dried, weighed and the percentage calculated and entered into the report size range.
Metals and metalloids	04-001 Metals by ICP-OES	Determination of trace elements in soils, sediments and sludges by ICP-OES Total recoverable trace elements are leached from soils, sediments and sludges using a mixture of hot nitric and hydrochloric acids. The digest is diluted with water and trace elements measured using Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES).
Mercury (Hg)	04-002 Mercury by CVAAS	Determination of mercury in soils, sediments and sludges by CVAAS Mercury Analyser Total recoverable mercury is leached from soils, sediments and sludges using a mixture of hot nitric and hydrochloric acids. The digest is diluted with 7% hydrochloric acid and trace element measured using Cold Vapour Atomic Absorption Spectrometry (CVAAS).
Total Recoverable Hydrocarbons (TRH) Benzene, Toluene, Ethyl Benzene, m + p xylenes, o-xylene (BTEX)	04-021 TRH C6-9 &BTEX by P&T GCMS	Determination of C6-C9 Hydrocarbons & BTEX in soils, sediments, sludges & waters using Purge and Trap with GCMS This method is used to determine volatile petroleum hydrocarbons in the C6-C9 fraction, including BTEX, in a variety of matrices including soils, sediments, sludges, waters, solid and liquid wastes. The volatile compounds are introduced into a gas chromatograph by the purge and trap technique and after separation are detected by an ion trap mass spectrometer operating in Electron Impact Ionization and full scan modes. In the purge and trap technique, a sample (normally >98% water) is purged with nitrogen or helium and the volatile sample components are trapped on a tube containing suitable adsorbents. After purging is completed, the sorbent tube is rapidly heated and back flushed with helium to desorb the trapped components and transferred them onto a capillary column operating in the split mode. The column is then

Analysis	AAA Laboratory method code	Laboratory method
		temperature and pressure programmed to separate the analytes. Detection, identification and quantitation are achieved by an ion trap mass spectrometer and associated data system.
	04-020 & 04-030 TRH by GC-FID & P&T GCMS	Determination of Total Recoverable Petroleum Hydrocarbons (C10-C36) in Soils, Sediments and Sludges by GC-FID Total recoverable petroleum hydrocarbons are extracted from a range of solids including soils, sediments and sludges using a mixture of dichloromethane and acetone, and the sample extract analysed using Gas Chromatograph – Flame Ionisation Detection (GC-FID).
Poly Aromatic Hydrocarbons (PAH)	04-022 PAHs & Phenols by GCMS	Soil samples are extracted with dichloromethane / acetone (1:1) after addition of an appropriate surrogate using ultrasonic extraction. Sediment samples are extracted with DCM / acetone / hexane after addition of an appropriate surrogate using ultrasonic extraction. The sediment sample extracts are then concentrated. All sample extracts are analysed by GCMS
Organotin compounds but primarily tributyltin (TBT)	04-026 Organotins by GCMS	The method involves extraction of the organotins from the sediment matrix with acidified calcium chloride hexahydrate containing tropolone (a chelating agent) and sodium acetate (for pH buffering). Organotins extracted this way are ethylated using sodium tetraethylborate, extracted into hexane, split with internal standard, and analysed by GCMS.
Multiresidue Screen (75 pesticides and 21 Ops)	In house LC/MS-MS	
Diuron	In house LC/MS-MS	
Nutrients	APHA 4500B & APHA 4500F	Total Kjeldahl Nitrogen, 1:5 sediment/water extract, FIA

The laboratory LOR is defined as the lowest chemical analysis concentration that can be reliably achieved within specified limits of precision and accuracy during routine operating conditions. The LORs achieved for respective analyses (Table 5-2) are reported in the results tables and generally comply with minimum PQLs (as described in Section 5.2.1.2 below) required under Appendix A, Table 1 of the NAGD.

5.2.1 QA/QC

Both laboratories (AAA and ALS) are NATA accredited for the methods used and are experienced in the analysis of marine sediments. QA/QC procedures for contaminant assessment will be used from sampling through to completion of laboratory analysis, including: chain of custody documentation and field and intra-laboratory QA/QC samples.

Laboratory QA/QC procedures will be carried out in accordance with the requirements of Appendix F of the NAGD. These requirements included analysis of laboratory blank, certified reference materials, replicate and spiked samples.

Validation of the analytical data will be undertaken in accordance with Appendix A of the NAGD to confirm that the data quality is suitable for undertaking an assessment to characterise sediment proposed for dredging and unconfined disposal at sea. This validation includes consideration of results for laboratory blanks, standards, spikes, duplicate samples, and comparison of results of field quality control duplicate and triplicate samples against laboratory and NAGD criteria.

5.2.1.1 Primary and secondary laboratories

Sediment analysis will be completed by laboratories. Both AAA and ALS are National Association of Testing Authorities (NATA) accredited for the analyses of marine sediments. AAA is the primary laboratory and ALS is the secondary laboratory. The secondary laboratory undertakes analysis of the split triplicate samples.

5.2.1.2 Practical quantitation limits

Analysis of the analytical parameters must meet the PQLs as detailed on page 29 of the NAGD. The laboratories engaged have confirmed that they can meet the PQLs as set out in the NAGD, with the following exceptions:

- Total Nitrogen and Total Phosphorus under the nutrients PQL of 0.1 mg/kg are not met.
- For total nitrogen, Advanced Analytical reports a PQL of 20 mg/kg and 1 mg/kg for Total Phosphorous.
- This is not normally an issue in analysis as concentrations are typically always more than these values from silty marine sediments.
- Nutrients do not have screening criteria under the NAGD for comparison.

The quoted laboratory methods are designed to minimise matrix interferences and to meet or exceed the NAGD PQLs However if moisture content exceeds 50%, PQLs may need to be raised to meet quality assurance protocols. Laboratory and Quality Assurance procedures comply with those specified in Appendix F of NAGD.

5.3 Data analysis

5.3.1 Phase II – Sediment Analysis for Total Sediment Concentrations

Chemical concentration levels for sediments will be compared against the screening levels listed in Appendix A Table 2 of the NAGD, to assess whether the sediment is suitable for placement at sea or if further testing is required (e.g. elutriate, bioavailability and/or direct toxicity assessment).

The assessment against NAGD criteria involves the comparison of mean concentrations at the upper 95% confidence level (95%UCL) of the mean to the NAGD screening levels. Detections for organic parameters will be normalised to % total organic carbon (TOC) where the recorded TOC value was 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 will be adopted as appropriate. For the purposes of calculation of normalised values and of 95% UCLs, values below detection limit will be set to one-half of the laboratory LOR in accordance with NAGD recommendations. For organic concentrations below detection, the half detection levels are not normalised to % TOC. Means, standard deviations and 95%UCLs will be calculated for each of the dredge areas. Means and 95% UCLs will be not calculated for contaminant groups that will be found to have concentrations below detection levels at all sampling locations.

The methods used to calculate the 95% UCLs will be based on the methods required in Appendix A of the NAGD (P38, Comparison of Data to Screening Levels as described below.

Normality of datasets will be determined using Shapiro-Wilks test and quantile-quantile plots in ProUCL Version 5 developed by the United States Environmental Protection Agency (USEPA 2016). Datasets will be determined as being either normal or log-normal, or neither in their distributions. Normal datasets will be analysed using the 1-tailed student's t UCL. Log-normal datasets will be analysed using non-parametric jacknife analysis as recommended in the NAGD. Datasets that will be neither normal nor log-normally distributed will be also analysed using non-parametric jacknife analysis.

According to the NAGD, if the 95%UCL values for all substances are below relevant screening levels, it is unlikely that contaminant substance concentrations in the sediment will have an adverse effect on organisms living in or on that sediment. Sediments are therefore considered non-toxic and there are no chemical obstacles to unconfined sea disposal.

5.3.2 Phase III – Elutriate Analysis

If required, elutriate analyses will be undertaken using sediments prepared in a 1:4 suspension of seawater from the proposed spoil ground.

The elutriate concentrations at the 95th percentile for the relevant dredge area will be compared with the relevant toxicant trigger level in the ANZECC/ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, following the procedures outlined in Appendix A of the NAGD (Commonwealth of Australia, 2009). Allowance will be made for dilution at the spoil ground when comparing elutriate concentrations against guideline values.

5.3.3 Phase III – Bioavailability Analyses

If required, dilute acid extraction (DAE) results for metals will be analysed similar to total sediments within the difference being that the metals will be extracted using a weak acid (1M HCl). Analysis of results will be as indicated in Section 3.7.1 for total metal concentrations.

For organic contaminants, collected sediment samples would be pressure squeezed or centrifuged to provide the chemical laboratory with porewater for chemical analysis. The 95th percentile of porewater concentrations would be compared with the relevant trigger level in the ANZECC/ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality, following the procedures outlined in Appendix A of the NAGD (Commonwealth of Australia, 2009).

5.3.4 Phase IV – Toxicity Testing

If required, toxicity testing will be undertaken using appropriate tests, as recommended by a laboratory experienced in toxicity testing.

5.4 Reporting

A report detailing the following information will be prepared after the sampling and analysis program once laboratory results are completed:

- Executive Summary
- Introduction and description of the study area
- Details of the sampling methodology (including any deviation from the approved SAP)
- A figure showing the sampling locations
- Physical descriptions of the sediment samples, based upon photographs and sediment logs
- Descriptions of any observations or anomalies during sampling and/or analysis
- Table of laboratories used and the analytical methods employed
- QA/QC procedures and results
- Summary table of results for each parameter analysed
- Comparison and interpretation of results
- Conclusions
- Recommendations
- Appendices containing sampling data sheets, core log sheets and images, all laboratory reports and associated QAQC reporting.

The report will provide summary data tables with colour-coded results for any parameters for which the Screening Levels are exceeded at the 95%UCL of the mean. The original laboratory reports will be provided as appendices. Mapping will be undertaken for all parameters where the screening level is exceeded.

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