Southern Ports

Long Term Monitoring and Management Plan Port of Bunbury

College of Science, Health, Engineering & Education
(Report No. MAFRL 21-03)
Murdoch University
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Glossary

Clean Material	Material from locations distant from appreciable pollution sources (i.e. in pristine locations) as well as material composed largely (>95%) of gravel, sand or rock, but only where this material is found in areas of high current or wave energy, where the seabed consists of shifting gravel and sandbars.
Contaminant	A substance, either inorganic or organic, present in the sediment at or near levels that could be toxic to some organisms.
Contaminated	Spoil is defined as contaminated if it contains contaminants of concern. Dredge sites will be classified as one of the following contamination levels: 'probably contaminated'; 'suspect', or 'probably clean'. Material is 'probably contaminated' if current data indicates the presence of contaminants of concern. Material is 'suspect' if the site is close to probably contaminated material or there is a new source of contamination since the previous testing. Material is 'probably clean' if current data indicates the absence of contaminants of concern or it is appreciably distant from potential pollution sources.
Contaminants of Concern	COC are those contaminants which exceed the background concentrations and the Screening Level and for which the bioavailability, bioaccumulation or toxicity assessments indicate that significant effects from the contaminants are likely. For COCs, definite action is required.
Contaminants of Potential Concern	COPC are those contaminants that exceed the background concentrations and the Screening Level (or elevated concentrations of contaminants for which guidelines do not exist). For COPCs, no immediate action may be required.
Currency of Data	Existing chemical or toxicity data for the sediments of the area to be dredged will have a maximum currency of five years, where there is no reason to believe that the contamination status has changed significantly, after which new data would need to be gathered. New data will be required where contamination of the site is likely to have increased or new pollution sources are present (such as a new industry or accidental spills). Information and data older than 5 years may be useful in some parts of an assessment to demonstrate trends over time.
Pristine Site	A location which is distant from, and unaffected by, anthropogenic contaminants.
Uncontaminated	Material is defined as uncontaminated for the purposes of sea disposal if it comes from a pristine environment, or it, after assessment, it contains no COCs.

Document history and status

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1.0 Introduction and background

1.1. Purpose and context of this document

This Long Term Monitoring and Management Plan (LTMMP) has been prepared on behalf of the Southern Port Authority (SPA) – Port of Bunbury in support of continued maintenance dredging of the Outer Harbour and Entrance Channel.

This document is provided on the SPA website (https://www.southernports.com.au/bunbury).

1.2. Regulatory framework

1.2.1. Commonwealth

In Australia, ocean disposal of dredged material both within and outside State and Territory waters is administered by the Department of Agriculture, Water and Environment (AWE) under the Environment Protection (Sea Dumping) Act 1981 and the National Assessment Guidelines for Dredging (NAGD) (CA 2009) and clarifications (AWE, 2021). The development of these documents has been guided by the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention), and the more recent 1996 Protocol to the London Convention, to which Australia is a signatory. These agreements aim to prevent pollution of the sea from the dumping of wastes or other matter, including dredged material.

Management of the potential impacts of ocean disposal of dredged material includes a requirement for physical and chemical analysis of sediment to be dredged to identify whether the material is suitable for ocean disposal or requires special management. Choice of the disposal site must also be guided by physical, chemical and biological parameters, so that the potential impacts of sea disposal can be identified, minimised and monitored as appropriate.

1.2.2. State of Western Australia

Capital dredging programs in Western Australia are subject to a formal environmental approval process involving the submission of documentation and public reviews. This process generally involves the Commonwealth Government when the Environmental Protection and Biodiversity Conservation Act (EPBC) process is triggered.

In addition, the Environmental Protection Authority of Western Australia (EPA) has released the Environmental Assessment Guideline for Marine Dredging Proposals (EAG7) (EPA 2011) which provides guidance for the State approval process. The guidelines are principally intended for capital dredging projects but may also apply to maintenance dredging projects. Specifically, this

guideline sets out an approach by which predictive uncertainty can be taken into account by reflecting a target that the proponent aims to achieve using best practice approaches to dredging and its management. It also recommends proponents identify an outcome that they are confident of achieving using best practice even if things do not go well.

This framework also guides the development of efficient and cost-effective monitoring and management programs that are linked to the predictions and that aim to keep impacts as low as practicable and ensure the environmental protection outcomes are achieved.

1.3. Long Term Monitoring and Management Plan (LTMMP)

It is the intention of this LTMMP to guide the management and monitoring of maintenance dredging and ocean disposal activities over a period of ten years. The current maintenance dredging program is usually undertaken on a biannual basis (two campaigns per year) pre and post the winter period to maintain maximum declared safe draughts. Seasonal variations in sedimentation rates and dredge availability may impact the timing and duration of each campaign.

1.4. Responsibilities

The Port of Bunbury is responsible for implementing the LTMMP. Where required, consultants will be engaged to undertake the data collection and monitoring programs outlined in the LTMMP and to provide advice and interpretation of monitoring data.

1.5. Review of the LTMMP

The LTMMP has been designed to guide the management and monitoring of maintenance dredging activities at the Port of Bunbury for a ten-year period, which is approximately two dredging campaigns per year. The status of the LTMMP will be reviewed two months prior to the occurrence of each dredging program or as required. In addition, as part of the continuous improvement process, the key performance indicators in the LTMMP will be reviewed annually and changes made as and if required.

1.6. Structure of the LTMMP

The LTMMP contains the following information:

- A description of the Port of Bunbury and its surrounding environment
- The history of maintenance and capital dredging and a description of dredging and disposal requirements for the life of the permit
- A description of the spoil ground and rationale for its location
- A dredge material management strategy
- A sampling and analysis plan (SAP) for the characterisation of the material to be dredged prior to each dredging campaign

- An outline of proposed management and monitoring of dredging and ocean disposal over the life of the plan

1.7. Port of Bunbury organisation structure

The person responsible for all aspects of this LTMMP including management measures associated with dredging and disposal is the Southern Ports Chief Executive Officer through the Bunbury Harbour Master who has day to day management responsibility for the planning, implementation and monitoring of dredging operations. Both Officers have accountabilities set out in Western Australian State Legislation in the Port Authorities Act 1999. Technical and administrative support and advice is provided by the Environment Manager.

1.8. Historical dredging and disposal programs

1.8.1. Previous capital dredging programs

Records of capital dredging associated with the early development of the Outer Harbour are not available. In fact, there may not be any factual accounts of dredging volumes or disposal areas for the Outer Harbour development. The Inner Harbour was developed during two capital dredging programs (**Table 1**). In the early 1970s approximately 7,400,000 m^3 (7.4 million cubic metres) of material was removed and used for reclamation and land raising works within the port.

Later in 1991, the Inner Harbour basin was extended with the removal of approximately 2,000,000 m^3 (2 million cubic metres) of material being disposed to Port land to the east of the Inner Harbour. It must be noted here that the dredged material was of varying quality in terms of its suitability for later construction fill. The Port has not had much success in encouraging third party use of the material and still has a number of stockpiles located on Port land. This was the last and most recent capital dredging undertaken by the Port.

- Table 1 Capital dredging program

Year	Disposal Location	Volume (m^3)
1971–75	Reclamation	~7,400,000
1991	Land disposal	~2,000,000

1.8.2. Previous maintenance dredging programs

Since completion of all breakwater and spur groyne extensions in 1961 and the construction of Berths 1 and 2, Southern Ports has continued to be engaged in a relatively continuous maintenance dredging program. Over the years maintenance dredging programs have involved Public Works Department dredges, private dredging contractors and grab dredging from the face of the wharves (PWD 1978).

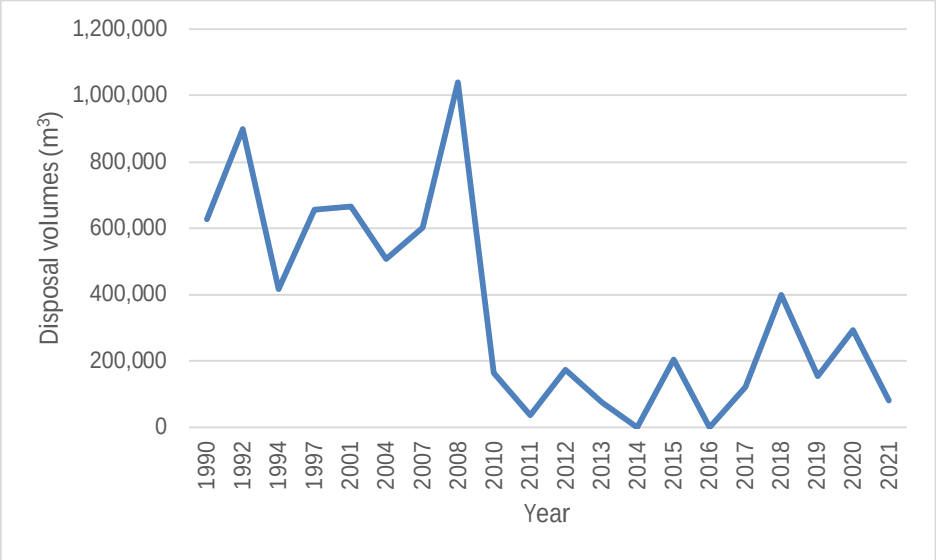
To date there have been 30 maintenance dredging programs that resulted in sea dumping. Sea dumping permits were issued for maintenance dredging programs between 1988 and 2022 (which includes the current 10 year permit incorporating 18 January 2012 to 17 January 2022); however, prior to this date it appears that the process was administered by the West Australian Public Works Department and subsequently the State Department of Marine & Harbours (now the Department of Transport) in consultation with the WA Environmental Protection Authority. Details of each of the maintenance dredging programs are provided in **Table 2**.

Since 1965, at least 9,718,717 m^3 (9.7 million cubic metres) of spoil has been disposed of to the spoil grounds. This material has been dredged primarily from the Approach Channel and Outer Harbour whilst a small quantity has been removed from the Inner Harbour (although nothing from the Inner Harbour has been disposed to the spoil ground in the last 10 years). The spoil has comprised fine silts, sands and some rocky rubble.

From 2010 there has been a reduction in maintenance dredge spoil volume disposed to the existing spoil ground. This is due to an improvement in the efficiency of dredging methods (**Figure 1**). There has also been an improvement in the record keeping of dredge volumes over time.

- Table 2 Historical maintenance dredging programs

Year	Disposal Location	Volume (m^3)
1965–66	Reclamation	Unknown
1966–67	Reclamation	~70,000
1967–68	Southern spoil grounds	Unknown
1969–70	Southern spoil grounds	Unknown
1971–72	Southern spoil grounds	~76,630
1973–74	Southern spoil grounds	320,000
1974–75	Southern spoil grounds	~6,200
1975–76	Southern spoil grounds	Unknown
1976–77	Eastern section of Existing spoil ground	~17,000
1977	Pumped to ocean side of breakwater	~19,000
1979	Eastern section of Existing spoil ground	Unknown
1982	Eastern section of Existing spoil ground	~300,000
1985	Eastern section of Existing spoil ground	~140,000
1988-89	Eastern section of Existing spoil ground	~1,650,000
1990	Eastern section of Existing spoil ground	627,000
1992	Existing spoil ground	~900,000
1994	Existing spoil ground	416,518
1997	Existing spoil ground	656,000
2001	Existing spoil ground	665,500
2004	Existing spoil ground	506,354
2007	Existing spoil ground	603,123
2008	Existing spoil ground	1,040,250
2010	Existing spoil ground	165,160
2011	Existing spoil ground	37,000
2012	Existing spoil ground	175,090
2013	Existing spoil ground	74,745
2014	Existing spoil ground	0 (no dredge available)
2015	Existing spoil ground	205,000
2016	Existing spoil ground	0 (delayed to 2017)
2017	Existing spoil ground	122,191
2018	Existing spoil ground	400,440
2019	Existing spoil ground	152,767
2020	Existing spoil ground	291,749
2021	Existing spoil ground	81,000 (March/April)



- Figure 1: Dredge spoil disposal volumes over time (period 1990 – 2021). Note 2021 volumes are only from one of the two campaigns for that year.

1.9. Spoil grounds

The history of the Bunbury spoil grounds is somewhat lacking in detail as scant records exist that accurately define their location and use. The present chart (see **Figure 3**) shows the following three spoil grounds:

- Northern spoil ground referred to as existing spoil ground
- Inner round spoil ground
- Inner rectangular spoil ground

The two inner spoil grounds were added to the AUS chart in 1978 while the existing (northern) spoil ground was added in 1992. Generally, spoil grounds are added to charts shortly after being gazetted; however, this is reliant upon information being provided to the Royal Australian Navy Hydrographic Service. As such, historical dates of inclusion on charts are indicative only.

It is only through the use of the limited historical records such as the 'Bunbury Outer Harbour Siltation Investigations' (PWD 1978) and sea dumping applications between 1988 and 2004 that approximate dates and spoil volumes could be attributed to the three spoil grounds at Bunbury. As such, the history of disposal prior to 1988 is approximate only.

1.9.1. Inner spoil grounds

The inner two spoil grounds (south of the existing spoil ground) were likely used prior to the development of the Inner Harbour. The records clearly show that use predated 1976 and the development of the Inner Harbour did not involve sea dumping as dredge material was used for reclamation. It is probably that the southern spoil grounds were used for capital and maintenance dredging associated with the Outer Harbour although no records have been found to substantiate this.

1.9.2. Existing spoil ground

The existing Spoil Ground has been in use since at least 1976. The Spoil Ground was originally 1,000 m long north to south and 400 m wide east to west and was located, in part, inshore of the present spoil ground location (see **Figure 7**). The bounding coordinates for the existing Spoil Ground are:

NW corner	33° 15.70' South	115° 39.25' East
NE corner	33° 15.70' South	115° 39.65' East
SE corner	33° 16.80' South	115° 39.65' East
SW corner	33° 16.80' South	115° 39.25' East

Datum is GDA94

The site selection for this Spoil Ground was not based on environmental considerations. At the time there were no environmental guidelines for spoil disposal. The main considerations were

ensuring the material would not pose a hazard to shipping and that it would not re-enter the harbours and channels again. As such the location of the Spoil Ground to the north, given the predominately northwards current, was suitable. In addition, the Department of Marine and Harbours in 1988 made the following statement when a spoil ground further offshore was proposed (DM&H 1988):

> *"This material should be placed in a position offshore from Leschenault Peninsular from where it may rejoin the coastal process system. The selection of the dumping grounds at about the 10 metre contour ensures that the rate at which the material rejoins the system is acceptable. Dumping sites to the west of Bunbury breakwater in deeper water would not be acceptable in this regard. Dumping at the preferred site during the periods 1976/77, 1979, 1982 and 1985 has been to the satisfaction of the Environmental Protection Authority."*

The key driver at the time of the establishment of the existing Spoil Ground was beach renourishment to stabilise the Leschenault Peninsula due to the effect the Port was having on interrupting the northerly littoral drift of sand and sediment along the coast. However, it can be seen that the Spoil Ground was also deemed to be environmentally acceptable, but under what criteria it is unclear as the Environmental Protection Act of 1981 and the Environmental Protection (Sea Dumping) Act of 1981 were not enacted at the time.

2.0 The Port of Bunbury

2.1. Background Information

The Port of Bunbury is located in Koombana Bay on the south-western coast of Western Australia, 175 kilometres south of the state capital Perth and is operated by the Southern Ports Authority. The Port is divided into two primary commercial areas: the older Outer Harbour and the man-made Inner Harbour constructed in the 1970s. The Port services the farming, mining and timber industries of the south west. Sandy beaches extend to the north-east and north-west of the Inner Port entrance, with the Leschenault Estuary immediately north-east of the Port and a remnant of the estuary to the west with both these water bodies connected to Koombana Bay via man-made channels. These features are shown in **Figure 2**.

- Figure 2: Aerial photo of Bunbury Port 2021

The Port has seven berths totalling 1,485 m in length capable of handling ships with an overall draft of up to 11.6 m in the Inner Harbour. Detailed information on the construction, dimensions, imports and exports of each of the current berths is provided in **Table 3**.

- Table 3: Berth information

Berth	Location	Construction	Dimensions	Imports	Exports
1	Outer Harbour	Land backed berth with rubber fendering Concrete piles (3 deep)	Length 184 m Depth 9.2 m		Scrap metal
2	Outer Harbour	Land backed berth with rubber fendering Concrete piles (3 deep)	Length 184 m Depth 8–9 m	Methanol (CH_3CH_2OH)	
3	Inner Harbour	Dolphin berth with metal faced rubber fendering Steel piles in clusters	Length 381 m Depth 11.6 m		Woodchips and grain
4	Inner Harbour	Dolphin berth with rubber or laminated metal faced fendering Vertical steel piles (4 deep)	Length 123 m Depth 11.6 m	Caustic soda (NaOH)	Alumina (Al_2O_3)
5	Inner Harbour	Land backed berth with rubber fendering Vertical steel piles (4 deep)	Length 240 m Depth 11.6 m	Vegetable oils (CnH_nO_n) Petroleum coke (C) and coal Mineral Sands (TiO_2, $FeTiO_3$ and ZrO_2) Heavy mineral concentrate ($FeTiO_3$, TiO_2, SiO_2, $ZrSiO_4$, $Fe_2Ti_3O_9$) Fertiliser (N:P:K plus trace metals Cd, Pb and Hg)	Scrap metal Heavy mineral concentrate ($FeTiO_3$, TiO_2, SiO_2, $ZrSiO_4$, $Fe_2Ti_3O_9$) Iron concentrate (NH_4Cl, SiO_2, Fe_3O_4, Fe_2O_3, TiO_2, MnO, Al_2O_3) Pine logs
6	Inner Harbour	Dolphin berth with rubber or laminated metal faced fendering Vertical steel piles in clusters	Length 123 m Depth 11.6 m	Caustic soda (NaOH)	Alumina (Al_2O_3)
8	Inner Harbour	Land backed berth with rubber fendering Steel casings (4 deep)	Length 250 m Depth 11.6 m		Mineral sands (TiO_2, $FeTiO_3$ and ZrO_2) Silica sand (SiO_2) Spodumene ($LiAlSi_2O_6$) Woodchips Copper sulphide concentrate Refined waste oil

3.0 Dredging and sea dumping requirements

3.1. Maintenance dredging

3.1.1. History

Since completion of all breakwater and spur groyne extensions in 1961, the construction of Berths 1 and 2 and the later development of the Inner Harbour commencing in the early 1970s, the Port of Bunbury has continued to be engaged in a relatively continuous maintenance dredging program to remove silt and sand from the harbour areas and shipping channel. Over the years maintenance dredging programs have involved Public Works Department dredges, private dredging contractors and grab dredging from the face of the wharves (PWD 1978).

To date there have been 30 maintenance dredging programs that resulted in sea dumping. Sea dumping permits were issued for maintenance dredging programs between 1988 and 2022 (which includes the current 10 year permit incorporating 18 January 2012 to 17 January 2022); however, prior to this date it appears that the process was administered by the Public Works Department and subsequently the Department of Marine & Harbours (now the Department of Transport) in consultation with the WA Environmental Protection Authority.

3.1.2. Future maintenance dredging requirements

During the 1960s and 70s the volume of material requiring dredging, principally from the Outer Harbour and Approach Channel, had been in the order of 200,000–300,000 m^3 per year, undertaken triennially. There was an increase in dredge material during 2008 with approximately 1,040,250 m^3 of material being disposed to the existing offshore Spoil Ground. This was a significant increase in volume over previous dredging programs and resulted in emergency dredging events and variations to the sea dumping permit at the time, to maintain the Port's declared depths.

The increased sand inundation of the Port appeared to be as a result of increased coastal process transporting sand around Point McKenna due to the sand traps created by groynes being full and thus being bypassed. At present there appears to be no solution to this other than to regularly remove the sand from the Outer Harbour by dredging and transporting it to the spoil ground.

As of 2010 there has been a reduction in maintenance dredge spoil volume disposed to the existing spoil ground (average of 180,000 m^3 per year, undertaken twice a year), this is considered to be due to an improvement in the efficiency of dredging methods. Unless there is a change in coastal processes, this is considered to be the average volume required for future maintenance dredging.

3.1.3. Dredging methods

Maintenance dredging of the fine to coarse sanding sediments of the Outer Harbours and the Entrance Channel is best achieved using a trailer suction hopper dredge (TSHD). The method has been employed on all maintenance dredging programs in the past and is proposed for future programs.

3.1.4. Disposal of dredged material

Spoil would continue to be disposed to the existing spoil ground until such time as there is insufficient capacity. Based on the present rate of disposal predictions indicate that the spoil ground has at least two to three decades of capacity for maintenance dredging.

3.2. Capital dredging

3.2.1. History

Records of capital dredging associated with the early development of the Outer Harbour are not available. In fact, there may not be any factual accounts of dredging volumes or disposal areas for the Outer Harbour development. The Inner Harbour was developed during two capital dredging programs. In the early 1970s approximately 7.4 Mm^3 of material was removed and used for reclamation works. Later in 1991, the Inner Harbour basin was extended with the removal of approximately 2 Mm^3 of material being disposed to Port land to the east of the Inner Harbour. It must be noted here that the dredged material was of varying quality in terms of its suitability for later construction fill. The Port has not had much success in encouraging third party use of the material and still has a number of stockpiles located on port land. This was the last and most recent capital dredging undertaken by the Port.

3.2.2. Future capital dredging requirements

Capital dredging may be required for future proposed development of the Inner Harbour area; however, no specific plans are yet in place and consequently no environmental approvals are being sought at this stage.

3.2.3. Dredging methods

If and when capital dredging is progressed it may necessitate the removal of portions of the underlying basalt layer by rock fracturing techniques.

3.2.4. Disposal of dredged material

Disposal of the basalt material removed from the Inner Harbour would be assessed at the time of seeking environmental approval from the Western Australian EPA and would consider, but would not be limited to, the following or a combination of the following:

- Sea disposal to the existing spoil ground;
- Sea disposal to a new spoil ground;

- Sea disposal as part of artificial reef creation;
- Reuse as structural material for the Inner Harbour or other Port infrastructure; and
- Recycling by crushing on land for sale.

Note that a separate approval under the Sea Dumping Act may be required if the dredge material is to be used for the creation of an artificial reef.

4.0 Existing environment and potential impacts

4.1. Existing environment

4.1.1. Port and adjacent area benthic habitat

A benthic habitat survey of the Bunbury area was conducted by Wave solutions in July 2011 (Wave solutions, 2012). In addition, a significant amount of seabed survey work has been undertaken over the past three decades associated with spoil ground site selection, monitoring programs and dredging investigations. The benthic habitat in the region can be described as follows:

- **Port Area:** The area bounded by a line between McKenna Point at the tip of the Outer Harbour and Point Hamila at the entrance to the Inner Harbour is dominated by sand with low biotic cover (<2%) made up of trace amounts of foliose and turf algae. No seagrass was observed.
- **Spoil Ground:** There is a lack of discrete substrata at the Spoil Ground with ROV surveys confirming that sand was the only substrata occurring in the location. Percentage cover of biota occurring on sand at the Spoil Ground was low (12.2% ± 5.2% SE) with biotic groups including *Amphibolis griffithii* (percentage cover = 6.7% ± 1.5% SE), *Posidonia angustifolia* (percent cover = 4.0% ± 1.4%) and turf algae (percentage cover = 0.13% ± 0.13%).
- **Nearshore Area (north):** The seabed in less than 10 m of water between Point Hamila and Binningup to the north is a wide expanse of predominantly sandy rubble with numerous low relief limestone reefs and small patches of sparse *Posidonia* sp. seagrasses. Macroalgae on the northern nearshore reef complex consisted of foliose (medium density of 20–50% coverage) and turf algae (up to 50% coverage). Sponges were the major group of filter feeders although they generally occurred in low densities (<2.5%), the highest (2.5–10%) being on the nearshore reef systems just north of “The Cut”.
- **Nearshore Area (south):** The seabed in less than 10 m of water between Point McKenna and Rocky Point to the south is a narrow strip of predominantly sandy rubble with numerous small low relief limestone reefs and small patches of sparse *Posidonia* sp. seagrasses. Macroalgae on the southern nearshore reef complex consisted of foliose (low density of 10–25% coverage) and turf algae (up to 50% coverage). Sponges were the major group of filter feeders although they generally occurred in low densities (<2.5%).
- **Offshore Area:** The area offshore of the Port and surrounding coastline between a depth of 10–20 m is predominantly sandy substrate with seagrass meadows interspersed with low to medium relief limestone reefs and patches of pavement colonised by macroalgae.

The existing environment in the region will require further description and delineation of habitats prior to the commencement of any future capital dredging for Port expansion. Potential impacts such as the reduction of seagrass meadows, smothering of reef habitat and impacts on recreational and commercial fishing would need to be assessed prior to capital dredging.

4.1.2. Spoil ground

The existing spoil ground has been in use since at least 1976. The spoil ground was originally 1,000 m long north to south and 400 m wide east to west and was located, in part, inshore of the present spoil ground location (see red dotted rectangle in **Figure 3**). The bounding coordinates for the existing spoil ground are:

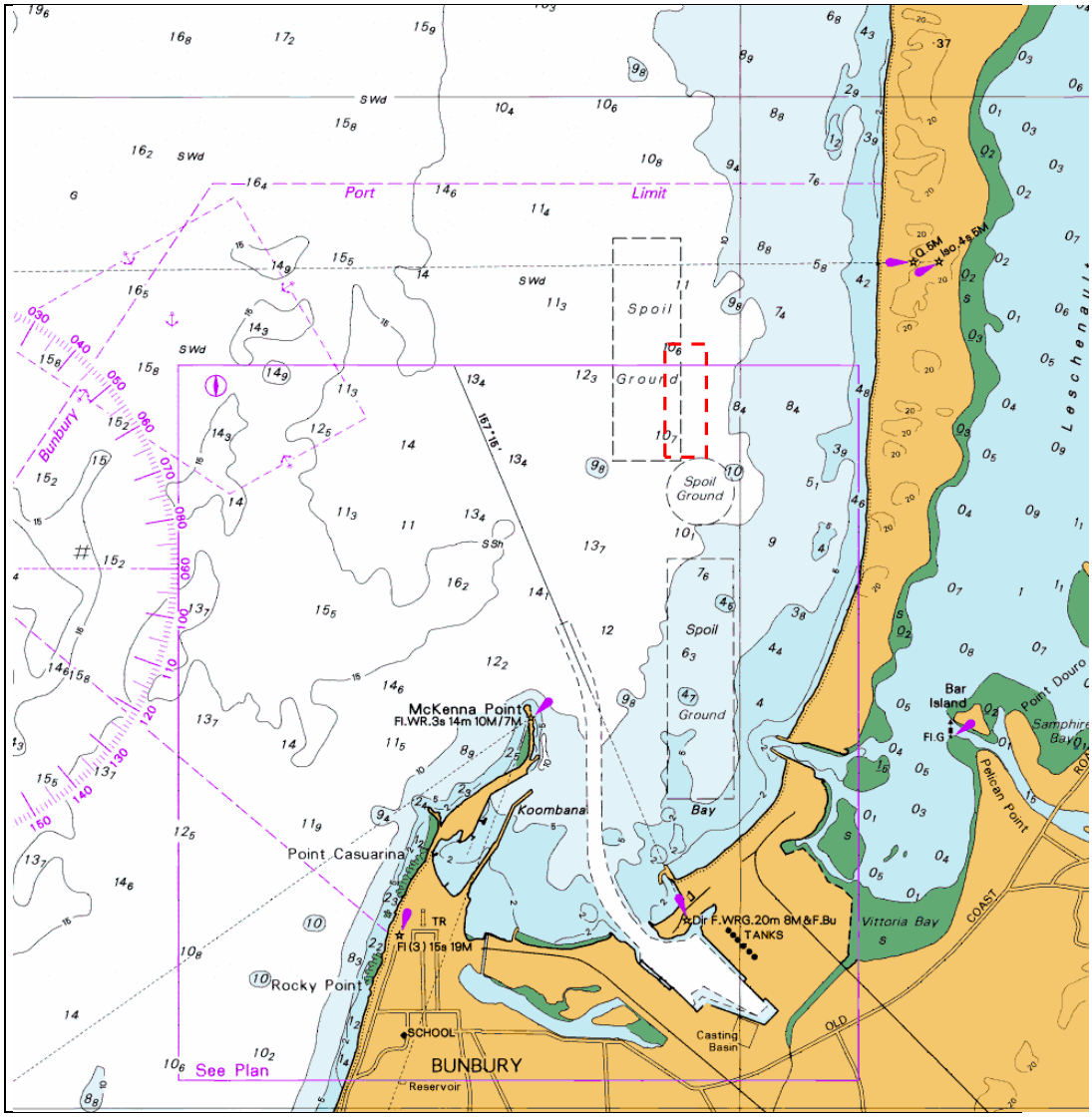
NW corner	33° 15.70' South	115° 39.25' East
NE corner	33° 15.70' South	115° 39.65' East
SE corner	33° 16.80' South	115° 39.65' East
SW corner	33° 16.80' South	115° 39.25' East

Datum is GDA94

The site selection for this spoil ground was not based on environmental considerations. At the time there were no environmental guidelines for spoil disposal. The main considerations were ensuring the material would not pose a hazard to shipping and that it would not re-enter the harbours and channels again. As such the location of the spoil ground to the north, given the predominately northwards current, was suitable. In addition, the Department of Marine and Harbours in 1988 made the following statement when a spoil ground further offshore was proposed (DM&H 1988):

> *"This material should be placed in a position offshore from Leschenault Peninsular from where it may rejoin the coastal process system. The selection of the dumping grounds at about the 10 metre contour ensures that the rate at which the material rejoins the system is acceptable. Dumping sites to the west of Bunbury breakwater in deeper water would not be acceptable in this regard. Dumping at the preferred site during the periods 1976/77, 1979, 1982 and 1985 has been to the satisfaction of the Environmental Protection Authority."*

The key driver at the time of the establishment of the existing spoil ground was beach renourishment to stabilise the Leschenault Peninsula due to the effect the Port was having on interrupting the northerly littoral drift of sand and sediment along the coast. However, it can be seen that the spoil ground was also deemed to be environmentally acceptable, but under what criteria it is unclear as the Environmental Protection Act of 1981 of Western Australia and the Environment Protection (Sea Dumping) Act of 1981 were not enacted at the time.



- Figure 3 Spoil grounds used for sea dumping

Note: Historical spoil grounds to the south of the existing spoil ground are referred to as the southern spoil grounds. The chart is presently being amended to remove these spoil grounds as they are no longer used. The red dashed area represents an earlier historical disposal area.

Source: AUS0115 Approaches to Bunbury.

4.1.3. Bathymetry

The Port is located within Koombana Bay which is a relatively shallow embayment (5–10 m) and protected by McKenna Point (see **Figure 7**). The Approach Channel, which runs through Koombana Bay to the Inner Harbour, has a maintained depth of at least 12.2 m. The Outer and Inner Harbours have maintained depths of 9.1 m and 12.2 m respectively. To the north of the Port the Spoil Ground lies offshore and is surrounded by a flat featureless seabed with water depths of 10–14 m. Further west the water depth gradually increases to 19–20 m.

4.1.4. Tides and currents

The tidal regime of the Bunbury region is diurnal meaning that there is one high and one low tide each 24 hour period. The highest astronomical tide (HAT) is 1.2 m and the lowest astronomical tide (LAT) is 0.4 m thus the tidal range is 0.8 m and mean sea level (MSL) is 0.6 m. The Port of Bunbury has tide gauges on the outer most channel marker Beacon 3 and at Beacon 10 in Koombana Bay. The Department of Transport maintains a tide gauge at the northern end of Berth 5 within the Inner Harbour.

The tides in the region are small and have negligible effect on the prevailing currents. The main current is predominantly to the north and results from the inshore Capes Current which dominates the Leeuwin Current. This current varies seasonally, having a southward movement in autumn and winter and a general northward tendency during the summer months (Rochford, 1969; Cresswell et al., 1989).

4.1.5. Climate

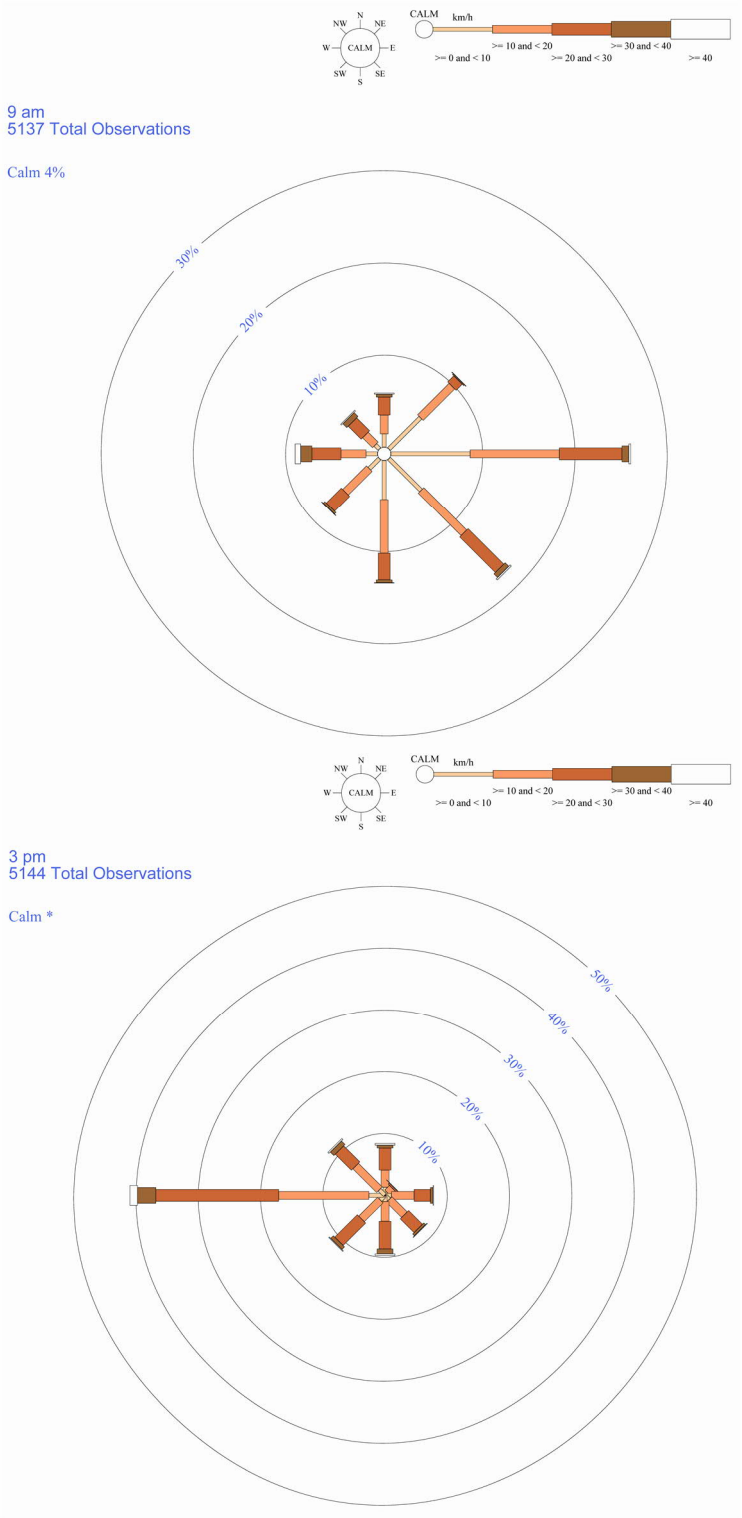
The Bunbury region has a Mediterranean climate meaning that it is characterised by warm to hot, dry summers and mild to cool, wet winters. The average monthly temperature and precipitation ranges are provided in **Table 4** below.

- Table 4 Bunbury climate

	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Average High (°C)	29.8	30.0	27.7	24.2	21.0	18.5	17.3	17.7	18.6	21.2	24.5	27.5	23.2
Average Low (°C)	15.3	15.9	14.4	11.8	9.2	8.0	7.1	7.6	8.5	9.7	12.1	13.5	11.1
Precipitation (mm)	11.2	9.0	20.3	37.5	99.0	135.5	140.1	118.1	79.5	33.1	21.9	16.6	718.4

Source: Bureau of Meteorology 1995–2021.

The summer wind climate is characteristically south easterly to easterly winds in the morning and sea breezes (south westerly to southerly) in the afternoon as depicted in the annual wind roses provided in **Figure 4**. The main driving force for wave action in all seasons is wind; however, there are periodic swell waves which are generated much further to the south-west and impact on the region due to the absence of offshore bathymetric conditions which would attenuate such wave activity. Wind and wave activity are measured on the outer most channel marker Beacon 3 and at Beacon 10 in Koombana Bay.



■ Figure 4 Bunbury annual 9 am and 3 pm wind climate

Source: Bureau of Meteorology 1995–2010.

4.1.6. Seabed sediments

Sediments in the region of the Port of Bunbury vary considerably depending upon depth of water and exposure to hydrodynamic conditions. Within the Inner Harbour, the area has been dredged to the level of the underlying basal bedrock and there are only thin layers of silt (<10 cm) which are derived from material carried in by wave activity along the Approach Channel. Koombana Bay has shallow sandy surficial sediments (<1 m) low in organic content. The Approach Channel and Outer Harbour berth areas often accumulate considerable quantities of drift algae and seagrass wrack which decompose and adds organic content and fine silt to the sediments. The Spoil Ground is located in an area of considerable hydrodynamic activity which results in sediment erosion. Seabed sediments in this area are transported shoreward and northwards and contribute to beach renourishment.

4.1.7. Water column

The water column in and adjacent to the Port is well mixed as a result of wind and wave action thus there is negligible potential for stratification. However, as a result of these hydrodynamic conditions, the water is often turbid, and it is only in very calm conditions that the water column clears resulting in vertical visibility approaching 10 m.

4.2. Protected areas and matters of national environmental significance

The purpose of this section is to undertake a self-assessment of the proposed action in accordance with the EPBC Act significant impact criteria as set out in the Significant Impact Guidelines 1.1 (DoE 2013). The results of this assessment will be used by the Port of Bunbury to determine if referral of the proposed action under the EPBC Act is required (see Appendix B for the EPBC Act Protected Matters Report created on 12 July 2021).

4.2.1. Protected areas (marine parks)

There are a number of protected areas or marine parks in the south west of Western Australia. The closest marine park to the north of the Port of Bunbury is the Shoalwater Marine Park over 100 km away. The closest marine park to the south is the Ngari Capes Marine Park over 70 km south of Bunbury. Offshore beyond state waters (3 nautical miles) is the Geographe Marine Park, the most north western corner of which is approximately 12 km south west of Bunbury.

4.2.2. Matters of national environmental significance

The Matters of National Environmental Significance (MNES) protected under the EPBC Act are listed below along with the significance based on the Commonwealth of Australia Protected Matters Search Tool (PMST) Beta within 10 km of the Port of Bunbury and the spoil ground:

- World heritage properties None
- National heritage places None

▪ Ramsar wetlands of international importance	None
▪ Great Barrier Reef Marine Park	None
▪ Commonwealth marine areas	None
▪ Listed threatened ecological communities	2
▪ Listed threatened species	55 species
▪ Listed migratory species protected under international agreements	44 species
▪ Nuclear actions (including uranium mines)	None
▪ A water resource, in relation to coal seam gas development and large coal mining development.	None

Of these, the two ecological communities (Banksia woodland and Tuart woodland) are specifically of terrestrial origin and would not be impacted by dredge and disposal activities.

4.2.3. Marine threatened species

Of the 55 threatened species listed for the area, 38 are marine species (terrestrial and solely freshwater species have been excluded as dredging and spoil disposal does not impact those areas) and of them 21 are known to occur or are likely to occur in the area. These species are provided in **Table 5** below. Of the species likely or known to occur, a summary of the status, preferred habitat and distribution of these species, as well as an assessment of the likelihood of occurrence of these species within the project area has been undertaken. The little penguin was also added to the list as they are known to occur in the area and their population has been declining.

4.2.4. Marine migratory species

Of the 44 migratory species listed for the area, 34 are marine species only, while 18 are known to occur or are likely to occur in the area. These species are provided in **Table 6** below.

■ Table 5 Marine threatened species within 10 km of the Port of Bunbury and the Spoil Ground

Species Name	Common Name	Status	Presence in area	Comments
Fish				
Thunnus maccoyii	Southern Bluefin Tuna	Conservation dependent	Likely to occur	Southern bluefin tuna (SBT) are highly migratory. After five years of age, they are seldom found in near shore surface waters. However, juveniles of one to two years of age can inhabit inshore waters in WA (SPRAT). SBT spawn in tropical waters between Java and northern Western Australia during summer and spring. Juveniles migrate south in April utilising the Leeuwin Current to reach the Great Australian Bight and are found in southern coastal waters during October to April (DSEWPaC 2012a). SBT are not caught recreationally in inshore Bunbury waters and there are no sighting or specimens in the Bunbury area on the Australian Museum website (https://australian.museum/learn/animals/fishes/southern-bluefin-tuna-thunnus-maccoyii/). Given the lack of records it is unlikely this species will occur within the project envelope.
Shark:				
Carcharias taurus	Grey Nurse Shark	Vulnerable	Known to occur	The Grey Nurse Shark typical habitat is considered to be reef areas with pronounced vertical and horizontal structure, including deep gutters, caves and large overhanging ledges, which is not found on the Bunbury coast. They are known to migrate up and down the West Australian coast and therefore single sharks may occur near the spoil ground at certain times of the year. However, DSEWPaC (2012b) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Carcharodon carcharias	Great White Shark	Vulnerable	Known to occur	Great White Sharks are known to migrate up and down the West Australian coast and therefore single sharks may occur near the spoil ground at certain times of the year. However, DSEWPaC (2012b) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Galeorhinus galeus	School Shark	Conservation dependent	May occur	
Rhincodon typus	Whale Shark	Vulnerable	May occur	
Sphyrna lewini	Scalloped Hammerhead	Conservation dependent	Likely to occur	There are no sighting or specimens of scalloped hammerhead sharks in the Bunbury area on the Australian Museum website (https://australian.museum/learn/animals/fishes/scalloped-hammerhead-sphyrna-lewini/) and the Department of Parks and Wildlife (https://www.dpaw.wa.gov.au/management/marine/marine-parks-wa/fun-facts/419-hammerhead-sharks) consider that scalloped hammerhead sharks are rarely seen south of the Houtman Abrolhos Islands. Given the lack of records it is unlikely this species will occur within the project envelope.
Reptile:				
Caretta caretta	Loggerhead Turtle	Endangered	Known to occur	Loggerhead turtles are one of the most commonly sighted turtles along the coast adjacent to the South-west Marine Region, with resident adult and large sub-adult turtles sometimes found in the Perth region between Rottnest Island and Geographe Bay; however, DSEWPaC (2012c) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.

Species Name	Common Name	Status	Presence in area	Comments
Chelonia mydas	Green Turtle	Vulnerable	Known to occur	Green Turtles nest, forage and migrate across tropical northern Australia. They usually occur between the 20°C isotherms although individuals can stray into temperate waters (SPRAT); however, DSEWPaC (2012c) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Dermochelys coriacea	Leatherback Turtle	Endangered	Likely to occur	The Leatherback Turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. They are a highly pelagic species, venturing close to shore mainly during the nesting season (SPRAT). There is no known nesting in the Bunbury area; therefore, it is unlikely to be found in the project envelope. DSEWPaC (2012c) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Natator depressus	Flatback Turtle	Vulnerable	Known to occur	One recording in the Bunbury region in 1995 by WA Museum. Although juvenile flatback turtles have been recorded stranding in the south-west of Western Australia, these species are generally restricted to warmer, tropical waters and occur as vagrants in the region (DSEWPaC, 2012c). Given the lack of records it is unlikely this species will occur within the project envelope.
Bird:				
Anous tenuirostris melanops	Australian Lesser Noddy	Vulnerable	May occur	
Botaurus poiciloptilus	Australasian Bittern	Endangered	Likely to occur	The Australasian bittern is a secretive, stocky, heron-like bird, living in wetlands where it forages (SPRAT). It breeds and feeds within wetlands (suitable habitat) and Birdlife Western Australia (2020) do not have it listed as being seen in the Bunbury area. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Calidris canutus	Red Knot	Endangered	Known to occur	According to Birdlife Western Australia (2020) the Red Knot is rare in the Bunbury area. It is most likely to be seen at the Leschenault Peninsula Conservation Park (LPCP) or Leschenault Estuary during the summer months. The Port is highly modified, and dredging takes place outside of the summer months. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Calidris ferruginea	Curlew Sandpiper	Critically Endangered	May occur	
Diomedea amsterdamensis	Amsterdam Albatross	Endangered	May occur	
Diomedea dabbenena	Tristan Albatross	Endangered	May occur	
Diomedea epomophora	Southern Royal Albatross	Vulnerable	Likely to occur	According to Birdlife International (2021) the species circumnavigates the Southern Ocean after breeding but is most commonly recorded in New Zealand and South American waters. They feed mainly on fish and squid taken from cool, oceanic waters, especially those enriched by up-welling nutrients and along the edge of continental shelves. They are unlikely to be found in Bunbury unless blown of course during massive storms. Birdlife Western Australia (2020) do not have it listed as being seen in the Bunbury area. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Diomedea exulans	Wandering	Vulnerable	Likely to	In Australia the Wandering Albatross breeds on Macquarie Is (SPRAT). This wide-ranging species has a

Species Name	Common Name	Status	Presence in area	Comments
	Albatross		occur	circumpolar distribution, and both breeding and non-breeding birds have very large foraging ranges (Birdlife International, 2021) and visits Australian waters from Fremantle, Western Australia to northern New South Wales between June and September each year. As dredging takes place outside of this period is unlikely that this species would occur in the project area.
Diomedea sanfordi	Northern Royal Albatross	Endangered	Likely to occur	The Northern Royal Albatross ranges widely over the Southern Ocean, with individuals seen in Australian waters off south-eastern Australia it feeds regularly in Tasmanian and South Australian waters, and less frequently in NSW waters (SPRAT). Birdlife Western Australia (2020) do not have it listed as being seen in the Bunbury area. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Falco hypoleucos	Grey Falcon	Vulnerable	May occur	
Halobaena caerulea	Blue Petrel	Vulnerable	May occur	
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	Critically Endangered	Known to occur	*L. l. menzbieri* breeds in northern Siberia between the Lena Delta and Chaunskaya Bay, wintering from south-east Asia to north-west Australia. According to Birdlife Western Australia (2020) the Bar Tailed Godwit is uncommon in the Bunbury area. It is most likely to be seen at the Leschenault Peninsula Conservation Park (LPCP) or Leschenault Estuary during the summer months. The Port is highly modified, and dredging takes place outside of the summer months. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Macronectes giganteus	Southern Giant-Petrel	Endangered	May occur	
Macronectes halli	Northern Giant-Petrel	Vulnerable	May occur	
Numenius madagascariensis	Eastern Curlew	Critically endangered	May occur	
Pachyptila tutur subantartica	Fairy Prion (southern)	Vulnerable	Likely to occur	Fairy Prion breeding colonies can be found off Macquarie Island and on the nearby Bishop and Clerk Island (SPRAT). Feeding is mainly offshore and there are no record of them being sighted in Bunbury (Birdlife Western Australia, 2020; Atlas of Living Australia - https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:f78f44c3-f551-46bf-ad48-c72fd0b4eb69#overview). Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Phoebetria fusca	Sooty Albatross	Vulnerable	May occur	
Pterodroma mollis	Soft-plumaged Petrel	Vulnerable	May occur	
Sternula nereis nereis	Fairy Tern (Australian)	Vulnerable	Known to occur	According to Birdlife Western Australia (2020) the Fairy Tern is uncommon in the Bunbury area. DSEWPaC (2012d) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Thalassarche carteri	Indian Yellow-nosed Albatross	Vulnerable	Likely to occur	Albatrosses typically feed in offshore areas of south west WA during the winter months, particularly along the edge of the continental shelf and over open waters. In July and August, they are very common between Cape

Species Name	Common Name	Status	Presence in area	Comments
Thalassarche cauta	Shy Albatross	Endangered	Likely to occur	Naturaliste and King George Sound, where a biologically important area for this species has been defined. There has been one record of a dead bird being found by the WA Museum in the Bunbury region. DSEWPaC (2012d) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope. The shy albatross breeds on only three islands off Tasmania, Australia: Mewstone, Pedra Branca and Albatross Island. When not breeding it is most frequently found around Tasmania and southern Australia. There has be one record by the WA Museum of this species being sighted north of Bunbury. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Thalassarche impavida	Campbell Albatross	Vulnerable	May occur	
Thalassarche melanophris	Black-browed Albatross	Vulnerable	May occur	
Thalassarche steadi	White-capped Albatross	Vulnerable	Likely to occur	*Thalassarche steadi* is endemic to offshore islands of New Zealand, where it appears to breed biennially. This species forages in Tasmania and Southern Africa/Namibia), and immature birds are thought to occur regularly throughout the South Atlantic and south-west Indian Ocean (Birdlife International,2021). It has been noted in shelf-waters, around breeding islands and over adjacent rises. During the non-breeding season, birds have been observed over continental shelves around continents (SPRAT). There are no records of it being sighted in the Bunbury region (Birdlife Western Australia, 2020; Atlas of Living Australia - https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:dd76d9f0-33ef-4fa3-b1f8-e0a62cf5d3e8). Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Eudyptula minor	Little Penguin	Marine	Likely to occur	The Little Penguin is considered to be uncommon in the Bunbury area (Birdlife Western Australia, 2020). DSEWPaC (2012e) consider that dredging is of potential concern for this species because dredging projects may drive away prey schools or contaminate seabird food chains.
Mammals:				
Balaenoptera musculus	Blue Whale	Endangered	Likely to occur	The blue whale is observed primarily in the southern section of the shallow bay adjacent to Cape Naturaliste, which is a resting point during the slow transit west through the bay. Observations frequently occur October–December in southern Geographe Bay where maximum water depth is 35–50 m (SPRAT). Blue whales are not usually seen in swallow waters (< 10 m) off Bunbury and DSEWPaC (2012e) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Eubalaena australis	Southern Right Whale	Endangered	Known to occur	The entire coastline from Kangaroo Island westward and south of the Perth Canyon is thought to be an important migratory pathway for the southern right whale. Principally they are found aggregating adjacent to the region, in state waters around the southern coastline off southern Western Australia and far west South Australia. DSEWPaC (2012e) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of potential concern to this species.
Megaptera novaeangliae	Humpback Whale	Vulnerable	Known to occur	Geographe Bay is considered to be a resting area for the Humpback Whale as they migrate through coastal areas between Esperance and Kalbarri, however, DSEWPaC (2012e) consider the threat of physical habitat

Species Name	Common Name	Status	Presence in area	Comments
				modification (including dredging and dredge spoil) to be of less or no concern to this species.
Neophoca cinerea	Australian Sea-lion	Vulnerable	May occur	

- Table 6 Marine migratory species within 10 km of the Port of Bunbury and the Spoil Ground

Species Name	Common Name	Status	Presence in area	Comments
Sharks and Rays:				
Carcharhinus longimanus	Oceanic Whitetip Shark	Migratory	May occur	
Carcharodon carcharias	Great White Shark	Vulnerable	Known to occur	Great White Sharks are known to migrate up and down the West Australian coast and therefore single sharks may occur near the spoil ground at certain times of the year. However, DSEWPC (2012b) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Rhinocodon typus	Whale Shark	Vulnerable	May occur	
Mobula alfredi	Reef Manta Ray	Migratory	May occur	
Mobula birostris	Giant Manta Ray	Migratory	May occur	
Reptiles:				
Caretta caretta	Loggerhead Turtle	Endangered	Known to occur	Loggerhead turtles are one of the most commonly sighted turtles along the coast adjacent to the South-west Marine Region, with resident adult and large sub-adult turtles sometimes found in the Perth region between Rottnest Island and Geographe Bay, however, DSEWPaC (2012c) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Chelonia mydas	Green Turtle	Vulnerable	Known to occur	Green Turtles nest, forage and migrate across tropical northern Australia. They usually occur between the 20°C isotherms although individuals can stray into temperate waters (SPRAT), however, DSEWPaC (2012c) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Dermochelys coriacea	Leatherback Turtle	Endangered	Likely to occur	The Leatherback Turtle is a pelagic feeder, found in tropical, subtropical and temperate waters throughout the world. They are a highly pelagic species, venturing close to shore mainly during the nesting season (SPRAT). There is no known nesting in the Bunbury area, therefore, it is unlikely to be found in the project envelope. DSEWPaC (2012c) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Natator depressus	Flatback Turtle	Vulnerable	Known to occur	One recording in the Bunbury region in 1995 by WA Museum. Although juvenile flatback turtles have been recorded stranding in the south-west of Western Australia, these species are generally restricted to warmer, tropical waters and

Species Name	Common Name	Status	Presence in area	Comments
				occur as vagrants in the region (DSEWPaC, 2012c). Given the lack of records it is unlikely this species will occur within the project envelope.
Birds:				
Anous stolidus	Common Noddy	Migratory	May occur	
Apus pacificus	Fork-tailed Swift	Migratory	Likely to occur	According to Birdlife Western Australia (2020) the Fork-tailed Swift is rare in the Bunbury area. DSEWPaC (2012d) considers this species to overfly the region during migration. There are no significant threats to the Fork-tailed Swift in Australia (SPRAT).
Ardenna carneipes	Flesh-footed Shearwater	Migratory	Likely to occur	According to Birdlife Western Australia (2020) the Flesh-footed Shearwater is uncommon in the Bunbury area. DSEWPaC (2012d) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species, however, they consider that there is a risk to this species of bioaccumulation of heavy metals released from sediments due to dredging activities.
Diomedea amsterdamensis	Amsterdam Albatross	Endangered	May occur	
Diomedea dabbenena	Tristan Albatross	Endangered	May occur	
Diomedea epomophora	Southern Royal Albatross	Vulnerable	Likely to occur	According to Birdlife International (2021) the species circumnavigates the Southern Ocean after breeding but is most commonly recorded in New Zealand and South American waters. They feed mainly on fish and squid taken from cool, oceanic waters, especially those enriched by up-welling nutrients and along the edge of continental shelves. They are unlikely to be found in Bunbury unless blown of course during massive storms. Birdlife Western Australia (2020) do not have it listed as being seen in the Bunbury area Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Diomedea exulans	Wandering Albatross	Vulnerable	Likely to occur	In Australia the Wandering Albatross breeds on Macquarie Is (SPRAT). This wide-ranging species has a circumpolar distribution, and both breeding and non-breeding birds have very large foraging ranges (Birdlife International, 2021) and visits Australian waters from Fremantle, Western Australia to northern New South Wales between June and September each year. As dredging takes place outside of this period is unlikely that this species would occur in the project area.
Diomedea sanfordi	Northern Royal Albatross	Endangered	Likely to occur	The Northern Royal Albatross ranges widely over the Southern Ocean, with individuals seen in Australian waters off south-eastern Australia it feeds regularly in Tasmanian and South Australian waters, and less frequently in NSW waters (SPRAT). Birdlife Western Australia (2020) do not have it listed as being seen in the Bunbury area. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Hydroprogne caspia	Caspian Tern	Migratory	Known to occur	According to Birdlife Western Australia (2020) the Caspian Tern is common in the Bunbury area. DSEWPaC (2012d) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species, however, they consider that there is a risk to this species of bioaccumulation of heavy metals released from sediments due to dredging activities.
Macronectes giganteus	Southern Giant-Petrel	Endangered	May occur	

Species Name	Common Name	Status	Presence in area	Comments
Macronectes halli	Northern Giant-Petrel	Vulnerable	May occur	
Onychoprion anaethetus	Bridled Tern	Migratory	Likely to occur	In Australia, Bridled Terns are widespread, breeding on offshore islands in western, northern and north-eastern Australia, extending from Cape Leeuwin in the south-west, around northern Australia (SPRAT). The species forages in offshore, continental shelf waters and is only rarely recorded along mainland coasts, even those adjacent or close to breeding colonies (SPRAT). Birdlife Western Australia (2020) do not have it listed as being seen in the Bunbury area. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Phoebetria fusca	Sooty Albatross	Vulnerable	May occur	
Thalassarche carteri	Indian Yellow-nosed Albatross	Vulnerable	Likely to occur	Albatrosses typically feed in offshore areas of south west WA during the winter months, particularly along the edge of the continental shelf and over open waters. In July and August, they are very common between Cape Naturaliste and King George Sound, where a biologically important area for this species has been defined. There has been one record of a dead bird being found by the WA Museum in the Bunbury region. DSEWPaC (2012d) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Thalassarche cauta	Shy Albatross	Endangered	Likely to occur	The shy albatross breeds on only three islands off Tasmania, Australia: Mewstone, Pedra Branca and Albatross Island. When not breeding it is most frequently found around Tasmania and southern Australia. There has been one record by the WA Museum of this species being sighted north of Bunbury. Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Thalassarche impavida	Campbell Albatross	Vulnerable	May occur	
Thalassarche melanophris	Black-browed Albatross	Vulnerable	May occur	
Thalassarche steadi	White-capped Albatross	Vulnerable	Likely to occur	The White-capped Albatross breeds on islands off of New Zealand and Tasmania. they generally only return onto land in order to breed. There are no records of it being sighted in the Bunbury region (Birdlife Western Australia, 2020; Atlas of Living Australia - https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:dd76d9f0-33ef-4fa3-b1f8-e0a62cf5d3e8). Given the lack of records and suitable habitat it is unlikely this species will occur within the project envelope.
Mammals:				
Balaenoptera edeni	Bryde's Whale	Migratory	May occur	
Balaenoptera musculus	Blue Whale	Endangered	Likely to occur	The blue whale is observed primarily in the southern section of the shallow bay adjacent to Cape Naturaliste, which is a resting point during the slow transit west through the bay. Observations frequently occur October–December in southern Geographe Bay where maximum water depth is 35–50 m (SPRAT). Blue whales are not usually seen in swallow waters (< 10 m) off Bunbury and DSEWPaC (2012e) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Caperea	Pygmy Right	Migratory	May occur	

Species Name	Common Name	Status	Presence in area	Comments
marginata	Whale			
Eubalaena australis	Southern Right Whale	Endangered	Known to occur	The entire coastline from Kangaroo Island westward and south of the Perth Canyon is thought to be an important migratory pathway for the Southern Right Whale. Principally they are found aggregating adjacent to the region, in state waters around the southern coastline off southern Western Australia and far west South Australia. DSEWPaC (2012e) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of potential concern to this species.
Lagenorhynchus obscurus	Dusky Dolphin	Migratory	May occur	
Megaptera novaeangliae	Humpback Whale	Vulnerable	Known to occur	Geographe Bay is considered to be a resting area for the Humpback Whale as they migrate through coastal areas between Esperance and Kalbarri however DSEWPaC (2012e) consider the threat of physical habitat modification (including dredging and dredge spoil) to be of less or no concern to this species.
Orcinus orca	Killer Whale, Orca	Migratory	May occur	

4.2.5. EPBC threatened and migratory marine species summary and mitigation measures

The Bunbury Harbour and Spoil Ground (including 10 km radius) EPBC PMST highlighted 38 listed marine threatened species (24 birds, five sharks, four mammals, four reptiles and one fish) and 34 migratory marine species.

The Port itself is a highly modified environment. Dredging has been occurring for over 50 years and the current spoil ground in use for more than 40 years. Therefore, the project area is unlikely to provide suitable core habitat for EPBC listed species. The Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) is the most sighted cetacean in the Bunbury area. However, records since 2005, confirm that there have been no incidents involving cetaceans or turtles during dredging or disposal operations at the Port of Bunbury. There also have been no recorded sightings of whales or turtles during dredging activities. For birds such as the Little Penguin (uncommon in the area), Flesh-footed Shearwater (uncommon in the area) and the Caspian Tern (common in the area), actual dredging and disposal is considered to be less or no concern by DSWPaC (2012d),) but consider that there is a risk to these species of bioaccumulation of heavy metals released from sediments due to dredging activities, however, it is acknowledged that guidelines are in place to mitigate environmental impacts.

A number of mitigation measures are considered appropriate to ensure that the significance of potential impacts remains low. These include:

- Dredge contractors to provide and comply with an Environmental Management Plan which demonstrates management of potential impacts associated with:
    - Marine fauna.
    - Accidental spills and discharges.
    - Waste management.
- Dredge contractors to provide and comply with a Safety Management Plan.
- To manage the risk of introduction of IMS through biofouling, vessels on the project should be antifouled in accordance with the following guidelines:
    - International Convention for the Control and Management of Ships Ballast Water and Sediments (BWM Convention 2004 – IMO)
    - National Biofouling Management Guidelines (Commonwealth of Australia, 2009).

  - Biofouling Biosecurity Policy (http://www.fish.wa.gov.au/Documents/biosecurity/biofouling_biosecurity_policy.pdf).

  - Biofouling management tools and guidelines (http://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biosecurity/Vessels-And-Ports/Pages/Biofouling-management-tools-and-guidelines.aspx).

- Prior to starting the dredger, a visual and/or sonar scan of the area should confirm no whales within 300 m of the dredger (dependent on visibility) this will constitute the shut-down zone for the dredge operation. Observations of the 300 m shut-down zone where visibility allows should last for at least 20 min prior to commencing the dredging.

- The dredger will commence with a soft start procedure, prior to engaging the dredger, in order to provide time for any marine mammals or birds to vacate the area. In the unlikely event a whale is sighted within 300 m of the dredger, operations shall cease, or not commence (whichever is applicable), or until the animal(s) have moved away and not been seen for 20 minutes.

4.2.6. Commercial, recreational and indigenous users of the area

The Port of Bunbury has no commercial or recreational fishing permitted within the Inner and Outer Harbours due to safety constraints with shipping operations in such enclosed spaces. Recreational diving takes place in the region but this is many kilometres from the Port and Spoil Ground. The closest recreational dive site to the Port is the scuttled vessel Lena approximately nine km south-west of McKenna Point.

There are a number of private vessels which moor at the Casuarina Boat Harbour at the western side of Koombana Bay. A small number of these vessels are commercial fishing vessels which operate well outside the Port limits. The Dolphin Discovery Centre operates out of premises located on the southern shoreline of Koombana Bay and takes tourists into Koombana Bay to see the local dolphins. While there are no specific fishing rights for local indigenous or other groups within the Port areas, limited recreational fishing and crabbing does take place within port waters away from Berth areas. These activities are rarely compromised by port operations including shipping movements.

The Bunbury Yacht Club conducts events within Port waters but these events are not impacted by dredging operations.

4.3. Potential impacts

The potential impacts of dredging and spoil disposal to sea are as follows:

- **Water Quality:** The most recent Spoil Ground water quality monitoring was conducted quarterly (seasonally) over the course of a year (July 2019 – April 2020) during non-dredging periods and on the 13 March 2020 during dredge disposal (MAFRL, 2020; **Appendix C**). For the quarterly sampling, nutrients and metal/metalloid concentrations were below the ANZG (2018) guideline values for marine water with a 95% level of species protection for slightly disturbed ecosystems during each sampling occasion and physico-chemical parameters (salinity, dissolved oxygen, temperature, pH and turbidity) were typical of the well mixed inshore marine water in this area.
- On the 13 March 2020, while dredging of the Bunbury Port was occurring, the dredge plume was monitored at the Spoil Ground while dumping was in progress, to determine the extent of the plume. The analysis of the water column samples showed that by approximately 350 m from the initial disposal of the plume, turbidity, total suspended solids and total and filtered metals had returned to background concentrations, indicating a very localised plume influence. The results of this and previous disposal monitoring shown that minor effects outside the boundary of the Port Harbours where dredging took place and at the Spoil Ground compared to reference locations. Any changes were of a short-term nature and water quality returned to pre-disturbance conditions quickly. The dredge spoil has no bioavailable contaminants and as such does not pose a threat to the area. Nutrients in the spoil are in an organic form that will be released upon decomposition, similar to that which occurs in the area through natural decomposition of seagrass and algal wrack. Oxygen depletion, if any, would be localised and short-term.
- **Sediment Quality:** Previous monitoring has shown that the footprint of impact from disposal is contained within the Spoil Ground boundary. The most recent monitoring (quarterly July 2019 – April 2020; MAFRL 2020; **Appendix C**) has also demonstrated that all metals/metalloids and hydrocarbons in sediment were below the Simpson et al. (2013) sediment quality guidelines (SQG) where guidelines were available, during all sampling occasions.
- **Flora and Fauna:** The impact of smothering is generally accepted for Spoil Grounds and monitoring of infauna has documented some recovery after dumping events; however, impacts outside the spoil ground were not significant. The substrate has changed little over time due to the dispersive nature of the Spoil Ground. There are no seagrass meadows within the area of impact. A benthic habitat survey of the Bunbury area, conducted by Wave solutions in 2012 (Wave solutions, 2012), concluded that there was no seagrass observed in Koombana Bay and biotic cover was low (<2%), while the percentage cover of biota occurring on sand at the Spoil Ground was low (12.2% ± 5.2% SE) with biotic groups including *Amphibolis griffithii*

(percentage cover = 6.7% ± 1.5% SE), *Posidonia angustifolia* (percent cover = 4.0% ± 1.4%) and turf algae (percentage cover = 0.13% ± 0.13%). Dolphins which inhabit the Port area appear to be unaffected by Port operations and are not harmed in any way. See Section 4.2.5 for a summary of EPBC threatened and migratory marine species and mitigation measures.

- **Invasive Marine Species Translocation:** Molecular surveys were conducted for seven priority marine pests in the Bunbury Port in February 2020 and May 2020. A single low level detection of *Sabella spallanzanii* was detected in May (Wiltshire et al., 2020). Prior to that, traditional surveillance undertaken in 2017 (MAFRL 2017), showed no suspected IMS that were listed on the Western Australian Prevention List for Introduced Marine Pests, Department of Fisheries (November 2016). Therefore, the potential for translocation of marine pest species is considered low. Species present in the Port of Bunbury have not been found to successfully colonise the spoil ground and are unlikely to do so. The potential for increased predation and/or loss of habitat is negligible in the area. The disposal of spoil does not affect predation because it provides no change to habitat complexity and thus does not alter the community structure for prey or predators. There is no sensitive habitat in the region of the Spoil Ground and, as such, there will be no loss of available habitat. The habitat offered by the Spoil Ground itself will not be significantly altered from its present character.
- **Other Users of the Area:** The social value of the Port area and areas immediately surrounding it are important to the residents of the Bunbury area as it has been for many decades. The Port Authority understands this and works well with the local community to ensure that there is a good flow of information regarding port activities and in particular when dredging is to occur. There has been no history of adverse public reaction to dredging as it is well accepted by the community as part of ensuring the continued viability of the Port. There is no scuba diving value in the vicinity of the Port or spoil ground due to the absence of seabed features.

5.0 Management measures and contingencies

This section of the LTMMP outlines the management measures contingencies to be employed to manage, where practicable to do so, the quality and quantity of the dredged material generated at the Port of Bunbury. This is a key aspect of managing the potential impacts of dredging and dredged material disposal and focuses on the following aspects:

- Targeted dredging campaigns
- Minimisation of dredging requirements in new development areas of the Port
- Reuse or recycling of dredged material
- Improvement of sediment quality
- Minimisation of impacts adjacent to the disposal ground

5.1. Management measures

5.1.1. Targeted dredging campaigns

The Port of Bunbury will attempt to better target its dredging campaigns at the Port by focussing on those areas of the Port subjected to the most frequent inundation.

Aims

- To more effectively undertake dredging at Port of Bunbury.
- To concentrate on the sand trap areas to increase their capture capacity an attempt to reduce future dredging requirement from the outset.

Management Measures

- Investigation of the coastal processes that are leading to the increased deposition of sand in the Outer Harbour and recommendation for mitigation strategies.
- Dredge closer into silt pockets and sediment traps where possible to increase the capture capacity of these traps.
- Minimise overflow dredging wherever practicable to do so.
- Ensure best practice dredging methods to improve efficiency of dredging and reduce future dredging requirements.
- Undertake research where necessary to gain an improved understanding of siltation rates and sediment movements at the Port of Bunbury.

Key Performance Indicators

- The % volume of sand as opposed to water carted to the spoil ground per sea dumping cycle.

- Cost of dredging per annum (as an average) (including dredge, hydrographic soundings etc).
- Length of time that declared drafts are maintained.

5.1.2. Minimisation of dredging requirements

The Port of Bunbury will attempt to minimise dredging requirements at the Port.

Aims

- To minimise the amount of maintenance dredging required at the Port of Bunbury.
- To consider maintenance dredging requirements in all port planning and development in an attempt to reduce future dredging requirement from the outset.

Management Measures

- Wrack removal from the Approach Channel annually to slow sand entrapment and build up.
- Investigation of the coastal processes that are leading to the increased deposition of sand in the Outer Harbour and recommendation for mitigation strategies.
- Utilise silt pockets and sediment traps where possible to prevent siltation in operationally important areas.
- Ensure best practice dredging methods to improve efficiency of dredging and reduce future dredging requirements.
- Undertake research where necessary to gain an improved understanding of siltation rates and sediment movements at the Port of Bunbury.
- Incorporate long term dredging requirements into all development proposal assessments.

Key Performance Indicators

- Amount of material dredged per annum (as an average).
- Cost of dredging per annum (as an average) (including dredge, hydrographic soundings etc).
- Length of time that declared drafts are maintained.

5.1.3. Reuse of dredge material

The dredge material in the Port of Bunbury consists of macroalgal and seagrass wrack and sand mainly from coastal process transport. The Port has been granted an Instrument of Exemption by the West Australian Department of Primary Industries and Regional Development to collect and relocate 'seawrack' from the Bunbury Port Shipping Channel (expires 30 January 2025). This wrack is currently being used on farmlands as a soil improver/fertiliser. For the sediment, where economically feasible and when the dredge material has such physical and chemical characteristics that it is fit to be used for other purposes, the Port of Bunbury will attempt to reuse dredged material to reduce the volumes disposed in the disposal ground. This will have the added benefit of reducing the requirement to import fill and extending the life of the existing spoil ground. However, reuse of clean sand will need to be balanced against the need to ensure that not too much sand is removed from the coastal process such that it results in regression of the shoreline on the Leschenault Peninsula.

Aims

- To reuse dredged material onshore if suitable and where economically feasible.
- To reduce volumes of dredged material disposed at the disposal ground where economically feasible.

Management Measures

- Assess composition of dredged material prior to dredging to determine whether it can economically and sustainably be utilised onshore for reclamation or other purposes.
- Where material can be disposed of onshore, include requirements for capability for onshore and offshore disposal in dredging tenders.
- If material is to be disposed of onshore, management of return waters is to be undertaken to reduce turbidity and contaminant concentrations.

Key Performance Indicators

- Percentage of dredged material that can be reused in each dredging campaign.
- Life of the disposal ground.

5.1.4. Improvement of sediment quality

The Port of Bunbury will seek to implement measures to improve the quality of the sediment to be dredged. This will reduce the risk of sediment being assessed as unsuitable for unconfined ocean disposal.

Aims

- To reduce the level of contamination within the sediments to be dredged.
- To reduce the potential for new contamination within the sediments to be dredged.
- To minimise the risk of sediment being assessed as unsuitable for unconfined ocean disposal.

Management Measures

- Implement the Port of Bunbury ISO 14001 – 2015 certified Environmental Management System (**Appendix A**) which contains a number of controls that will contribute to reducing the introduction of contaminants into sediments.
- Ensure implementation of appropriate dust controls on conveyors and ship loaders.
- Ensure implementation of storm and wash down water capture controls on wharves to minimise contaminated runoff into the marine environment.
- Prevent hosing of excess product from ship decks into surrounding waters.
- Ensure emergency response procedures are in place for incidents during ship loading and unloading so that spillage of product is minimised.
- Do not allow sediments to build up over long periods in areas that are known to be at risk of contamination.
- Ongoing training of Port of Bunbury staff and Port users in oil and chemical spill response and clean-up procedures.
- HAZID analysis of existing and proposed products exported or imported through the Port to ensure that adequate risk management strategies and controls are in place to prevent environmental impacts.

Key Performance Indicators

- Contaminant levels in sediment compared to previous sampling programs.
- Contaminant levels in sediment compared with reference sites.
- Suitability of sediments for unconfined ocean disposal.

5.1.5. Minimisation of impacts on the spoil ground

The Port of Bunbury will minimise the impacts of dredged material disposal on the spoil ground.

Aims

- To minimise the impacts of dredged material disposal on water quality, sediment quality and the marine communities on and adjacent to the spoil ground.

Management Measures

- Dredged material will be evenly disposed throughout the disposal ground to achieve the minimum possible dredge material depth (maximum water depth for ships draft).
- Undertake bathymetric surveys pre and post dredging to determine depth and location of dredged material deposition.
- Minimise the volume of dredged material disposed at the disposal ground (see **Section 5.1.1**).
- Undertake sampling and analysis of the material to be dredged prior to disposal and assess suitability for disposal in accordance with the National Assessment Guidelines for Dredging (NAGD) and its subsequent versions.
- Utilise best practice dredging technology for the reduction of turbid plumes.
- Ensure that turbid plumes do not impact on any future identified sensitive marine environments.

Key Performance Indicators

- Sediments disposed in disposal ground are assessed as suitable for ocean disposal under the requirements of the (NAGD) and its subsequent versions.
- Turbid plumes do not impact on any future identified sensitive marine environments.

5.1.6. Improvement to understanding of dredging and disposal impacts

The Port of Bunbury will improve the current understanding of the impacts of dredging and disposal.

Aims

- To implement a long-term monitoring program to fill the current gaps in knowledge regarding the pathways (sediment, water and biota) of Port related contaminants and to identify changes in contaminant status that could impact on the dredging and sea dumping programs.

Management Measures

- Undertake baseline surveys to fill information gaps regarding marine communities.
- Undertake sediment, water quality and biota monitoring on a regular basis.
- Undertake hydrodynamic modelling to quantify sediment deposition and remobilisation, the capacity and stability of the disposal ground and the migration of turbid plumes.

Key Performance Indicators

- Improved level of information regarding the extent, composition and condition of the marine environment within and adjacent to the Port.
- Identification of changes in sediment status that could impact on dredging and sea dumping.
- Quantification of sediment dynamics in the region, including the ability to model the movement of turbid plumes during dredging and disposal.

5.1.7. Management of potential contaminating material

The Port of Bunbury will continue its routine monitoring programs (both marine and land based) to identify any increases in material from port operations that has the potential to cause contamination and implement appropriate controls to ensure that there is no environmental harm.

Aims

- To proactively risk assess, identify, contain, and remove contaminated material from the Port in a manner that does not result in environmental harm.

Management Measures

- Undertake sediment sampling and analysis in accordance with the Sampling and Analysis Plan (see **Section 6.0**) prior to each round of maintenance dredging.
- Undertake routine land-based monitoring including soil and groundwater to identify any potential contaminants that may impact the marine environment and implement control strategies as required to prevent any of this material entering marine waters.
- Material (solid and liquid) that has the potential to impact marine environmental quality is collected during routine conveyor washdowns, road sweeping and dust collector maintenance and transported to the appropriately classified off-site landfill site.

Key Performance Indicators

- Removal of contaminated material from the Port.
- Containment or treatment of contaminated material to prevent environmental harm.

5.1.8. Review of Key Performance Indicators

The Port of Bunbury has developed an Environmental Management System (EMS) to meet ISO 14001-2015 requirements (**Appendix A**). The EMS contains the Port of Bunbury Environmental Policy which commits the Port of Bunbury to continual improvement and the prevention of pollution and putting in place a framework for setting and reviewing environmental objectives and key performance indicators including those that will form part of the LTMMP. The EMS requires periodic review of the system by the Port of Bunbury senior management including a review of the discrete programs and plans that comprise the Environmental Management Program Hierarchy.

The LTMMP will be reviewed annually and pre and post any dredging campaign by senior Port of Bunbury Officers including the Southern Ports Chief Executive Officer, the Bunbury Harbour Master and Environment Manager. External consultants will also be engaged as required to ensure sufficient technical expertise and experience is available ensure the objectives of the LTMMP are being met and that opportunities for improvement are identified.

The routine monitoring program indicated in Section 5.1.6 is established to identify any potential contamination issues and to trigger investigation as it could impact upon the sea dumping program. A significant deviation from sediment status could ultimately mean that an investigation (following the SAP based on NADG) is undertaken.

5.2. Contingencies

Dredging at the Port of Bunbury has taken place on a regular basis for several decades and to date no impacts to the planning or implementation of sampling or monitoring has taken place that required any contingencies. The weather and sea-state in Bunbury does not adversely affect field programs due to the relatively protected nature of the majority of the Port environment. In addition, the Port of Bunbury is at this time the only proponent for dredging and disposal at the Port and as such does not require contingencies for cumulative impacts by other users.

The activities of the commercial users of the Port are continually being assessed and the routine monitoring program implemented by the Port of Bunbury is aimed at detecting changes to seawater, sediment and biota quality. Changes that would impact on the ability to dredge or sea dump, would be immediately addressed and the necessary action taken to rectify the situation on a case by case basis.

6.0 Sampling and analysis plan

6.1. Introduction

The Sampling and Analysis Plan (SAP) proposes a sampling program with the objective of characterising sediments within the Bunbury area proposed for dredging and sea disposal of dredged material. As well, the SAP outlines how the possibility of environmental risk resulting from dredging and sea disposal is to be evaluated. The data quality objectives of the SAP include validating data before analysing results, following appropriate quality assurance/quality control (QA/QC) procedures and using appropriate replication.

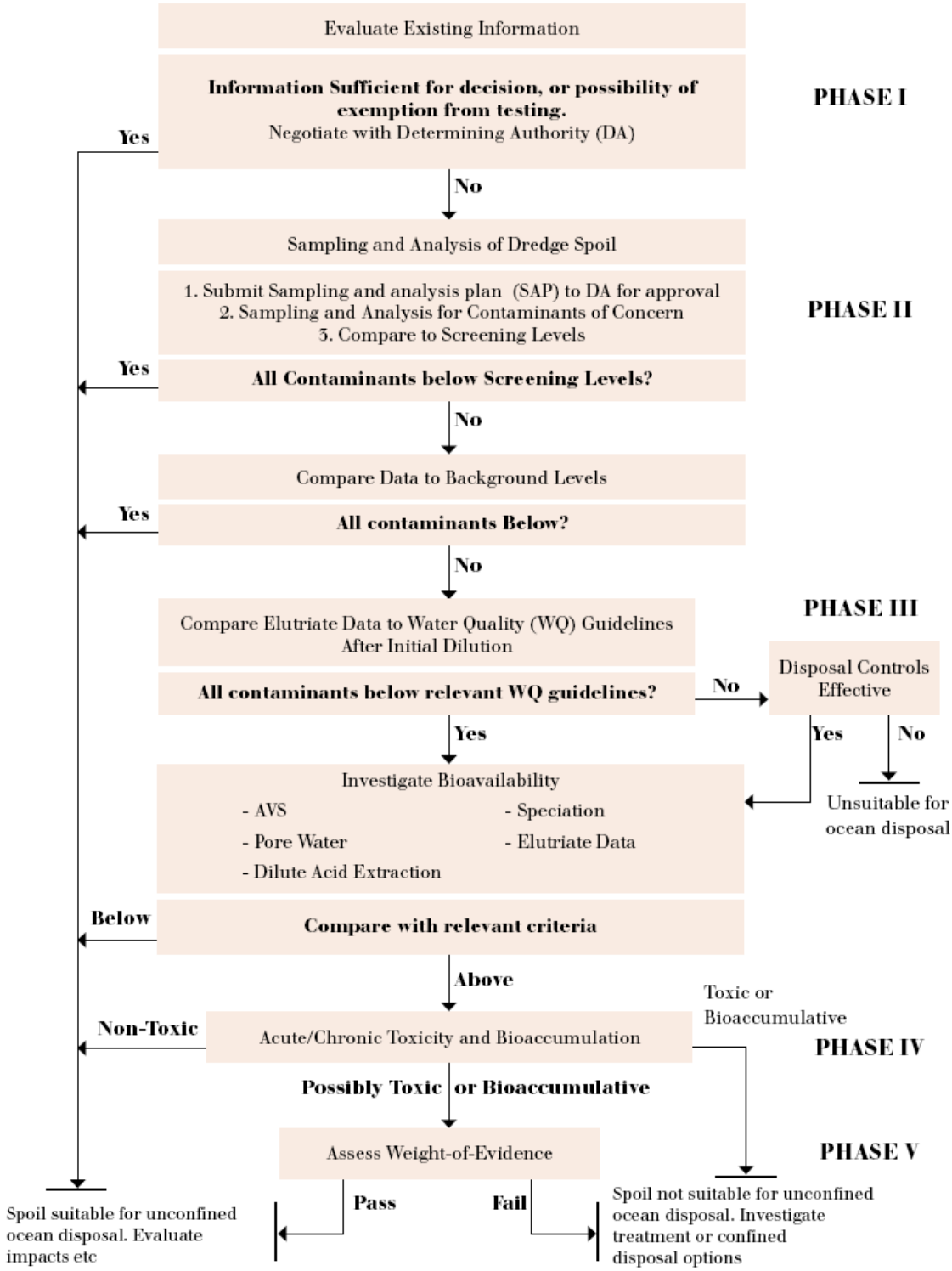
The development of this SAP has been based upon the National Assessment Guidelines for Dredging (NAGD) (CA 2009). Characterisation of the potential contaminants in material to be removed from the proposed dredge area will be made by comparing analytical results of sediments with the screening sediment contaminant levels detailed in the NAGD (CA 2009).

6.1.1. The document

The design of the sampling procedures intended to assess sediment quality, is based upon the recommendations provided in the NAGD (CA 2009). **Figure 5** illustrates the decision-tree approach for assessing sediment quality as proposed by the NAGD (CA 2009) and **Figure 6** illustrates the decision tree approach for assessing tributyltin (TBT) in dredge spoil (AWE, 2021). To ensure appropriate consideration of the decision-tree approach has been incorporated into the SAP, the following information has been included in this document:

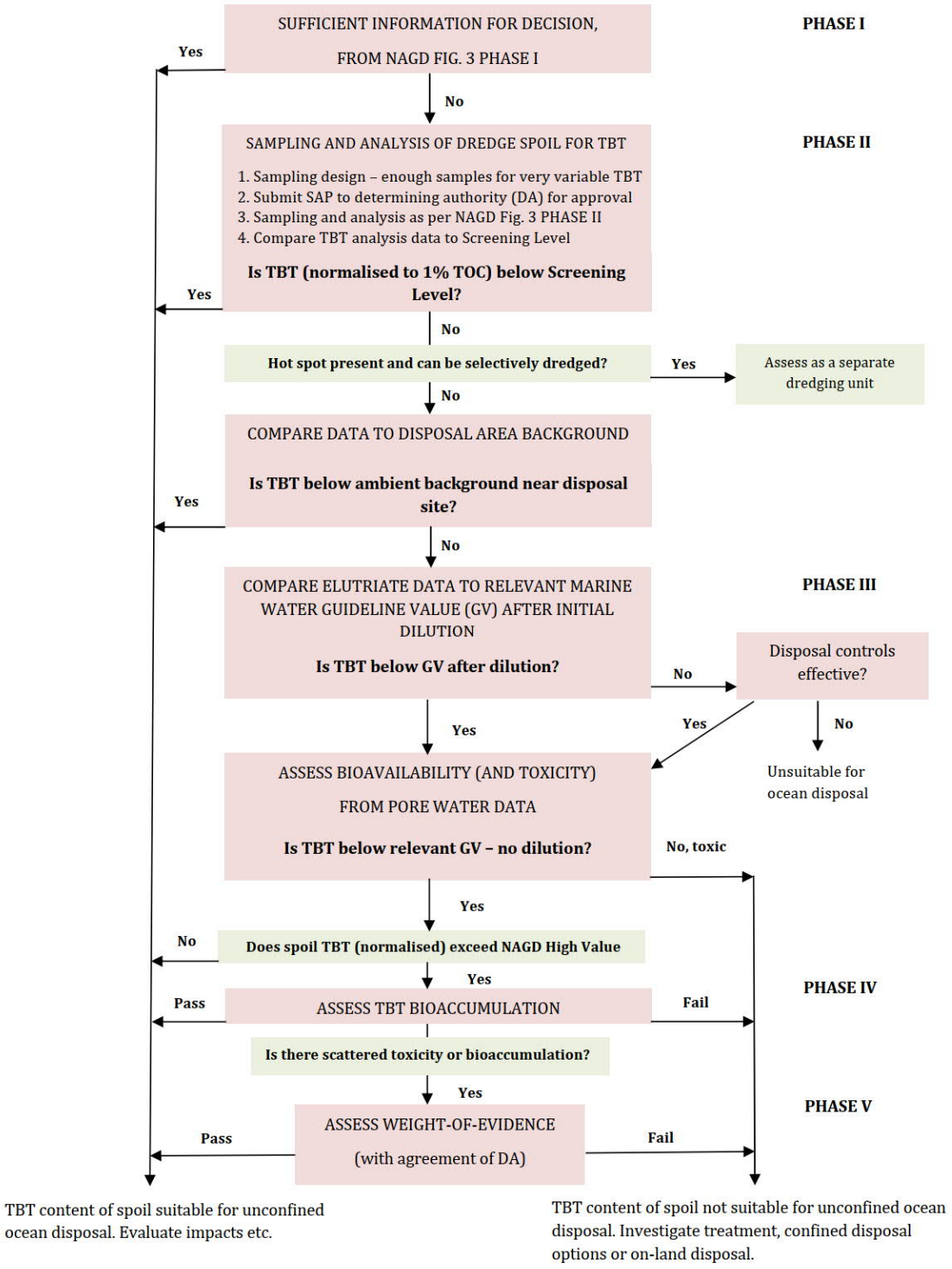
- Project background and description (**Section 6.2**).
- Environmental setting including an overview of the regional geology, habitats in the region, the proposed spoil ground, tides, currents and circulation and factors potentially affecting sediment quality or the proposed sampling programme (**Section 6.3**).
- Existing information on history of dredging and disposal, sediment quality, potential contaminants of concern and any exemptions from further testing (**Section 6.4**).
- The phase II sampling and analysis including sampling design rationale (**Section 6.5.1**), sampling protocols (**Section 6.5.4**) sampling equipment and personnel (**Section 6.5.4.2**).
- Field sampling contingency plan (**Section 6.5.4.3**).
- Health and safety precautions (**Section 6.5.4.4**).
- QA/QC procedures (**Section 6.5.4.5**).
- Sample handling, preserving, storage and transport procedures (**Section 6.5.4.6**).
- Field data requirements (**Section 6.5.4.7**)

- Laboratories to be used for analyses (**Section 6.5.4.8**).
- Data management, validation, statistical routines (**Sections 6.5.4.9, 6.5.4.10 and 6.5.4.11**).
- Additional sampling and analyses that may be required (**Section 6.6** and Section **6.7**).



- Figure 5 Sediment quality assessment process

Source: NAGD (CA 2009).



- Figure 6 TBT assessment process

Source: AWE (2021).

6.2. Project background

6.2.1. Bunbury Port

Bunbury is the major commercial and regional centre for the south west of Western Australia. Situated 175 km south of Perth on the western end of the Leschenault Estuary, Bunbury currently has a population of close to 90,000.

The port was first established in 1864 with the construction of the original wooden jetty and officially proclaimed as a Port Authority on 1 January 1909. The jetty, used for general cargo handling, was progressively lengthened as more and larger ships visited the port. Between 1896 and 1899 a breakwater extending northwards from Casuarina Point was built to protect the jetty. The primary function of the breakwater was to reduce wave action in the harbour. In addition, the breakwater intercepted the natural northerly long-shore sand drift into Koombana Bay. Jetty extensions continued in 1900, 1902, 1906, 1910, 1921 and 1952 whilst the breakwater was extended in a north-easterly direction in 1906, 1916, 1933, 1948, 1951 and finally 1961 (PWD 1978). A major reason for these extensions was to reduce sedimentation in the berthing area.

A spur groyne near the breakwater abutment, on the ocean side (the western spur) was commenced in 1948 and later extended in 1961. This spur, although very effective in trapping littoral sand, was soon saturated. A further spur groyne (the eastern spur) was constructed in 1949 by extending the original main breakwater in a north-easterly direction (PWD 1978).

In 1951 the natural outlet for Leschenault Inlet to the ocean at Point MacLeod was closed to eliminate the accumulation of river silt in the old port area. At the same time, a connection to the ocean was cut through the sand dunes opposite the mouth of the Collie River (The Cut).

In 1968–69, the Preston River downstream of the Australind Road Bridge was realigned to allow for the construction of the Inner Harbour. Work on the Inner Harbour commenced in 1971, cutting off the southernmost part of the Leschenault Estuary. On completion of the Inner Harbour in 1976, a channel was cut at Point MacLeod (The Plug) to allow water circulation to this small body of water and allow the passage of boats to and from Koombana Bay. These modifications have resulted in the renaming of the water bodies; the smaller water body at Point MacLeod is now known as the Leschenault Inlet and the main water body to the north is known as the Leschenault Estuary.

The Port of Bunbury became the region’s main export channel and saw the closure of the Busselton Port in 1972. Today Bunbury is one of the State’s major exporting ports, handling total throughput of more than 16.82 million tonnes in 2020/21, an increase of 20% over that of 2010/11.

6.2.2. Project description

The Bunbury Port Authority (BPA) has routinely dredged the Inner and Outer Harbours and the Approach Channel to remove accumulated material. This material has historically been derived from silt discharged from the Leschenault Estuary via the Cut, wrack (dead seagrass and seaweed) deposited by winter storms from the north-west and marine sand transported northwards by inshore littoral drift.

The material being discharged from the Cut appears to be relatively constant with most the material being carried northwards away from the Port. However, during the winter period, sediment flow from the Cut can be pushed southwards towards the Approach Channel by north westerly winds ahead of approaching cold fronts. The silt laden turbid plume from the discharge through the Cut can extend some number of kilometres out to sea. Also, material deposited during winter storms, primarily from offshore reefs, is a constant source of infilling for the outer region of the Approach Channel. The Port of Bunbury have been removing the wrack using a fishing trawler and using it on farmlands as a soil improver/fertiliser. The process has markedly reduced the build-up of organic material in the Approach Channel and subsequently its potential to trap sediment is reduced.

The most recent maintenance dredging program took place during 2021 with approximately 81,000 m^3 of material being disposed to the existing offshore Spoil Ground. From 2010 there has been a reduction in maintenance dredge spoil volume disposed to the existing spoil ground, this is due to an improvement in the efficiency of dredging methods (see **Table 7**)

The sand inundation of the Port, particularly at the Outer Harbour appears to be as a result of coastal process transporting sand around Point McKenna due to the traps created by groynes being full and thus being bypassed. At present there appears to be no solution to this other than to regularly remove the sand from the Outer Harbour by dredging and transporting it to the spoil ground.

The Port has very little area suitable for land disposal and storage of dredge material and there is no local market for the material as fill thus sea dumping is the only viable option in the foreseeable future.

A long-term sea dumping permit allows the Port of Bunbury to have a more flexible dredging and disposal program in place to accommodate the seasonally variable need for dredging of the Outer Harbour and Approach Channel. The long-term permit also provides flexibility to utilise available dredges more cost effectively. The more effective and regular maintenance dredging of the Outer Harbour and Approach Channel facilitated by a long-term sea dumping permit significantly reduces the need for dredging of the Inner Harbour by removing material that could be transported in there

by currents and shipping movements. Any minor sediment accumulation in the Inner Harbour can be easily managed in the short term by bed levelling using a sweep bar. This also has the added advantage of retaining the most contaminated material (historically TBT and most recently copper) within the Inner Harbour rather than having to bury it on the Spoil Ground. Should the requirements for dredging of the Inner Harbour change in the future, a revised SAP will be prepared and submitted for a specific sea dumping permit to accommodate the change.

6.3. Environmental setting

6.3.1. Existing environment

A benthic habitat survey of the Bunbury area was conducted by Wave solutions in July 2011 (Wave solutions, 2012). In addition, a significant amount of seabed survey work has been undertaken over the past three decades associated with spoil ground site selection, monitoring programs and dredging investigations. The benthic habitat in the region can be described as follows:

- **Port Area:** The area bounded by a line between McKenna Point at the tip of the Outer Harbour and Point Hamila at the entrance to the Inner Harbour is dominated by sand with low biotic cover (<2%) made up of trace amounts of foliose and turf algae. No seagrass was observed.
- **Spoil Ground:** There is a lack of discrete substrata at the Spoil Ground with ROV surveys confirming that sand was the only substrata occurring in the location. Percentage cover of biota occurring on sand at the Spoil Ground was low (12.2% ± 5.2% SE) with biotic groups including *Amphibolis griffithii* (percentage cover = 6.7% ± 1.5% SE), *Posidonia angustifolia* (percent cover = 4.0% ± 1.4%) and turf algae (percentage cover = 0.13% ± 0.13%).
- **Nearshore Area (north):** The seabed in less than 10 m of water between Point Hamila and Binningup to the north is a wide expanse of predominantly sandy rubble with numerous low relief limestone reefs and small patches of sparse *Posidonia* sp. seagrasses. Macroalgae on the northern nearshore reef complex consisted of foliose (medium density of 20–50% coverage) and turf algae (up to 50% coverage). Sponges were the major group of filter feeders although they generally occurred in low densities (<2.5%), the highest (2.5–10%) being on the nearshore reef systems just north of “The Cut”.
- **Nearshore Area (south):** The seabed in less than 10 m of water between Point McKenna and Rocky Point to the south is a narrow strip of predominantly sandy rubble with numerous small low relief limestone reefs and small patches of sparse *Posidonia* sp. seagrasses. Macroalgae on the southern nearshore reef complex consisted of foliose (low density of 10–25% coverage) and turf algae (up to 50% coverage). Sponges were the major group of filter feeders although they generally occurred in low densities (<2.5%).

- **Offshore Area:** The area offshore of the Port and surrounding coastline between a depth of 10–20 m is predominantly sandy substrate with seagrass meadows interspersed with low to medium relief limestone reefs and patches of pavement colonised by macroalgae.

6.3.2. Site condition

The material is likely to have originated from a combination of wrack carried to the area from seagrass meadows and reefs to the north by winter storms and from sediment carried around McKenna Point by the predominant northwards flowing longshore currents. This process gradually leads to the infill of the Approach Channel and Outer Harbour areas and, to a much lesser extent, the Inner Harbour.

6.3.3. Spoil ground

The site selection for the existing spoil ground was not based on environmental considerations. At the time there were no environmental guidelines for spoil disposal. The main considerations were ensuring the material would not pose a hazard to shipping and that it would not re-enter the harbours and channels again. As such the location of the spoil ground to the north, given the predominately northwards current, was suitable. In addition, the Department of Marine and Harbours in 1988 made the following statement when a spoil ground further offshore was proposed (DM&H 1988):

> *"This material should be placed in a position offshore from Leschenault Peninsular from where it may rejoin the coastal process system. The selection of the dumping grounds at about the 10 metre contour ensures that the rate at which the material rejoins the system is acceptable. Dumping sites to the west of Bunbury breakwater in deeper water would not be acceptable in this regard. Dumping at the preferred site during the periods 1976/77, 1979, 1982 and 1985 has been to the satisfaction of the Environmental Protection Authority."*

The key driver at the time of the establishment of the existing spoil ground was beach renourishment to stabilise the Leschenault Peninsula due to the effect the Port was having on northerly littoral drift of sediment. While the spoil ground location was deemed to be environmentally acceptable at the time it was established and this continues to be the case, the criteria for this decision is unclear as the Environmental Protection Act of 1981 and the Environmental Protection (Sea Dumping) Act of 1981 were not then enacted. However, the other criteria for choosing this location are very robust in that the location was such that the deposited material would not pose a hazard to shipping and that it would not re-enter the harbour or Approach Channel due to the predominant northwards flowing current.

The location of the existing spoil ground is shown in **Figure 7**. The bounding coordinates for the existing spoil ground are:

NW corner	33° 15.70’ South	115° 39.25’ East
NE corner	33° 15.70’ South	115° 39.65’ East
SE corner	33° 16.80’ South	115° 39.65’ East
SW corner	33° 16.80’ South	115° 39.25’ East

Datum is GDA94

6.3.4. Environmental factors

Numerous environmental factors have been identified that may potentially affect contamination of the surficial sediments (e.g. currents, bathymetry, particle size etc.) or may limit/hinder the implementation of the proposed sampling program (depths, tidal movements, currents, waves, weather, shipping movements etc.).

6.3.4.1 Factors affecting contamination of surficial sediments

Prior to the obtaining the current 10 year dredging permit, contamination primarily consisted of the antifouling compound tributyltin (TBT) and its presence in surficial sediments, predominantly within the Inner Harbour, however in the last five years TBT concentrations at all monitoring sites have been below the NAGD Screening Levels. Loading of copper sulfide concentrate at Inner Harbour Berth 8 from 2011 has resulted in contamination of sediments in the Inner Harbour. Both TBT and copper contamination are directly related to the location of ship berths as dispersal is limited in the Port of Bunbury. The Inner Harbour is excluded from this Long Term Sea Dumping application.

6.3.4.2 Factors affecting the implementation of the SAP

The implementation of the SAP will not be affected by any environmental or anthropogenic factors based on previous SAP programs.

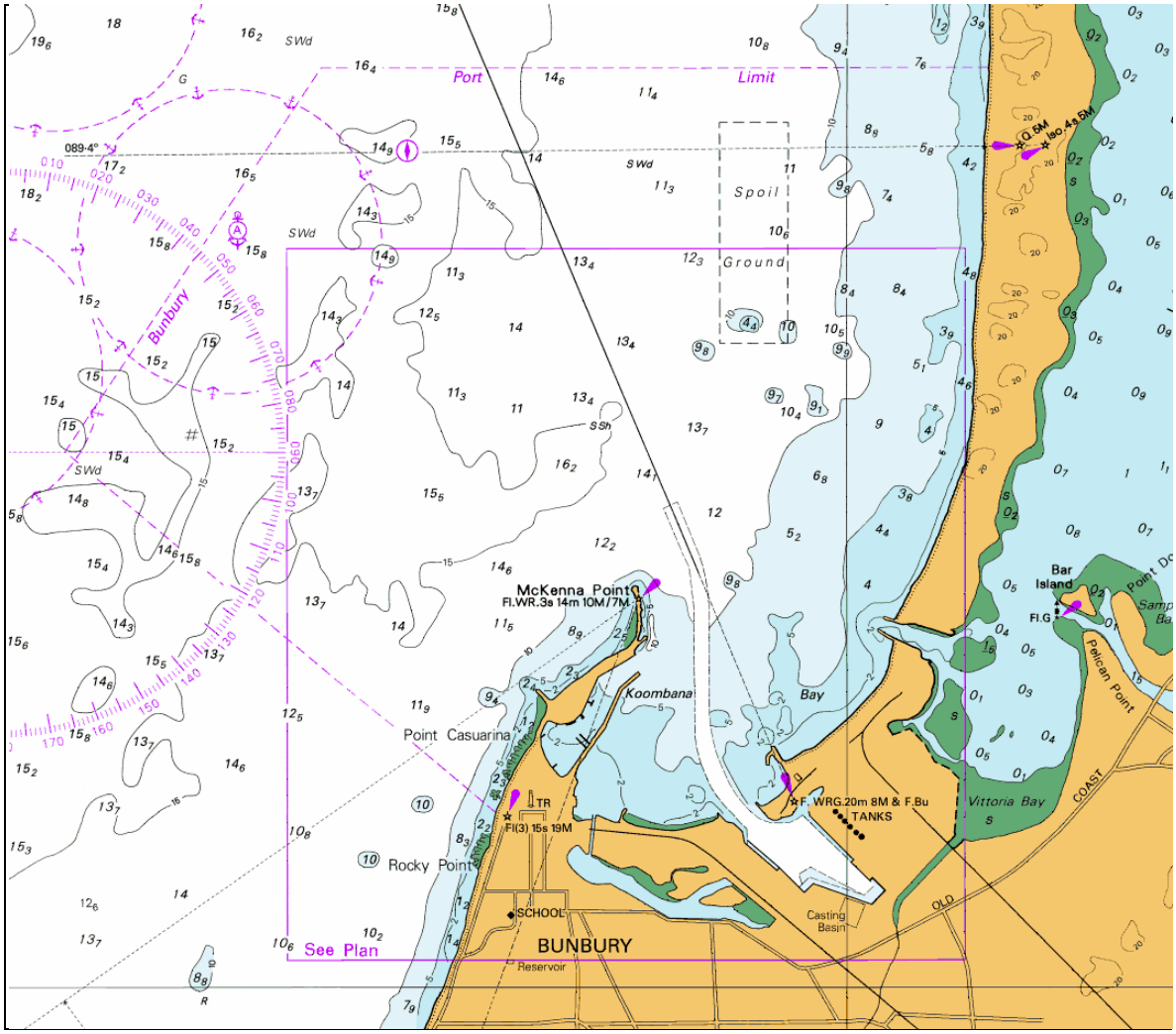


Figure 7 Location of existing spoil ground

6.4. Existing information

6.4.1. Previous maintenance dredging programs

Since completion of all breakwater and spur groyne extensions in 1961 and the construction of Berths 1 and 2, the Port of Bunbury has continued to be engaged in a relatively continuous maintenance dredging program. Over the years maintenance dredging programs have involved Public Works Department dredges, private dredging contractors and grab dredging from the face of the wharves (PWD 1978).

To date there have been thirty maintenance dredging programs that resulted in sea dumping. Sea dumping permits were issued for maintenance dredging programs between 1988 and 2022 (which

includes the current 10 year permit incorporating 18 January 2012 to 17 January 2022); however, prior to this date it appears that the process was administered by the Public Works Department and subsequently the Department of Marine & Harbours (now the Department of Transport) in consultation with the WA Environmental Protection Authority. Details of each of the maintenance dredging programs are provided in **Table 7**.

Since 1965, at least 9,718,717 m^3 (9.7 million cubic metres) of spoil has been disposed of to the spoil grounds. This material has been dredged primarily from the Approach Channel and Outer Harbour whilst a small quantity has been removed from the Inner Harbour (although nothing from the Inner Harbour has been disposed to the spoil ground in the last 10 years). The spoil has comprised fine silts, sands and some rocky rubble.

6.4.2. Requirement for future dredging

Historically the volume of material requiring dredging, principally from the Outer Harbour and Approach Channel, has been in the order of 200,000–300,000 m^3 per year but undertaken triennially. There was an increase in dredge material during 2008 with approximately 1,040,250 m^3 of material being disposed to the existing offshore Spoil Ground. This was a significant increase in volume over previous dredging programs and resulted in emergency dredging events and variations to the sea dumping permit at the time, to maintain the Port's declared depths.

The variation in sand inundation of the Port appears to be as a result of year on year changes in coastal process transporting sand around Point McKenna due to the traps created by groynes being full and thus being bypassed. At present there appears to be no solution to this other than to regularly remove the sand from the Outer Harbour by dredging and transporting it to the spoil ground.

As of 2010 there has been a reduction in maintenance dredge spoil volume disposed to the existing spoil ground (average of 180,000 m^3 per year, undertaken biennially), this is considered to be due to an improvement in the efficiency of dredging methods including more targeted wrack removal in the Approach Channel. Unless there is a marked change in coastal processes, this is considered to be the average volume required for future maintenance dredging.

Table 7 Historical maintenance dredging programs

Year	Disposal Location	Volume (m^3)
1965–66	Reclamation	Unknown
1966–67	Reclamation	~70,000
1967–68	Southern spoil grounds	Unknown
1969–70	Southern spoil grounds	Unknown
1971–72	Southern spoil grounds	~76,630
1973–74	Southern spoil grounds	320,000
1974–75	Southern spoil grounds	~6,200
1975–76	Southern spoil grounds	Unknown
1976–77	Eastern section of Existing spoil ground	~17,000
1977	Pumped to ocean side of breakwater	~19,000
1979	Eastern section of Existing spoil ground	Unknown
1982	Eastern section of Existing spoil ground	~300,000
1985	Eastern section of Existing spoil ground	~140,000
1988-89	Eastern section of Existing spoil ground	~1,650,000
1990	Eastern section of Existing spoil ground	627,000
1992	Existing spoil ground	~900,000
1994	Existing spoil ground	416,518
1997	Existing spoil ground	656,000
2001	Existing spoil ground	665,500
2004	Existing spoil ground	506,354
2007	Existing spoil ground	603,123
2008	Existing spoil ground	1,040,250
2010	Existing spoil ground	165,160
2011	Existing spoil ground	37,000
2012	Existing spoil ground	175,090
2013	Existing spoil ground	74,745
2014	Existing spoil ground	0 (no dredge available)
2015	Existing spoil ground	205,000
2016	Existing spoil ground	0 (delayed to 2017)
2017	Existing spoil ground	122,191
2018	Existing spoil ground	400,440
2019	Existing spoil ground	152,767
2020	Existing spoil ground	291,749
2021	Existing spoil ground	81,000 (March/April)

6.4.3. Existing sediment quality information

Numerous sediment quality surveys have been undertaken as part of sea dumping applications. These surveys have involved the preparation of a Sampling and Analysis Plan (SAP) which was

subsequently approved for use by the Department of the Environment, Water Heritage and the Arts (DEWHA) or its predecessors and then implemented. The following indicates the dates of various analyses:

- Sediment assessment of full suite of prescribed contaminants 1995
- Sediment assessment of radionuclides in 1999, 2016, 2021
- Sediment assessment of metals in 1995, 1999, 2001, 2003, 2006, 2008, 2010, 2011, 2012, 2013, 2015, 2016, 2019, 2021
- Sediment assessment of TBT in 1995, 1999, 2001, 2003, 2006, 2016, 2019, 2021
- Organochlorines (OCs), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) assessment in 1995, 2003 and total petroleum hydrocarbons (TPHs) and PAHs in 2010, 2016, 2021.

The results were then reported in the sea dumping applications.

The action of dredging and disposal makes historical data of little relevance as the material that was tested has been removed from the Port and placed on the Spoil Ground.

In addition, the Port of Bunbury has implemented a routine monitoring program for sediment, seawater and biota with surveys having been completed to date and another planned for late November 2022. The sediment results of these surveys indicate the following (see **Figure 8** for the locations of the various areas):

- Arsenic levels were above the ANZG (2018) default guideline value and NAGD screening level of 20 mg/kg outside the Harbour indicating a natural occurrence of this metal at levels above generally recognised levels.
- Arsenic concentrations have been above the ANZG (2018) DGV in the sediments nearest the entrance of the Inner Harbour in the past indicating elevated levels from outside the Harbour have distributed into the Harbour, possibly by tides, waves or shipping movements. However, during the last two surveys, arsenic has been below the DGV at all monitoring sites in the Outer Harbour, Area B and Entrance Channel.
- Elevated levels of copper adjacent to Berth 8 in the Inner Harbour are indicative of a spill event that occurred during the loading of copper concentrate after the baseline survey. During the most recent survey the 95%UCL for total copper in the Inner Harbour (78 mg/kg) was above the ANZG (2018) DGV of 65 mg/kg, similar to the last four sampling occasions. Copper at all monitoring sites in the Outer Harbour, Area B and Approach Channel are below DGV.

6.4.4. Contaminants of potential concern

Contaminants of potential concern are defined in the NAGD as:

> *"COPC are those contaminants that exceed the background concentrations and the Screening Level (or elevated concentrations of contaminants for which guidelines do not exist). For COPCs, no immediate action may be required."*

For the three surveys conducted in the Bunbury Outer Harbour in the last five years (Sept 2016, February 2019 and March 2021) contaminants found to be above the NAGD Screening Level or ANZG (2018) DGV are as follows (see **Figure 10** for site locations):

- Metals and metalloids: All metals and metalloids were below NAGD screening levels except for arsenic, aluminium, and cobalt. Arsenic was above the screening level of 20 mg/kg at sites OH1 (25 mg/kg) and OH2 (25 mg/kg) in the Outer Harbour, and C3 (32 mg/kg; corresponding to C06 in Figure 6) in the Approach Channel during the 2016 survey. At all other sites and subsequent surveys, arsenic concentrations were below the screening level. Arsenic also exceeded the screening level at the reference sites during all three surveys. Arsenic is commonly found in Western Australian sediments at levels close to or just above screening levels. Aluminium and cobalt currently do not have ANZG (2018) sediment guideline values. The mean aluminium and cobalt concentrations of the Outer Harbour and Approach Channel were higher than those of the 80th percentile of the reference sites.
- Organics – Tributyltin, polycyclic aromatic hydrocarbons, total petroleum hydrocarbons were below screening levels at all sites and surveys.

There are no contaminants of potential concern recorded for the Outer Harbour or Approach Channel in previous sediment surveys at the Port of Bunbury.

6.4.5. Contaminants of concern

Contaminants of concern are defined in the NAGD as:

> *"COC are those contaminants which exceed the background concentrations and the Screening Level and for which the bioavailability, bioaccumulation or toxicity assessments indicate that significant effects from the contaminants are likely. For COCs, definite action is required."*

There were no contaminants of concern recorded for the Outer Harbour or Channel in previous sediment surveys at the Port of Bunbury.

6.4.6. Currency of data

Data currency is defined in the NAGD as follows:

"Currency of Data Existing chemical or toxicity data for the sediments of the area to be dredged will have a maximum currency of five years, where there is no reason to believe that the contamination status has changed significantly, after which new data would need to be gathered. New data will be required where contamination of the site is likely to have increased or new pollution sources are present (such as a new industry or accidental spills). Information and data older than 5 years may be useful in some parts of an assessment to demonstrate trends over time."

Data currency for the assessment of contaminants of concern is provided below:

- Sediment assessment of radionuclides in 2016, 2021
- Sediment assessment of metals/metalloids in 2016, 2019, 2021
- Sediment assessment of TBT in 2016, 2019, 2021
- Polycyclic Aromatic Hydrocarbons (PAHs) and total petroleum hydrocarbons (TPHs) 2016, 2021.

6.4.7. Sufficiency of data

Existing data on contaminants of concern could be considered sufficient for the renewal of a dredging and disposal application; however, the intention of this SAP is to facilitate a long-term sea dumping application and, as such, the data would not have a currency sufficient for that purpose.

6.4.8. Exemption from further testing

Exemption from further testing is subject to the approval of the Determining Authority. The NAGD states:

"If the proponent believes further testing is not warranted, based on the evaluation of existing information, they should contact the Determining Authority prior to submitting a permit application to seek exemption from further testing (Section 4.2.1)."

Exemption for further testing is relevant to several principal groups of contaminants listed in Table 1 of the NAGD. These include the following:

- Radionuclides: Radionuclides have been tested on a number of occasions the most recent being 2016 and 2021 which showed that all sites sampled were much lower (<2 Bq/g) than the NAGD screening level (35 Bq/g) and the Outer Harbour sites were similar to background concentrations. Radionuclides are not imported or exported at the Port and bulk materials, including mineral sands, do not contain radionuclides.
- PCBs and OC pesticides: Polychlorinated biphenyls and organochlorine pesticide levels in the sediments in the area to be dredged have twice before been tested and been found to be below

detection. These contaminants are not imported or exported at the Port and bulk materials do not contain them. In addition, the catchment for the Port does not include riverine discharge thus agricultural runoff is not a potential source. Equally, there is no industry adjacent to the Port that could contribute PCBs or OC pesticides.

6.4.9. Contaminants list

The NAGD defines the contaminants list as:

"This is the list of contaminants which could be present at elevated levels in the sediments of the dredge area, and therefore require analysis. The list includes those chemical substances for which sources are known or suspected in the dredge area or its catchment, based on the historical survey. Where good chemical data are available on the sediments, the list includes those toxic substances known, from previous investigations, to occur at levels greater than background concentrations or one tenth of the Screening Levels when the background data is below detection or, for substances which do not have Screening Levels, present at elevated levels."

The list of contaminants to be investigated in this SAP is as follows:

- Metals: Sb, Al, As, Cd, Cr, Co, Cu, Pb, Mn Hg, Ni, Se, Ag, V, Zn
- Tributyltin (TBT)
- Total Polycyclic Aromatic Hydrocarbons (PAHs)
- Total Petroleum Hydrocarbons (TPHs)

6.5. Phase II – Sampling and analysis

This section provides details of the assessment of sediment quality relative to Phase II of the NAGD (CA 2009) assessment process (**Figure 5** and **Figure 6**). While it is expected that characteristics of the surficial sediments to be assessed in the SAP will be similar in nature to the other sediments recently dredged in this area, there is some uncertainty about the presence of any contaminants of concern within these sediments. Therefore, the proponent proposes to adequately characterise the physical properties and contaminant status of the surficial sediments to be dredged.

6.5.1. Sampling design rationale

Anthropogenic contamination of surficial sediments in the proposed study area is generally accepted to occur in the upper mobile sediment layers. As a maintenance dredging project, the full depth of potentially contaminated material within the proposed dredge footprint will be sampled (i.e. to the declared depth in each dredge area).

Sampling will be carried out either by grab sampling or by divers using hand cores, in accordance with occupational diving operations standards as described in AS/NZ 2299.1 (2015). The implementation of the SAP in 2010 undertook a side by side comparison of grab sampling and diver cores and found the results to be statistically similar.

The NAGD requires that the material to be dredged be classification as follows (Appendix D):

> *"Each site should be classified as either 'probably contaminated', 'suspect' or 'probably clean'. Where good quality, current data for the site is already available to support this classification, the number of sample locations in the 'probably contaminated' and 'probably clean' categories may be halved. Note that a site so classified can be made up of a number of discontinuous areas. For example, if a number of discrete berth pockets are classified as 'probably contaminated', they can be considered as one site for the purpose of sampling, with the proviso that a minimum of two sampling locations would be required from each area making up the overall site."*

The material to be dredged has been classified as follows based on previous sediment quality data less than five years old and the history of anthropogenic contamination at the site (see **Section 6.4.3** and **Figure 8** for dredge area locations):

- Area B – is classified as 'probably clean'
- Outer Harbour – is classified as 'probably contaminated'
- Approach Channel – is classified as 'probably contaminated'

6.5.2. Sampling design

The sampling procedures described below have been selected on the basis of recommendations made in the NAGD (CA 2009). Specifically, the following information provided in the opening paragraph of Appendix D Sampling Methods (pg. 53) provides valuable guidance to preparation of this proposal:

> *"For maintenance dredging, where the full depth of sediment could be contaminated, material must be sampled throughout. For capital dredging, samples are needed from the full depth of contaminated as well as potentially contaminated sediment. Full depth is taken to mean at least the top 1 metre of sediment, and more if contamination could be found deeper. It is not normally necessary to sample (for chemical analysis) consolidated natural geological materials underlying these surface sediments, although physical testing of such consolidated materials would still be required to assess turbidity movement and behaviours of the dredged material, post-disposal."*

- Figure 8 Three areas proposed for dredging

- Dredge Area 1 is the Sand Trap Area
- Dredge Area 2 is the Outer Harbour
- Dredge Area 3 is the Approach Channel

The consolidated material below the declared dredge depth is basalt which cannot be sampled and is unlikely to contain anthropogenic contamination. As such, focus has been given to the evaluation of contaminants of concern in surficial, unconsolidated materials within the proposed dredging footprint, as this is considered to be the portion of sediment within the dredge volume to have the highest risk of contamination. The approach proposed below in evaluating the potential environmental risk of dredging and disposing of the sediments includes the stepwise assessment approach recommended by the NAGD (CA 2009): phase I evaluate existing information; phase II sample and analysis of dredge spoil; phase III investigate bioavailability and elutriate data; and

phase IV toxicity and bioaccumulation (**Figure 5** and **Figure 6**). Detail of how this approach will be adopted in this SAP is detailed in the sections below.

6.5.2.1 Number of sampling locations

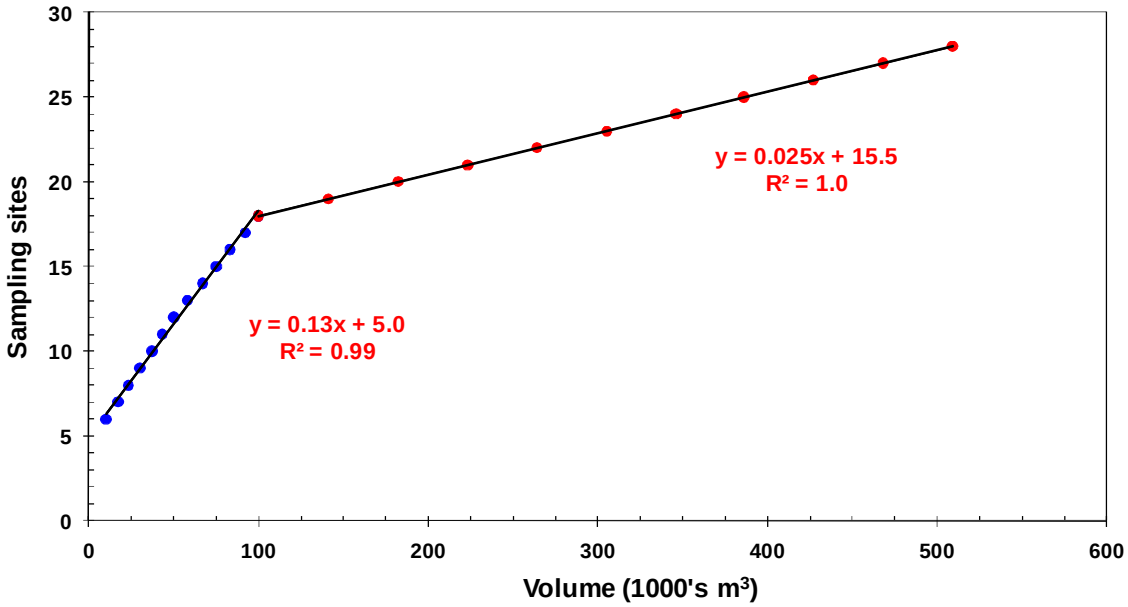
The number of sampling sites for characterisation of potentially contaminated material was based on the volume of material to be dredged as recommended in the NAGD (Appendix D) (CA 2009). The volume was determined from hydrographic surveys (**Table 8**).

Based on the sampling rationale presented in **Section 6.5.1**, sediment core samples for analytical testing against the NAGD (CA 2009) screening levels will be collected to corer refusal which is anticipated to be less than one metre based on hydrographic survey data.

- Table 8 Dredge material volume and required number of sample sites

Dredge Area	Volume (m^3)	Depth of Potentially Contaminate Material (m)	Sampling Sites	
			NAGD [1]	Proposed
1 (Sand Trap)	175,000	1.0	10	10
2 (Outer Harbour)	180,000	0.5	10	10
3 (Approach Channel)	345,000	0.5	12	12
Total	**700,000**		**32**	**32**

1 Number represents the minimum requirement as per the NAGD (CA 2009) and **Figure 9** below.



- Figure 9 Phase II sample numbers required per volume of surface material

Given the expected homogeneity of the sediments due to mixing and knowledge gained from previous sediment sampling in the study area, a random sampling pattern was used to locate sampling sites within the three dredging areas. The selection of sampling locations was undertaken by laying a grid over the two areas within the proposed dredge footprint, with at least five times as many cells as samples to be collected (CA 2009), and the numbered cells for placement of a sampling location were chosen using random number generation.

Sampling locations and coordinates are provided diagrammatically in **Figure 10** and **Figure 11** and in tabular form in **Table 11** and **Table 12**. Further information on the proposed analytical tests and approach to QA/QC is given in **Section 6.5.4**. It should be noted that sampling location IDs will correspond to that of the individual sample ID.

In addition to the sampling of the areas to be dredged, sampling will occur at the spoil ground and at reference sites distant from anthropogenic contamination as a prediction of background levels (ambient baseline concentrations).

- Table 9 Required sampling locations at the spoil ground and reference sites

Location	Sampling Sites	
	NAGD [1]	Proposed
Spoil Ground	7	7
Reference Site 1	4	4
Reference Site 2	3	3
Total	**14**	**14**

1 The number represents the minimum requirement as per the NAGD (CA 2009).

* The two reference sites that have been monitored in the past will be considered as one as they are close together in the same general area.

6.5.2.2 Number of samples

Each core obtained will be split into 0.5 m depth increments, and each depth increment will be sampled separately. If only 0.5 m total sediment depth is obtained due to shallow refusal which is anticipated in the Outer Harbour and Approach Channel sites based on previous programs, only one sample will be collected. However, where 0.7 m is recovered, then two samples will be obtained, one sample at 0.0 to 0.5 m and one at 0.5 to 0.7 m.

The expected maximum number of primary samples to be collected from the 32 sampling locations and two depth increments within Areas 1 through 3 of the dredge footprint will be 64 (see **Table 10**). Note that this number will vary depending on the depth of corer refusal.

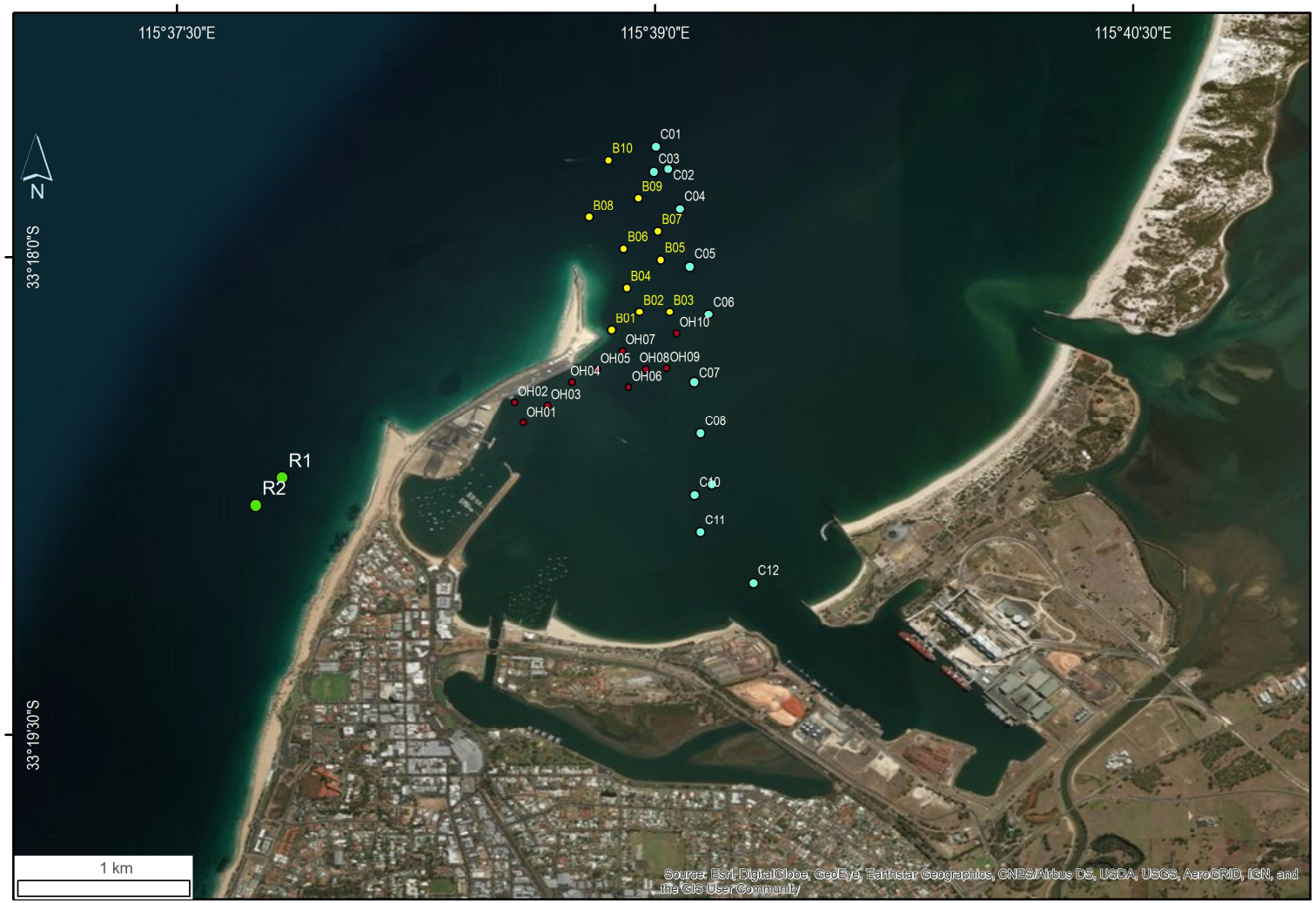
- Table 10 Sample numbers for sediment chemistry

Area	Sample sites[1]	Sample numbers[2]	Sub-total
1 (Sand Trap)	10	20	20
2 (Outer Harbour)	10	20	20
3 (Approach Channel)	12	24	24
Reference Sites	7	7	7
Spoil Ground	7	7	7
QA/QC[3]	4 triplicates, 3 splits, 1 field blank, 1 transport blank		24
		Total	**102**

1) Sample sites based on hydrographic survey predictions of volumes to be dredged (see NAGD Appendix D).

2) The sample numbers anticipate being able to sample to 100 cm; however, if cores to a greater depth can be achieved then the number of samples will exceed this number. Equally if core refusal is reached at 50 cm the number of samples will be a lesser value.

3) Field triplicates (10% of sites rounded up require triplicates i.e. two more samples) and field splits (5% of sites rounded up require splitting i.e. one more sample) (see NAGD Appendix F).



- Figure 10 Sampling site locations within each dredge area and at the reference sites

- Figure 11 Sampling site locations within the spoil ground

- Table 11 Sampling site coordinates for the spoil ground and reference sites

Sampling Location Id	Easting	Northing
SG-1	374770	6318750
SG-2	375150	6318750
SG-3	374959	6317950
SG-4	374770	6317000
SG-5	375150	6317000
SG-6	374968	6317413
SG-7	374968	6318377
R1	372514	6313340
R2	372388	6313179

Datum GDA94, Projection MGA94 Zone 50H

- Table 12 Sampling site coordinates and QA/QC requirements

Sampling Location Id	QA/QC	Easting	Northing
B01		374106	6314215
B02		374240	6314323
B03		374387	6314325
B04		374177	6314462
B05	T	374340	6314626
B06		374158	6314687
B07		374323	6314790
B08		373988	6314869
B09	S	374225	6314983
B10		374078	6315199
C01		374307	6315280
C02		374370	6315152
C03	T	374300	6315137
C04		374429	6314923
C05		374482	6314589
C06		374577	6314312
C07	T	374512	6313920
C08		374546	6313622
C09		374605	6313329
C10	S	374523	6313266
C11		374554	6313048
C12		374815	6312758
OH01		373683	6313672
OH02		373640	6313792
OH03		373800	6313776
OH04	T	373917	6313912
OH05		374039	6313986
OH06		374193	6313886
OH07		374160	6314095
OH08	Sx	374275	6313992
OH09		374376	6313999
OH10		374422	6314200
FB		N/A	N/A
TB		N/A	N/A

Datum GDA94, Projection MGA94 Zone 50H
S = Split QA/QC sample (see **Section 6.5.4.5**).
Sx = Triplicate QA/QC split for inter-laboratory comparison (see **Section 6.5.4.5**).
T = Triplicate QA/QC sample (see **Section 6.5.4.5**).
FB – Field blank, 1 per survey.
TB – Transport blank, 1 per survey.

6.5.3. Analytical parameters

To adequately characterise the physical properties and contaminant status of the surficial sediments to be dredged several parameters will be analysed, as described below.

6.5.3.1 Physical properties

The particle size distribution of sediment will be measured using laser diffraction. Moisture content of the sediment will be determined gravimetrically by measuring the mass of water lost following drying at 110ºC over a 12 hour period.

6.5.3.2 Sediment chemistry

Table 13 lists the parameters that will be investigated in sediments collected from the proposed locations in the study area, as well as the NAGD (CA 2009) screening levels and Practical Quantitation Limits (PQL) against which sediment quality data will be evaluated. The analytical parameters have been selected as there are potential input sources to sediments from the Harbour or surrounding catchment, or these parameters have been previously recorded at concentrations of greater than one tenth of the relative NAGD (CA 2009) screening level in the vicinity of the proposed dredge footprint. No contaminants of potential concern through the review of existing information have been identified (**Section 6.4**).

- Table 13 Parameters to be sampled and relevant PQLs and screening levels

Parameter	Units	PQL		Screening Level
		NAGD	Laboratory	
Moisture content	%	0.1	0.1	—
PSD	%	—	0.01	—
Antimony (Sb)	mg/kg	0.5	0.2	2.0
Aluminium (Al)	mg/kg	200	5	—
Arsenic (As)	mg/kg	1	0.1	20
Cadmium (Cd)	mg/kg	0.1	0.02	1.5
Chromium (Cr)	mg/kg	1	0.2	80
Cobalt (Co)	mg/kg	0.5	0.1	—
Copper (Cu)	mg/kg	1.0	0.2	65
Lead (Pb)	mg/kg	1.0	0.1	50
Manganese (Mn)	mg/kg	10	0.2	—
Mercury (Hg)	mg/kg	0.01	0.01	0.15
Nickel (Ni)	mg/kg	1	0.2	21
Selenium (Se)	mg/kg	0.1	0.1	—
Silver (Ag)	mg/kg	0.1	0.02	1.0
Vanadium (V)	mg/kg	2	0.1	—
Zinc (Zn)	mg/kg	1	1	200
Total Organic Carbon	%w/w	0.1	0.01	—
Organotin (TBT)	µg/kg	1	0.5	9
Total Polycyclic Aromatic Hydrocarbons	µg/kg	100	4–5	10,000
Total Petroleum Hydrocarbons	mg/kg	100	3–5	280

6.5.4. Field sampling procedures

MAFRL has a Standard Operating Procedure (SOP) for field sediment sampling. This procedure details all aspects of sampling in accordance with NAGD and accompanies the SAP, once approved, for the implementation phase. A brief content of the SOP is shown in flowchart format in **Figure 14**. A summary of key elements of the SOP pertinent to this SAP is provided in the sections below.

6.5.4.1 Sample collection

Sediments will be sampled with a grab sampler or to refusal, using a 1.0 m by 50 mm polycarbonate hand corer by divers on SCUBA. Occupational diving operations standards will be followed as described in AS/NZ 2299.1 (2015).

All sampling equipment will be decontaminated between samples. Equipment will be washed with a mixture of Decon 90 and seawater and then rinsed with fresh seawater. Prior to sampling, sample containers will be cleaned by the laboratory.

6.5.4.2 Equipment and personnel

The following equipment and personnel will be used for sampling:

- Vessel suitable for diving operations (MAFRL vessel Pelagic)
- Personnel including a Coxswain, dive supervisor and at least two commercially qualified divers who are marine scientists
- Handheld GPS for position fixing and data collection
- Glass mixing bowls and plastic spoons for metals, metal spoons for hydrocarbons
- 1.0 m by 50 mm diameter polycarbonate cores
- Small van Veen grab
- Sample containers provided by the laboratory
- Decon 90, for decontaminating sampling equipment
- Eskies and ice
- Digital camera
- Data forms for logging sample collection information
- Chain of custody forms
- Field safety/dive operations safety plan
- Standard operating procedures
- Sample location map
- Miscellaneous items for sample mixing (i.e. table, ruler, bowls, etc)
- Disposable powder free gloves for sample handling

6.5.4.3 Field sampling contingency plan

The field sampling plan will allow for extra time as a contingency for adverse weather conditions and other potential interruptions (e.g. shipping movements in the turning basin). Additional sampling equipment (i.e. GPS, sample containers, mixing bowls etc.) will be taken into the field as contingency for any losses or breakages.

Adverse weather conditions will also be factored into the timing of the sampling plan, with alternate dates planned in the event of a trip cancellation. Shipping movements will be sought from the Harbour Master prior to sampling, to assist in planning dive operations.

Duplicate samples from each site have been planned as contingency for samples broken or lost in transit, failed laboratory procedures. Additional sampling sites have been planned for a situation where no surficial sediment is encountered at the sampling location.

In addition, the laboratories used to analyse samples will be requested to retain samples after initial analysis, in the case that outliers need to be reanalysed.

6.5.4.4 Health and safety precautions

In water sediment sampling will be conducted by commercially qualified scientists (AS2815.1) on SCUBA. All diving practices will be in accordance with AS2299.1:2015 following a detailed safety plan which identifies and mitigates health and safety issues related to field sampling, will be compiled and provided to the relevant parties for approval prior to the commencement of the fieldwork. The safety plan will include a definition of hazards, a risk assessment, risk mitigation measures and an emergency plan. Activities aboard the vessel will be subject to a safety analysis prior to commencement of work and all activities will be monitored by the skipper for compliance and for continual improvement. Regular communication will be maintained with Port during diving operations.

6.5.4.5 QA/QC procedures

The laboratories used for analysis are NATA certified for the parameters being measured. As part of their procedures they will undertake the required blanks, testing of standards and replicate tests to the satisfaction of the NATA requirements. These data will be reported. MAFRL is certified to ISO/IEC17025 and as such will ensure all documentation and procedures adhere to the standard.

A total of 10% of sampling locations will be sampled in triplicate (field triplicates), that is three individual samples (including the primary sample), from each of 10% of sites to determine the variability of the sediment physical and chemical characteristics (see **Table 14**). Samples from 5% of sampling locations will be homogenised and split into three sample containers (field splits),

to assess laboratory variation (see **Table 14**). One of the field split sample containers will be sent to a second (reference) NATA accredited laboratory for analysis of metals, to allow comparison between analytical laboratories.

The allocation of sampling locations where triplicate and split samples are to be collected was performed via the generation of random numbers. Triplicate and split sampling locations are presented in **Table 12**. The number of individual samples collected per sampling location may vary depending on the depth of corer refusal (refer to Appendix D of the NAGD).

Where samples are analysed in separate batches, one sample that has been analysed in a previous batch will be reanalysed in the subsequent batch to determine the analytical variation between batches, as per the NAGD, Appendix F. The laboratories undertaking the analyses will be requested to hold a portion of all original samples after initial analysis, in the circumstance that re-testing may be required (for example, when outliers are detected).

- Table 14 Number of QA/QC samples to be collected

Site Locations	Number of Sampling Locations	Indicative Number of Samples	Triplicates [1]	Splits [2]	Field and transport blanks	Sub-total of Samples
1 (Sand Trap)	10	20	1	1	-	26
2 (Outer Harbour)	10	20	1	1	-	26
3 (Approach Channel)	12	24	2	1	-	34
Reference Sites	7	7	0	0	-	7
Spoil Ground	7	7	0	0	-	7
Total	**39**	**71**	**4**	**3**	**2**	**102**

1 Field triplicates (10% of sites rounded up require triplicates i.e. two more samples) (see NAGD Appendix F).

2 Field splits (5% of sites rounded up require splitting i.e. one more sample) (see NAGD Appendix F).

1 **Transport blank:** to estimate any contamination introduced to the sample during the transport and storage stage acid washed sand will be poured directly into the sample containers with no filtering or handling

2 **Field blank:** to estimate any contamination introduced to the sample during the collection procedure. This involved following the same sampling procedure using acid washed sand that was used for the sample sediment

6.5.4.6 Sample handling, preservation, storage and transportation

Samples will be handled according to the procedures set out in the SOP in **Figure 14**. Multiple cores will be collected so that adequate material for analyses is retrieved from the same sampling location and depth increment.

Upon returning to the surface samples from all cores within the same depth increment will be homogenised prior to being placed into separate container (see **Table 15**) and kept at 4°C until the end of the day where all samples will be frozen. Samples for sediment chemistry will be transported by the field crew directly to the laboratories. Samples will be analysed immediately; however, if short-term storage is required by the laboratory it will be in accordance with **Table 15**.

Table 15 Sample containers, preservation, storage and transportation

Parameter	Container	Preservation and Storage	Transportation
Metals/metalloids	70 mL polypropylene jar	Freeze at -20 ºC. 180 day holding time	Transported with field crew directly to laboratory in eskies with frozen ice bricks
Mercury	70 mL polypropylene jar	Freeze at -20 ºC. 28 day holding time	
TOC	70 mL polypropylene jar	Freeze at -20 ºC. 28 day holding time	
TBT and moisture content	250 mL solvent rinsed glass jar with Teflon lid	Chill to 4ºC 14 day holding time	
PAHs	250 mL solvent rinsed glass jar with Teflon lid	Chill to 4ºC 14 day holding time	
TPHs	250 mL solvent rinsed glass jar with Teflon lid	Chill to 4ºC. 14 day holding time	
PSD	500 g in a Ziplock bag	Freeze at -20 ºC. 28 days.	

6.5.4.7 Field data

Field data relating to the sampling being undertaken at each site will be recorded on a datasheet. This datasheet will also be transcribed into an electronic spreadsheet. Information recorded in the electronic spreadsheet will include the following:

- Date and time sample taken
- Site location
- Depth
- Waypoint number
- Latitude
- Longitude
- Sample ID number
- Weather conditions
- Person responsible
- Additional comments.

Each sample will be photographed and a description of the sediment (grain size, texture sorting, colour etc) written on the datasheet.

6.5.4.8 Analytical laboratories

Analyses will be undertaken by laboratories that are accredited under National Accredited Testing Association (NATA) for the parameters to be measured (**Table 13**). All samples will be consigned using a chain of custody (CoC) to the designated laboratories.

- ALS (NATA 825) (sediment analyses)
- MAFRL (NATA 10603) (sediment analyses)

As part of their procedures, the laboratories undertake the required blanks, spikes, testing of standards and split tests to the satisfaction of the NATA requirements. MAFRL is certified to ISO/IEC17025 and as such will ensure all documentation and procedures adhere to the standard.

6.5.4.9 Data management procedures

Data management will be to ISO/IEC17025 requirements, with all data being validated prior to reporting. Specifically, organics measured in sediments (i.e. TBT and PAH) will be normalised to 1% TOC, within the upper and lower limits of 0.2 and 10% TOC, prior to any analysis. Sediment chemistry concentrations that are reported below the PQL will be halved in accordance with NAGD Appendix A (CA 2009).

6.5.4.10 Data validation

Analytical data will be validated by evaluating the laboratory QA/QC results from blanks, standards, spikes and replicate samples. This will aid in identifying possible false positives (where a compound will appear to be detected when it is actually not present) and false negatives (where a compound being tested is suppressed by another very abundant compound). Duplicate samples will be validated by examining whether the relative percent difference (RPD) and relative standard deviation (RSD) values are below the specified criterion (35% and 50%, respectively).

In addition, all data spreadsheets and calculations will be technically reviewed by a qualified marine scientist prior to reporting.

6.5.4.11 Comparison of phase I data to NAGD screening levels

Data will be tested for normality using the Shapiro-Wilkes Test and depending upon the results, (normal or log-normal), the 95% UCL, (upper confidence limit), will be calculated for all sediment quality parameters as follows:

(1) Normal Data $UCL \quad average = \overline{X} + t_{\alpha, n-1}\frac{s}{\sqrt{n}}$

where: $\overline{X}$ is the arithmetic average of the sample measurements
α is the level of significance of 0.05
n is the number of sample measurements
s is the standard deviation of the sample measurements
$t_{\alpha,n-1}$ is the test statistic (Student's t for α and n-1 degrees of freedom)

(2) Non-normal data: Non-normal data will be analysed by either the Bootstrap method using Monte Carlo re-sampling techniques or by ProUCL written by the United States Environmental Protection Agency (USEPA). The resulting 95% UCLs will then be compared to the NAGD (CA 2009) screening levels (**Table 13**).

The resulting 95% UCLs will be compared to the guideline values. Statistical comparisons with background values derived from the proposed Spoil Ground and/or the Reference Sites will be made should the screening value be exceeded in any of the dredge areas in accordance with the NAGD (**Figure 5** and **Figure 6**). If these criteria are exceeded then Phase III testing is required (see **Section 6.6**).

6.6. Phase III – Elutriate and bioavailability testing

6.6.1. Rationale

Should further testing be required as required as prescribed in **Section 6.5.4.11** then the following sampling and analysis procedures would be followed for the parameters in question. Essentially, if the 95% UCL of a contaminant exceeds the relative NAGD (CA 2009) screening level, concentrations will be compared to background (ambient baseline concentrations) in sediments at the reference sites. Where a contaminant of potential concern exceeds the background, additional sediment samples will be collected from the proposed dredge footprint for elutriate and bioavailability testing as outlined in Phase III of the NAGD (CA 2009) (**Figure 5** and **Figure 6**).

Collection of sediment samples for bioavailability and elutriate testing will be taken from sites representative of the dredged material. Particularly, where high total sediment concentrations are observed at a number of sites, these sites will be prioritised for sampling of sediments for bioavailability and elutriate testing.

This section details the sampling and analysis requirements for elutriate and bioavailability testing as per the NAGD (CA 2009), which will be undertaken in the event that an exceedance of baseline concentrations is identified.

6.6.2. Elutriate testing

Unconfined ocean disposal of dredged material could result in contaminants within the material being released into the water column, presenting an environmental risk to biota living in the water column. Elutriate testing mimics the ocean disposal of dredged material and the associated liberation of potential contaminants into the water, thus providing an indication of the associated potential environmental impacts (CA 2009). 'Elutriate' is the concentration of the contaminant in the elutriate sample, calculated by deducting the ambient water concentration from the raw elutriate concentration.

6.6.3. Bioavailability testing

Unconfined ocean disposal of dredged material could result in contaminants within the material being released into the water column, presenting an environmental risk to biota. Sediment characteristics largely contribute to the toxicity of a particular contaminant, not just the total concentration of the substance. For example, high levels of organic matter will reduce the availability of many organic compounds and some metals. In order to take this into account when evaluating the potential environmental risk associated with dredging and disposal of sediments, bioavailability testing measures the amount of the bioavailable fraction of the contaminant that has the ability to affect organisms.

6.6.4. Sample collection

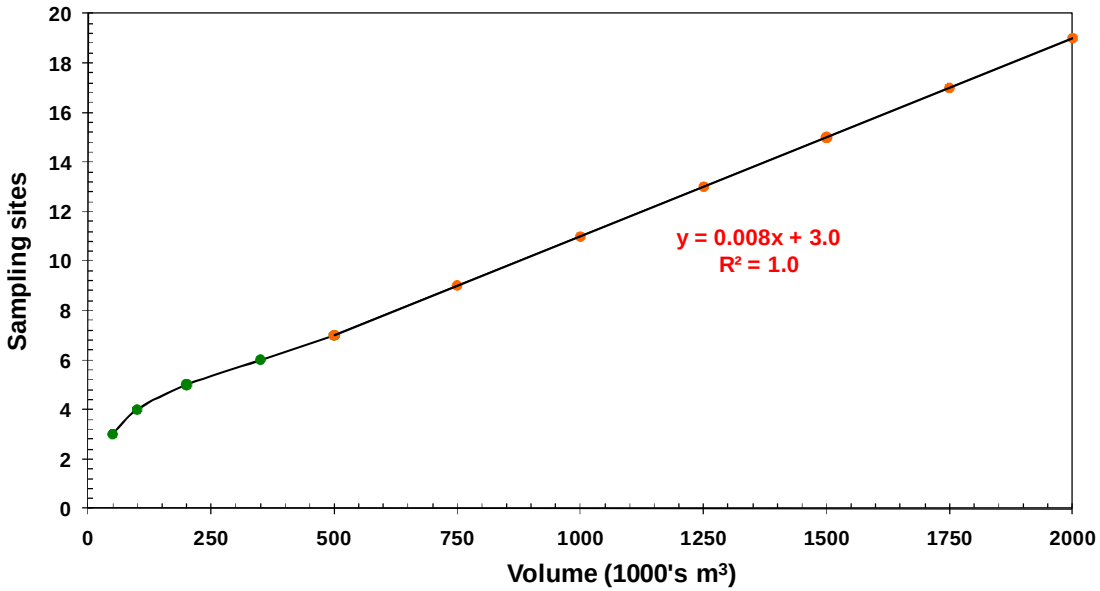
MAFRL has a Standard Operating Procedure (SOP) for field sediment sampling. This procedure details all aspects of sampling in accordance with NAGD and accompanies the SAP, once approved, for the implementation phase. A brief content of the SOP is shown in flowchart format in **Figure 14**. A summary of key elements of the SOP pertinent to this SAP is provided in the sections below.

Collection of samples for elutriate and bioavailability testing will follow the procedures and details outlined in **Section 6.5.4.1** and **Figure 14**. **Table 16** provides the number sampling locations required to be sampled for elutriate and bioavailability testing in each dredge area, based on the volume of spoil to be dredged and recommendations of the NAGD, Appendix D (CA 2009). Samples will be representative of the overall dredge material in the specific dredge areas where the testing is required. Where a specific area of the dredge footprint has been selected for testing due to the exceedance of a NAGD screening level, samples will be representative of the sub-area, including the most contaminated sampling locations.

- Table 16 Number of phase III sampling locations required

Site	Volume (m^3)	Depth of Potentially Contaminated Material (m)	Number of Sampling Locations Required for Elutriate and Bioavailability Testing	
			NAGD [1]	Proposed
1 (Sand Trap)	175,000	1.0	5	5
2 (Outer Harbour)	180,000	1.0	5	5
3 (Approach Channel)	345,000	1.0	6	6
Reference Sites	—	—	2	2

1 Number represents the minimum requirement as per the NAGD (CA 2009) and Figure 12 below.



- Figure 12 Phase III sample numbers required per volume of surface material

Seawater samples, representative of the spoil ground, will be collected for elutriate preparation. One litre acid-rinsed polyethylene or glass bottles will be filled by hand from the vessel.

Samples will be kept on ice in a cooler and transported by with field crew directly to laboratory within 24 to 48 hours of collection. Samples will be analysed immediately upon arrival at the laboratory and short-term storage, preservation and holding times of samples by the laboratory will be in accordance with appropriate standards as outlined in **Table 17**.

Table 17 Sample containers, preservation, storage and transportation

Parameter	Container	Preservation and Storage	Transportation
Elutriate testing	4 x 250 mL glass jars with Teflon-lined lid	Completely fill and chill to 4°C. 14 day holding time for extraction.	Transported with field crew directly to laboratory in eskies with frozen ice bricks
Seawater from spoil ground	1L acid-rinsed polyethylene or glass jar	Completely fill and chill to 4°C. 14 day holding time for extraction.	
Bioavailability testing	4 x 250 mL glass jars with Teflon-lined lid	Completely fill and chill to 4°C. 14 day holding time for extraction.	

6.6.5. Comparison of phase III data to ANZG guidelines

Contamination concentrations will be determined for the samples selected for bioavailability and elutriate testing. Analyses will be undertaken by the laboratories as detailed in Section **6.5.4.8**, following the appropriate QA/QC procedures set forth in Section **6.5.4.5**.

6.6.5.1 Elutriate data

Parameter concentrations within elutriate data will be compared with ANZG (2018) water quality guideline values. Before comparing concentrations with guideline values, the elutriate test data is to be adjusted to allow for initial mixing, defined by the NAGD (CA 2009) as the mixing which occurs within four hours of dumping. Initial mixing will depend on a number of factors such as water depth, layering in the water column, and current velocities and directions. The initial mixing can be calculated using the US Army Engineers Waterways Research Station Short-term Fate (STFATE) of dredged material model.

The 95th percentile levels of contaminants of potential concern will be compared to the relevant 90% trigger values (to assess impacts at the dredge areas within the area to be dredged) and 95% trigger values (to assess impacts at the disposal area of the Spoil Ground) as prescribed in the ANZG (2018) guidelines for water quality, after accounting for appropriate dilution. The 90% trigger value suggests 90% of species would be protected, whilst the 95% trigger value suggests 95% of species would be protected. A moderate level of ecological protection (90%) has been applied to areas around existing and approved wharves, jetties and ship turning basins in the Port in accordance with ANZG (2018). A slight to moderately disturbed level of ecological protection (95%) has been applied to the Spoil Ground in accordance with ANZG (2018). To account for the bioaccumulating nature of cadmium and mercury, the 99% species protection level DGV is instead of the 95% species protection ANZG (2018). In the case of TBT, the DGV may not protect key test species from chronic toxicity and therefore using the 99% species protection in place of the 95% is recommended, however, the 99% species protection (0.0004 µg/L) is lower than the current laboratory PQL (0.002 µg/L), so in this case the 95% species protection will remain.

In case it is not possible to obtain sufficient pore water for analysis or where the chemical stability of pore water cannot be assured, the elutriate test without dilution will be used to estimate the pore water contaminant concentrations and thus a surrogate measure of bioavailability for TBT, as per the NAGD (2009).

The seawater to be used for elutriate testing, collected in the vicinity of the proposed spoil ground, will also be analysed for the parameters listed for the elutriate test.

The method and analytical PQL for elutriate analyses are provided in **Table 18**.

Table 18 Analytical PQLs and trigger values for elutriate testing as required

Parameter	Units	Laboratory PQL	ANZG (2018)	
			90% trigger level	95% trigger level
Antimony (Sb)	µg/L	0.5	-	270[1]
Aluminium (Al)[2]	µg/L	5	69	24
Arsenic (As)	µg/L	0.5	-	4.5[1]
Cadmium (Cd)[3]	µg/L	0.1	5.5	0.7
Chromium (Cr VI)	µg/L	0.2	20	4.4
Cobalt (Co)	µg/L	0.05	14	1.0
Copper (Cu)	µg/L	0.2	3	1.3
Lead (Pb)	µg/L	0.1	6.6	4.4
Manganese (Mn)[4]	µg/L	0.5	660	390
Mercury (Hg)[3]	µg/L	0.1	0.4	0.1
Nickel (Ni)	µg/L	0.3	200	70
Selenium (Se)	µg/L	1.0	—	3 [1]
Silver (Ag)	µg/L	0.1	1.8	1.4
Vanadium (V)	µg/L	0.3	160	100
Zinc (Zn)	µg/L	1.0	23	15
Organotin (TBT)	µg/L	0.002	0.02	0.006

1 Unknown reliability trigger value.
2 Golding et al. (2015) and draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW).
3 To account for the bioaccumulating nature of this toxicant, it is recommended that the 99% species protection level DGV is used for slightly to moderately disturbed systems.
4 Draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW 2014). Guidelines applicable where corals are absent.

6.6.5.2 Bioavailability data

Results from the dilute acid extraction of metals will be compared to the NAGD (CA 2009) screening levels, based on the calculation of the 95% UCL. The NAGD (CA 2009) states that while the comparison is not equivalent to the bioavailable fraction, it is a closer approximation than comparison of total metal sediment data and will be a guide to bioavailability, particularly to sediment-ingesting organisms.

Where it is not possible to obtain sufficient pore water for analysis by centrifugation of the sediment samples or where the chemical stability of pore water cannot be assured, the elutriate test without dilution will be used to estimate the pore water contaminant concentrations and thus a surrogate measure of bioavailability for TBT and organic compounds, as per the NAGD (2009).

6.6.5.3 Data management, data quality validation and analysis

Data management will be to ISO/IEC17025 requirements, with all data being validated prior to reporting. Concentrations that are reported below the PQL will be halved in accordance with NAGD Appendix A (CA 2009).

Validation of elutriate and bioavailability data will follow that described in **Section 6.5.4.10**. The reporting and comparison of dilute acid extraction of metals to the NAGD (CA 2009) screening levels will be as per **Section 6.5.4.11**. Elutriate data will be reported as described in **Section 6.6.5.1**. Raw elutriate and bioavailability data will be provided in the laboratory certificates of analysis (COA) appended to the SAP Implementation Report.

6.7. Phase IV – Toxicity testing

6.7.1. Rationale

Should further testing be required as prescribed in **Section 6.6.5** then the following ecotoxicological testing will be undertaken.

6.7.2. Ecotoxicological testing

Should ecotoxicological investigations be required three direct sediment tests (marine) can be conducted and include amphipod 10 day survival, copepod, 96 h survival and polychaete worm 10 day survival bioassays (**Table 19**), for those species in direct contact with sediment.

- Table 19 Sediment (marine) bioassays

Sediment Bioassays	Species	Details:
Amphipod	*Corophium sp.*	10-Day Survival
Copepod	*Robtersonia sp.*	96-h Survival
Polychaete worm	*Australonereis ehlersi*	10-Day Survival

For species that come in contact with water contaminants that partition from sediment to the overlying water column, three elutriate tests prepared from sediment samples are available including the microalga, sea urchin and mollusc test (**Table 20**).

Table 20 Elutriate (marine) bioassays

Elutriate Bioassays	Species	Details:
Microalga	*Nitzschia closterium.*	72-hour Growth inhibition
Sea urchin	*Heliocidaris tuberculata*	72-hour Larval development
Rock oyster	*Saccostrea commercialis*	48-hour Larval development

Generally, a minimum of three toxicity tests should be undertaken, and these tests should comprise both acute and chronic endpoints, and at least one whole-sediment toxicity test and represent the main contaminant exposure routes. The test results should be presented as 'effect as a % of control response' (in an uncontaminated sediment with similar properties as the test sediment) (Simpson et al., 2013; CA, 2009).

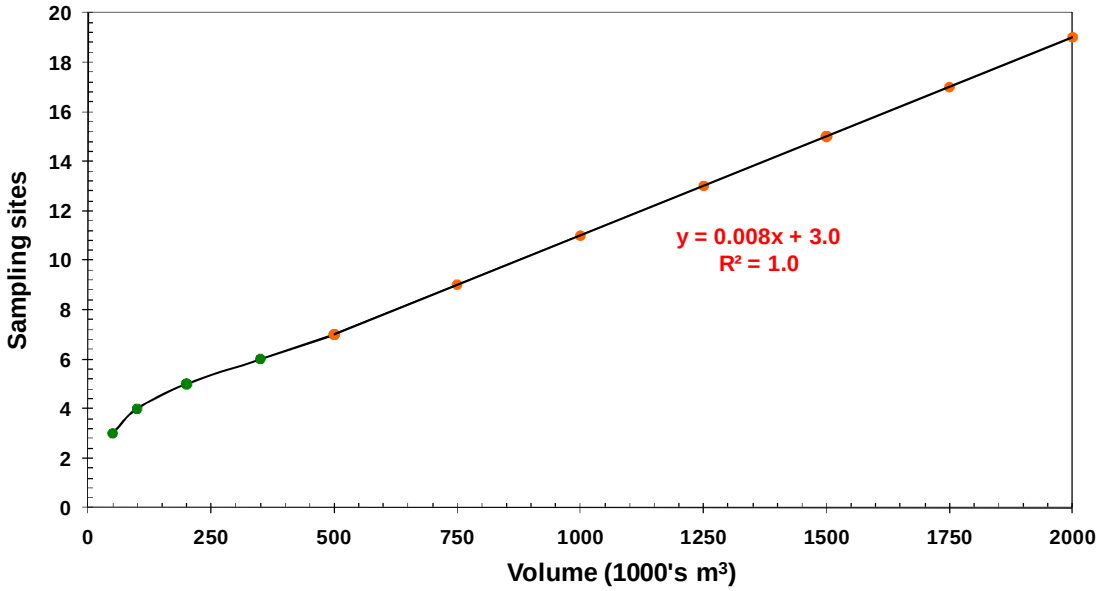
6.7.3. Sample collection

Collection of samples for ecotoxicological testing will follow the procedures and details outlined in **Section 6.5.4.1** and **Figure 14**. **Table 21** provides the number sampling locations required to be sampled for ecotoxicological testing in each dredge area, based on the volume of spoil to be dredged and recommendations of the NAGD, Appendix D (CA 2009). Samples will be representative of the overall dredge material in the specific dredge areas where the testing is required. Where a specific area of the dredge footprint has been selected for testing due to the exceedance of a NAGD screening level, samples will be representative of the sub-area, including the most contaminated sampling locations.

Table 21 Number of phase III sampling locations required

Site	Volume (m^3)	Depth of Potentially Contaminated Material (m)	Number of Sampling Locations Required for Ecotoxicological Testing	
			NAGD [1]	Proposed
1 (Sand Trap)	175,000	1.0	5	5
2 (Outer Harbour)	180,000	1.0	5	5
3 (Approach Channel)	345,000	1.0	6	6

1 Number represents the minimum requirement as per the NAGD (CA 2009) and Figure 13 below.



- Figure 13 Phase IV sample numbers required per volume of surface material

Seawater samples, representative of the spoil ground, will be collected for toxicity test preparation. Glass containers will be filled by hand from the vessel.

Samples will be kept on ice in a cooler and transported directly by the field crew and will arrive at the laboratory within 48 hours of collection. Samples will be analysed immediately upon arrival at the laboratory and short-term storage, preservation and holding times of samples by the laboratory will be in accordance with appropriate standards as outlined in **Table 22**.

- Table 22 Sample containers, preservation, storage and transportation

Parameter	Container	Preservation and Storage	Transportation
Ecotoxicological testing (sediment)	3 x 0.5 L glass containers per site	Completely fill and chill to 4°C. 96 hr holding time	Transported with field crew directly to laboratory in eskies with frozen ice bricks
Ecotoxicological testing (elutriate)	3 x 0.5 L glass containers per site	Completely fill and chill to 4°C. 96 hr holding time	
Site water	8 x 1 L glass per area requiring testing	Refrigerate to < 4°C.	

6.7.3.1 Quality control procedures

The laboratories used for analysis are NATA certified for the parameters being measured. As part of their procedures they will undertake the following procedures to the satisfaction of the NATA requirements:

- Controls (positive control (reference toxicant) and negative control (control treatment))

- Replicates
- Examining continuity of parameters, such as pH, throughout the experiment
- Statistical difference between treatment and controls

These data will be reported. MAFRL is certified to ISO/IEC17025 and as such will ensure all documentation and procedures adhere to the standard.

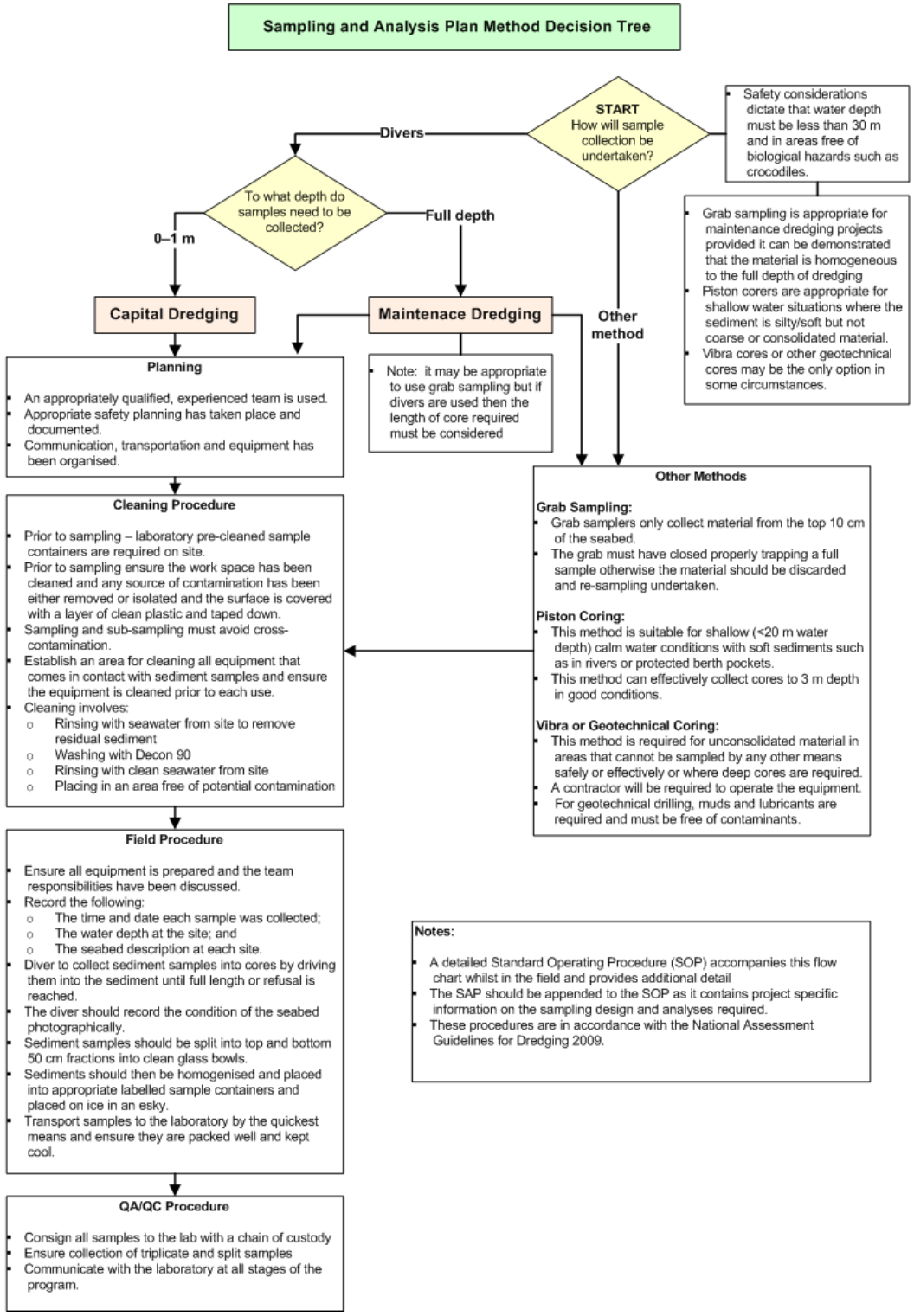
6.7.4. Comparison of phase IV data to guidelines

NADG (CA, 2009) and Simpson et al. (2013) provide guidance to determine if the toxicity data can be assessed as toxic or non-toxic as follows:

- Determine whether the toxic effects may be attributed to factors other than the contaminants of potential concern (COPC). For example, ammonia and sulfide at naturally occurring concentrations are not COPCs but may cause significant toxicity. The sediment may have been too compact for burrowing or insufficiently nutritious (e.g. clay), resulting in non-COPC mortality (may be an example of poor test procedure selection). If non-COPC factors are shown to be the cause of the toxicity, these test results should be discarded from the assessment, and alternative tests may be necessary.

- Toxicity data are assessed as non-toxic if the response is <20% toxic effect compared to a control response, toxic with significant effects for 20-50%, and toxic with significant and major effects if the response is ≥50%.

According to NAGD, in rare circumstances, it may be possible to go beyond the assessment of toxicity (or bioaccumulation) to make a more definitive evaluation of the potential effects of the contaminated sediment after disposal, using a weight-of-evidence assessment (phase V), which takes into account the outcomes of each available line of evidence. Each line of evidence is tabulated, ranked, weighted, according to its reliability as an assessment tool and its ecological significance, and they are then combined to arrive at an overall assessment of whether the material is acceptable or unacceptable for ocean disposal. Where sediments are found to be unacceptable for unconfined ocean disposal after the weight of-evidence assessment, and should the proponent, after evaluating alternatives, still wish to consider ocean disposal, they will need to investigate management options, such as treatment, control measures and confined disposal, to see if impacts can be successfully mitigated.



- Figure 14 Standard operating procedures

7.0 References

ANZECC/ARMCANZ (2000a) National Water Quality Management Strategy: Paper No 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1 – The Guidelines (Chapters 1–7). Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, Canberra, Australian Capital Territory, October 2000.

ANZECC/ARMCANZ (2000b) National Water Quality Management Strategy: Paper No 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 2 – Aquatic Ecosystems – Rationale and Background Information (Chapter 8). Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, Canberra, Australian Capital Territory, October 2000.

ANZG (2018). Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia.

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

Birdlife International (2021). IUCN Red List for birds. Downloaded from http://www.birdlife.org on 29/07/2021.

Birdlife Western Australia (2020). https://direct.birdlife.org.au/images/uploads/branches/documents/WA-Bunbury_Bird_Guide-21AB-Revised-2020.pdf

CA (Commonwealth of Australia) (2009). National Assessment Guidelines for Dredging. Commonwealth of Australia.

Cresswell, G.R., Boland, F.M., Peterson, J.L., Wells, G.S. (1989). Continental shelf currents near the Abrolhos Islands, Western Australia. Australian Journal of Marine and Freshwater Research 40:113–128.

DM&H (1988). Letter to the Secretary of the Department of the Arts, Sport, The Environment, Tourism and Territories.

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012a). Species group report card – bony fishes.

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012b). Species group report card – sharks.

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012c). Species group report card – marine reptiles.

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012d). Species group report card – seabirds.

DSEWPaC (Department of Sustainability, Environment, Water, Population and Communities) (2012e). Species group report card – cetaceans.

EPA (2011). Environmental Assessment Guideline for Marine Dredging Proposals. EAG7: Environmental Protection Authority of Western Australia, September 2011.

Gensemer, R.W. and Playle, R.C. (1 999). The bioavailability and toxicity of aluminium in aquatic environments. Critical Reviews in environmental Science and Technology 29:315–450.

Golding, L.A. Angel, B.M. Batley, G.E. Apte, S.C. Krassoi, R. and Doyle, C.J. (2015). Derivation of a water quality guideline for aluminium in marine waters. Environmental Toxicology and Chemistry, 34, 141-151.

MAFRL (2017). Bunbury Port Invasive Marine Species (IMS) Survey May 2017. MAFRL 17-4. September 2017.

MAFRL (2020). Spoil Ground Survey Dispersion Investigation. Prepared for the Southern Ports Authority. MAFRL Report 20-2. June 2020.

PWD. (1978). Bunbury Outer harbour Siltation Investigations. Prepared by the Coastal Investigations Section of the Harbours and Rivers Branch within the Public Works Department of Western Australia.

Rochford, D.J. (1969). Seasonal interchange of high- and low-salinity surface waters o¤ South-west Australia. CSIRO Division of Fisheries and Oceanography Technical Paper 29, 8pp.

SCEW (2014). Guidelines for the protection of aquatic ecosystems, toxicant trigger values: Manganese – marine. Australian and New Zealand guidelines for fresh and marine water quality. Council of Australian Governments Standing Council on Environment and Water, Canberra, ACT, Australia, 12 pp.

Schropp, S.J and Windom, H.L. (1988). A guide to the interpretation of metal concentrations in Estuarine Sediments. Florida Department of Environmental Protection, United States.

Simpson, SL, Batley, GB and Chariton, AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07. CSIRO Land and Water.

SKM (Sinclair Knight Merz) (2010). Bunbury Port Development. Compilation and Review of Existing Information. Prepared on behalf of the Bunbury Port Authority.

Strong, J. (2005). Antifoulant and trace metal contamination of sediments from the Napier inner harbour. Report prepared for the Hawkes Bay Regional Council, New Zealand.

Wiltshire, KH., Theil, MJ., Giblot-Ducray, D and Deveney MR. (2020). Molecular surveys in 2020 of priority marine pests for the ports of Bunbury, Kwinana, Fremantle and Geraldton. SARDI publication number F2020/000354-01. SARDI Research Report Series No. 1082. Report to the Department of Agriculture, Water and the Environment.

Appendix A **Port of Bunbury Environmental Management System and other relevant documentation**

SOUTHERN PORTS
ALBANY BUNBURY ESPERANCE

MARINE ENVIRONMENTAL MANAGEMENT PLAN

DOCUMENT CONTROL

Version Number	Description	Reviewed by	Approved by	Revision Date	Issue Date
01	New SPA PoB Document – General updates to reflect current practice	Environmental Officer	HSE Manager	02/03/2016	02/03/2016
02	Document update – New Record Number	Environmental Officer	HSE Manager	21/08/2018	21/08/2018
03	Scheduled review - General updates to reflect current practice	Environmental Officer	Environment Manager	19/08/2021	19/08/2021

AUDIT

This plan shall be reviewed / revised

- Where a Risk Assessment / Audit identifies a need to review;
- Following a significant incident involving this plan; or
- At least every 3 years.

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DEFINITIONS

SPA-Bun	Southern Ports – Bunbury
DWER	Department of Water and Environment Regulation

1. INTRODUCTION

1.1. Background

The present Southern Ports - Bunbury (SPA-Bun) operations consist of 2 Outer Harbour berths and 5 Inner Harbour berths (see Figure 1-1).

At the Outer Harbour, there are two berths both owned and operated by the SPA-Bun (see http://www.southernports.com.au/):

- Berth 1 – Has limited use due to draught restrictions but can accommodate vessels for scrap metal loading, vessels for ship cleaning and potentially cruise vessels.
- Berth 2 - A general purpose berth equipped for discharging Methanol from tankers and for the mooring of tugs.

At the Inner Harbour there are five berths:

- Berth 3 - a fixed woodchip ship loader owned by WAPRES situated on a dolphin berth for loading woodchip and for the loading of grain.
- Berth 4 - A specialised bulk alumina loading berth. Bulk caustic soda is also discharged at this berth. The berth and all associated infrastructure is owned and operated by Alcoa.
- Berth 5 - A general purpose berth for the loading and unloading of bulk materials and break-bulk cargo owned and operated by the SPA-Bun.
- Berth 6 - A specialised bulk alumina loading, bulk caustic soda is also discharged at this berth. The berth and all associated infrastructure is owned and operated by South32 (Worsley Alumina).

Berth 8 - A common user berth owned and operated by the SPA-Bun for the loading of bulk materials including mineral sands, silica sands, spodumene, copper sulphide concentrate, alumina hydrate and woodchips. Other operations at the Inner Harbour are:

- Two wood-chipping, screening and stockpiling operations.
- The Tronox Mineral Separation Plant located at the northwestern end of the Inner Harbour.
- Bulk caustic storage facilities located to the east of the South32 Worsley Alumina and Alcoa operations.
- Bulk refined waste oil and bitumen storage facilities located on the southeastern edge of the IH. This facility is owned and managed by Wren Oil.

1.2. Environmental setting

The port of Bunbury is situated in the southwest corner of Western Australia, 170 road kilometres south of the state capital, Perth.

The eastern side of the Inner Harbour is bordered by the Leschenault Estuary (Vittoria Bay) and the Preston River delta system. The western side of the Inner Harbour is bordered by the Leschenault Inlet.

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2. SCOPE AND OBJECTIVES

2.1. Scope

To facilitate the effective management of marine waters and potential pollution related issues associated with port activities which may impact on port waters and associated marine life. This management program identifies marine management requirements, quantifies port emissions and impacts, sets objectives and targets, and monitors ongoing performance to achieving these objectives.

In addition to this overarching program, individual plans will be produced to mitigate specific potential marine pollution issues inherent in development scenarios and new development proposals.

2.2. Objectives

The Southern Ports - Bunbury's objectives with regards to its marine environment are as described in the ISO 14001 - 2015 accredited SPA-Bun Environmental Management System Objectives and Targets:

Objectives	Targets	Key Performance Indicators
Marine Waters - Maintain quality and integrity of marine harbour waters.	No deterioration year on year in marine water quality directly related to SPA-Bun controlled operations.	No net increase in marine water nutrients or metals.
Harbour sediments – Maintain quality and integrity of harbour sediments	Minimise spillage, storm and wash water runoff into the marine environment from SPA-Bun controlled operations	No net increase in sediment metals year on year.

3. LEGISLATIVE REQUIREMENTS

- Environmental Protection and Biodiversity Conservation (EPBC) Act, 1999 - The principles of ecologically sustainable development are regarded in new proposals. Environmental approval is to be sought when development is likely to impact areas of national significance.
- Environmental Protection (Sea Dumping) Act, 1981 - Proponents must hold a permit to carry out dumping of waste or any matter from vessels in Australian waters.
- National Ocean Disposal Guidelines for Dredged Material, 2002 - Establishes guidelines and best practice for ocean disposal of dredged material
- National Assessment Guidelines for Dredging 2009 - The National Assessment Guidelines for Dredging set out the framework for the environmental impact assessment and permitting of the ocean disposal of dredged material. The framework includes:
  - evaluating alternatives to ocean disposal;
  - assessing loading and disposal sites;
  - assessing potential impacts on the marine environment and other users;
  - Determining management and monitoring requirements;
  - Australian Ballast Water Management Requirements;
  - Vessels must have permission to discharge ballast water in Australian waters and develop and implement management procedures. Vessels must report on ballast discharge activities Vessels with international itinerary must lodge Ballast Water Decision Support System (BWDSS).
- ANZECC Marine and Fresh Water Guidelines 2000
- Environmental Protection Act, 1986 - This act establishes the Environmental Protection Agency (EPA) and requires the approval through Environmental Impact Assessment (EIS) of new proposals. Also requires works approvals for constructions and licenses to operate on prescribed premises.
- Protection of the Sea (Prevention of Pollution from Ships) Act 1983 - Establishes regulations regarding vessels, discharges, emissions, and other harmful substances emitted from ships
- Protection of the Sea (Harmful Anti-fouling Systems) Act 2006 - Offence for any ship bearing harmful chemical compounds on their hulls or external parts or surfaces to enter an Australian Port, shipyard

or offshore terminal, unless the ship bears a coating to prevent such compounds leaching into the water. Act provides for the issuing of 'International Anti-fouling System Certificates'.

- Environmental Protection (Unauthorized Discharges) Regulations 2004 - This imposes penalties for unauthorized discharges to the environment. Exceptions such as pesticides and lower thresholds
- Management of Sewage Discharges from Vessels into the Environment - Any treated or non-treated sewage discharge by recreational and commercial vessels is prohibited in marinas, yacht clubs, boat harbours and ports.
- Pollution of Waters by Oil and Noxious Substances Act, 1987 - No discharges of oil or oil wastewater into the marine environment are allowed. Notification of 'prescribed incidents' – incidents which involve discharge of oily waste into the marine environment, is required.
- Waterways Conservation Act, 1976 - Enacts licence requirements for disposal of wastes into certain water bodies
- Western Australian Maine (Sea Dumping) Act 1981 - Established permit requirements for the dumping of waste from any vessel or aircraft into coastal waters or Port waters. Also covers incineration and loading of any prescribed matter.
- Western Australian Marine (Sea Dumping) Regulations, 1982 - Delineates specific requirements for sea dumping reports.
- Western Australian EPA Guidance Document No.29 – Benthic Primary Producer Habitat Protection - Gives advice and best practice guidelines regarding how to carry out development planning and work so as to protect benthic habitat.

4. POTENTIAL ENVIRONMENTAL IMPACTS TO THE MARINE ENVIRONMENT WITHIN PORT WATERS

4.1. Effects of dredging and disposal of the dredged material

- Dredging within the Bunbury port is undertaken due to a loss of pre-existing depths due to a build-up of sediment (maintenance dredging). Short-term turbidity can result from dredging activities.
- Under the Environment Protection (Sea Dumping) Act 1981 (the Sea Dumping Act), a Sea Dumping Permit is required to authorize the loading for the purposes of dumping dredged material at sea.
- The Port of Bunbury holds a sea dumping permit.

4.2. Effects of antifouling paints

- Another significant environmental issue is the use of organotins such as tributyltin (TBT) as biocides in antifouling paints used on vessels to prevent the build-up of organisms on ships' hulls. Its use has been of critical importance to efficient commerce and to impeding the spread of marine pests, parasites and diseases into ports, harbours and coastal waters. Due to contamination concerns, the use of TBT is in the process of being phased out world- wide for use on commercial vessels and is being replaced with copper based antifoulants.

4.3. Introduced marine species – see section 7 for further details

4.4. Ship waste discharge while in port

- In the course of normal operations, there is a risk of spills of oil, wastes from vessel maintenance, bilge water and sewage, and these could affect port water quality. The Port through the Harbour Master restricts intentional operational discharge of waste into the marine environment.

4.5. Risk of oil or hazardous cargo spills

- Oil and hazardous cargo spills can occur either in ports and harbours or in offshore waters. Spills can happen as a result of accidents, such as collisions or groundings on off-shore reefs. Their

environmental impacts depend on the nature and quantity of oil spilt and the habitat and species that are affected.

4.6. Other Hazards associated with shipping within port waters

- Underwater Noise.
- Ship strike on cetaceans and other marine life.
- Disturbance of sea floor due to anchorage activity – to minimise this environmental impact. designated anchorages are nominated.
- Accidental discharge of material into the sea during loading and unloading of ships.

5. IMPLEMENTATION STRATEGY AND MANAGEMENT ACTION

5.1. Strategy

SPA-Bun plans to mitigate, where practicable, Port associated impact risks through this program. The key strategic elements of this program are:

- Apply marine pollution management controls where practicable to do so.
- Monitor emissions and take necessary action where practicable to reduce pollution.
- Give due consideration to marine environmental impact potential in planning and port development proposals.

5.2. Management Action - Roles and Responsibility

- Port Management which includes the Harbour Master are collectively responsible for marine environmental management activities and efforts with the technical assistance and advice of the Environment Manager.
- The Environmental Officer who reports to the Environment Manager provides technical assistance and advice and carries out monitoring duties including reporting, field analysis and data analysis and maintains a database of all marine environmental monitoring and management activities.

6. MONITORING

Monitoring is required to enable an assessment of the effectiveness of the marine environmental management controls. Where monitoring is indicating the need for improvement to port practices or infrastructure, this will be brought to the attention of Senior Management for consideration.

- **Marine Pest Monitoring** – this monitoring is to identify any marine organisms that are not naturally occurring in the SW Region. This has been done since the mid 90's and in this time, no new introduced marine organisms have been identified which indicates that ship ballast water control protocols have been successful. In addition, IMS risk surveys are conducted on non-trading vessels including barges that may enter the Bunbury Port from time to time.
- **Water quality monitoring** - Water quality in the harbour waters has been conducted predominantly to monitor the potential impacts of bulk materials loading and the discharge of storm and wash water into the harbour. To date this monitoring has not shown bulk loading activities or water run-off into the harbour to have had a deleterious effect on water quality.

  Due to permitted the ship waste discharge while in port, the marine water at the IH is sampled for micro-organisms that could have an impact on human health at a concentration above the drinking water guideline.
- **Marine Sediment sampling** – As part of its Long Term Monitoring Management Plan and in association with its periodic maintenance dredging program, the SPA-Bun undertakes extensive sampling of the marine sediments and water quality in the Inner Harbour, Outer Harbour, Shipping Channel and Spoil Ground to monitor the condition of the sediments and waters to ensure that Port

activities are not negatively impacting the marine environment and that sediments continue to be suitable for unconfined sea disposal.

- **Underwater Noise Monitoring** – There have been no binding requirements identified pertaining to underwater noise impacts but SPA-Bun recognises the pertinence of recent research highlighting the effects of noise on marine ecological systems and thus aims to mitigate such effects where practicable to do so. Marine underwater noise will be monitored in events where significant underwater noise is likely to occur. Rock fracturing, capital dredging and certain construction activities will be required to model potential noise impacts and put in place mitigation strategies to reduce these impacts. Underwater noise monitoring will form part of the management plan.

7. MARINE IMPACT MITIGATION AND MANAGEMNT

- Use of rotaboxes for loading bulk material at the Inner harbour - The use of boxes has been shown to significantly reduce dust emissions and allow better control of spillage. This has the potential to significantly reduce the volume of water used for washing down of loading infrastructure.
- The Berth 8 WasteWater Capture system was commissioned in early 2011 to ensure that potentially contaminated washdown and stormwater water from the Berth 8 facility does not enter the marine environment.
- Enclosed loading infrastructure to contain bulk granular products to prevent dust and spillage. A truck wash-down bay was installed by the SPA-Bun in 2006 at the Inner Harbour to ensure that wash-down water from trucks was put through an oil separator to eliminate the risk of hydrocarbon contamination in the environment. This system has been well accepted by trucking contractors and was upgraded during 2020 with the installation of a more efficient oil separator.
- Use of the CCTV network at the Inner Harbour to monitor port operations and record potential and actual marine impact events.
- Spill containment equipment stored in a purpose-built shed south of Berth 5 for rapid deployment by appropriately trained personnel.
- Sampling equipment available to port operational and pilot boat personnel to collect potential marine pollutants for analysis.

8. FREQUENCY OF MONITORING AND REPORTING

- Marine Pest Monitoring – marine pest monitoring is conducted on a biennial basis. In addition, 10 yearly comprehensive baseline surveys will also be conducted.
- Water and sediment quality monitoring – this is conducted on a biennial basis. In addition, monitoring of water quality will also be carried out in conjunction with 12 monthly sediment metals surveys in the Inner Harbour relating to copper concentrate exports over Berth 8. The Inner Harbour is not included in the Port's Sea Dumping Permit.
- Micro-organism sampling of the IH twice yearly.
- Incident reporting - Minor and major accidental spillages into the marine environment must be reported immediately to the Environment Manager and Harbour Master.
- Complaint and Incident Handling - The Environment Manager is responsible for ensuring that community contacts and complaints regarding the quality of marine waters within the port boundary and any issues associated with maintenance dredging are properly documented and investigated. Details of community contacts and complaints will be captured in the Records Management System. Contacts or complaints regarding non- SPA-Bun controlled operations will be referred to that Port User for their action.

9. CONSULTATION AND INVOLVEMENT

SPA-Bun engages regularly with the local community through the Port Community Consultation Committee (PCCC) regarding environmental management issues including dredging campaigns. SPA-Bun also engages in regular consultation with the following stakeholders regarding marine water quality management strategies:

- Department of Water and Environmental Regulation (DWER) - as required
- City of Bunbury
- Port Users
- Dept of Agriculture Water and the Environment (DAWE)
- Department of Transport
- Department of Biodiversity Conservation and Attractions (DBCA) - Department of Fisheries

10. Review and Revision

This management plan will be reviewed and revised by SPA-Bun:

- On a 3 yearly basis or;
- If there are major changes to port operations;
- In response to issues raised by the DWER or any other statutory body;
- In response to issues raised through community feedback; and
- In response to any incident which results in a failure to meet any of the commitments of this Plan.

11. References

- Bunbury Port Development - Long Term Monitoring and Management Plan (LTMMP)

SOUTHERN PORTS

ALBANY BUNBURY ESPERANCE

ENVIRONMENTAL MANAGEMENT SYSTEM (EMS) MANUAL - BUNBURY

DOCUMENT CONTROL

Version Number	Description	Reviewed by	Approved by	Revision Date	Issue Date
00	N2184 - New document and format	HSE Manager – Document Controller	Chief Executive Officer – Kevin Schellack	18/11/2012	18/11/2012
01	N4175 – Document formatted	HSE Manager – Document Controller	Chief Executive Officer – Kevin Schellack	30/04/2014	30/04/2014
02	N144429 – Document Review	Environmental Officer – HSE Manager	HSE Manager	17/05/2017	17/05/2017
03	D18/20049 – Document Review	Environmental Officer – HSE Manager	HSE Manager	17/08/2018	17/08/2018
04	Document Review	Environmental Officer – Environment Manager	ENV Manager	25/10/2019	25/10/2019
05	Document Review	Environmental Officer – Environment Manager	Environment Manager	16/09/2020	16/09/2020

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1. INTRODUCTION

This manual provides information for understanding the structure of the EMS of the Southern Ports – Bunbury (SP - PoB). It identifies organisational structure, planning activities, roles and responsibilities within the organisation, development of staff and processes, and the procedures for continual improvement.

The Southern Ports (SP) was established on 1 October 2014 following the merger of the Albany Port Authority, Bunbury Port Authority and Esperance Ports Sea and Land. The legislation enabling the merger of the ports, *"The Ports Legislation Amendment Act 2013"*, was given Royal Assent on 21 May 2014.

In late 2017, Southern Ports Authority adopted the registered business/ trading name of Southern Ports (SP) with Southern Ports Authority remaining as the legal entity name in the Port Legislation Amendment Act 2014 – subdivision 2.

The Ports of Albany (PoA), Bunbury (PoB) and Esperance (PoE) continue to operate under local management, with supervision and governance under SP. SP is responsible to and reports to the Minister for Regional Development; Agriculture and Food; Ports; Minister assisting the Minister for State Development, Jobs and Trade (the Minister). SP is committed to contribute to the economic growth and development of the State of WA by facilitating trade in a commercial, efficient and sustainable manner.

2. STRUCTURE OF THE MANUAL

This manual is structured as follows:

- It uses the 10 control headings as set out in the ISO14001:2015 standard.
- Under each heading, the ISO14001 requirements are shown in italics.
- Brief description of how the organisation complies with the requirements of the ISO1400:2015 standard is outlined immediately below it.
- This is followed by a reference to any corresponding supporting documents.

3. LIST OF ABBREVIATIONS USED IN THIS DOCUMENT

Table 1 - List of Abbreviations

ARC	Audit and Risk Committee
BAU	Business as Usual
CCO	Chief Commercial Officer
CEO	Chief Executive Officer
COO	Chief Operating Officer
GM PORT	General Manager Port
DAWR	Department of Agriculture and Water Resources - Federal
DWER	Department of Water and Environment Regulation (WA)
DIMRS	Department of Mines, Industry Regulation and Safety
DoT	Department of Transport
DPIRD	Department of Primary Industries and Regional Development

EMS	Environmental Management System
HSE	Health, Safety and Environment
IMS	Introduced Marine Species
IMT	Incident Management Team
ISO	International Organization for Standardisation
JSA	Job Safety Analysis
KPI	Key performance indicators
MOSCP	Marine Oil Spill Contingency Plan
MSIC	Marine Security Identification Card
NORM	Naturally Occurring Radioactive Materials
OEPA	Office of the Environmental Protection Authority
OHS	Occupational Health and Safety
PDF	Portable Document Format
PoA	Port of Albany
PoB	Port of Bunbury
PoE	Port of Esperance
PCCC	Port Community Consultation Committee
RM	Regional Manager
RMF	Risk Management Framework
RMS	Records Management System
RTAP	Risk Treatment Action Plans
S &SC	Safety & Sustainability Committee
SPA	Southern Ports Authority
SP	Southern Ports
SP - PoB	Southern Ports – Port of Bunbury
SWI	Safe Working Instruction
WA	Western Australia

4. CONTEXT OF THE ORGANIZATION

4.1. Understanding the organization and its context

Requirement:

The organization shall determine:

a) the interested parties that are relevant to the environmental management system;

b) The relevant needs and expectations (i.e. requirements) of these interested parties;

c) Which of these needs and expectations become its' compliance obligations.

Demonstrating Compliance:

Understanding the external context – this is facilitated by considering issues arising from legal, technological, competitive market, cultural, social, and economic environments, whether international, national, regional or local.

Understanding the internal context – this is facilitated by considering issues related to values, culture knowledge and performance of the organization.

To comply with both requirements:

- Risk Management Framework across SP was implemented.
- SP commissioned staff and stakeholder surveys, the results of which reinforced our mission to facilitate safe, efficient and innovative trade for the benefit of our three regions, port users and our shareholder, the state government.
- The survey helped SP to better understand and determine the important issues that can affect, either positively or negatively, the way the organization manages its health, safety and environmental responsibilities.
- The stakeholder survey helped to develop the Southern Ports' Vision, Mission, and Values.
  - **Our Vision**

    Strong Regional Ports, Strong Regions
  - **Our Mission**

    To Strengthen our regional communities through smart and sustainable development of our ports,
  - **Our Values**

Accountability	Empowering people to perform well, demonstrating initiative and acting responsibly.
Safety	Demonstrating an uncompromising commitment to safety at all times.
Integrity	Holding high standards of conduct and decision making to ensure confidence and trust.
Teamwork	Working as one team to achieve common goal.
Future Focus	Building sustainable future aligned with our vision, while respecting our history.

  - The management of the stakeholder and community survey was contracted out to Kantar Public (formerly TNS). The survey involves:
    - 200 quantitative telephone interviews with stakeholders
    - 25 in-depth qualitative interviews with key stakeholders

- 300 quantitative telephone interviews with the community
- Analysis of the research findings.
    - The initial survey took place in June 2016 and repeated every year.
    - The summary of the survey findings is documented in the Annual Report

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Bunbury Port – Inner Harbour Structure Plan 2009.
- Environmental Management System Manual.
- Competitor analysis – Finance Dept.
- Economic reports from business sectors or consultant's reports - Finance Dept.
- Annual analysis of data from the stakeholder survey - CEO
- Business plans and strategy reviews - Finance Dept.
- Risk Management Framework - Risk and opportunity assessments
- HS and E Policies.
- Code of conduct Statement
- Minutes of Environmental Management review meetings (that show decisions and actions relating organizational context.
- Annual Report.

4.2. Understanding the needs and expectations of interested parties

Requirement:

The organization shall determine:

a) the interested parties that are relevant to the environmental management system;

b) The relevant needs and expectations (i.e. requirements) of these interested parties;

c) Which of these needs and expectations become its compliance obligations.

Demonstrating Compliance:

- Internal stakeholders:

Internal interested parties:	Needs and expectations:	How key issues are captured:
Employees and contractors	Shared culture, attitudes and job security	Employee meetings, consultation and feedback
Port Users	Competitive pricing, reliability and value	Client/customer reviews and relationship management/customer feedback Compliance verified during regular Port User meeting – the Port provides an operational environment that is safe and secure
Suppliers	Beneficial supplier-client relationships	Supplier reviews and relationship management
Unions and worker representatives	Representation and cooperation	Consultation and feedback on employment and safety issues

Table 2 - Internal Stakeholders

- External stakeholders could include:

External interested parties:	Needs and expectations:	How key issues are captured:
Regulators - Department of Water and Environment Regulation (DWER) – (previously known as Dept of Environment and Regulation and The Dept of Water).	• Compliance with the site Environmental Licence and the Environment Protection Act • Compliance against the issue of the licence under the 'Rights in Water and Irrigation Act 1914'.	• annual submission of AACR to the regulator • Annual Payment of Licence fee • Regulator inspection and audit • Emissions monitoring • Annual reporting of the bore water usage at berths 5 and 8
Regulators - Other	• Compliance against Requirements of the Port Authorities Act 1999 • Profitability and growth	• Consultation and engagement exercises to identify concerns • Annual reporting to the Minister
Regulators - Department of Mines and Industry Regulation Safety. (DIMRS) - previously known as DMP	Compliance to the Requirements of Mines and Safety inspection Act 1994, Occupational Safety and Health Act 1984	• Regulator inspection and audit • Consultation and engagement exercises to identify concerns.
Regulators - Department of Agriculture and Water Resources (DAWR) - Previously known as The Australian Quarantine and Inspection Service (AQIS) Following a period operating under the name Department of Agriculture, Fisheries and Forestry (DAFF) Biosecurity	Management of Biosecurity and first point of entry protocols	• Provide receptacles to accept biosecurity waste and report foreign species (IMS) intrusions. • Provide locations for the positioning of bee attractant boxes and bee surveillance hives. • Undertake IMS surveys in the marine environment.
Regulators - The Department of the Environment and Energy	Compliance with the 10 year dredging permit	• Annual dredging volume return is submitted to the regulator. • Conditions set on the permit are managed via LTMMP.

External interested parties:	Needs and expectations:	How key issues are captured:
Regulators - Department of Biodiversity, Conservation and Attractions (DBCA).	To provide assistance where necessary to the relevant Regulatory Agency or Agencies to facilitate the safe and effective rescue and or removal of any land or marine wildlife within the Port boundaries.	Report any unusual occurrence to the regulator.
Regulators - Australian Maritime Safety Authority (AMSA) and IMO	Provision of Port waste reception facilities	Oil spill management plan and Emergency Management Plan are in place.
Regulators - Clean Energy Regulator - NGER	Green House and Energy reporting established by the National Greenhouse and Energy Reporting Act 2007 (NGER Act), is a single national framework for reporting and disseminating company information about greenhouse gas emissions, energy production, energy consumption and other information specified under NGER legislation.	Estimate energy usage annually and register with NGER if the usage exceeds the reporting threshold.
Neighbours and communities	Social responsibility and engagement	Consultation and engagement exercises to identify environmental concerns via quarterly Port Community Consultation Committee (PCCC) meetings.
Local Authorities and Government	Consultation and information	Engagement with planning and development issues.
Bureau Veritas	Compliance against the ISO14001 - 2014	Internal and External audits

Table 3 - External Stakeholders

Supporting documents to demonstrate Compliance – the following documented information is available to demonstrate compliance: -

- Survey report – available from the CEO;
- Port User meeting minutes;
- Monitoring Reports;
- External regulators communications and documentation;
- PCCC meeting minutes.

4.3. Determining the scope of the environmental management system

Requirement:

The organization shall determine the boundaries and applicability of the environmental management system to establish its scope.

When determining this scope, the organization shall consider:

a) The external and internal issues referred to in 4.1;
b) The compliance obligations referred to in 4.2;
c) Its organizational units, functions and physical boundaries;
d) Its activities, products and services;
e) Its authority and ability to exercise control and influence.

Once the scope is defined, all activities, products and services of the organization within that scope need to be included in the environmental management system.

The scope shall be maintained as documented information and be available to interested parties.

Demonstrating Compliance:

Scope of the EMS:

The EMS applies to all SP - PoB operations and administration functions (see map shown below - area shaded in purple) under the direct day to day control of the SP - PoB, excluding those activities conducted by lease holders on leased sites within the port, their contractors, the licenced towage company, the lines boats and the licensed stevedores (see red dotted line on the map).

In addition, the EMS includes all marine areas within the SP - PoB limits including the shipping channel and the spoil ground for the purposes of periodic maintenance dredging, dredge material disposal and periodic sediment, water chemistry and invasive marine species monitoring and potential emergency situations, including those that can have an environmental impact.

Figure 1- Scope of the EMS – excludes lease holder site (red dotted line)

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:

- EMS scope statement clearly defines the boundaries of the EMS
- Evidence of communication of this scope to interested parties:-
  - DWER was informed of the ISO14001 certification
  - As required by the dredging permit
  - Copy of the EMS is available on the SP -Bun website and MyPort

4.4. Environmental Management System

Requirement:

To achieve the intended outcomes, including enhancing its environmental performance, the organization shall establish, implement, maintain and continually improve an environmental management system, including the processes needed and their interactions, in accordance with the requirements of this International Standard.

The organization shall consider the knowledge gained in 4.1 and 4.2 when establishing and maintaining the environmental management system.

Demonstrating Compliance:

Overview of the SP - PoB EMS

The SP - PoB EMS has been established, documented and supported with the specific objective of ensuring that all port related activities under the direct day to day control of SP - PoB achieve the environmental commitments set out in the Environmental Policy and meet ISO 14001:2015 requirements.

The EMS is designed to enable SP - PoB to address both environmental and compliance imperatives by creating a system of processes, plans and procedures that guide its performance against its environmental objectives and targets.

The ISO 14001:2015 standard emphasises continual improvement in the performance of the system and through this, improvements in SP - PoB's environmental performance are expected to be demonstrated.

SP - PoB believes that sound environmental management is a key component of its overall management responsibility from both a corporate, legal, sustainability and community responsibility perspective.

The cornerstones of the EMS are:

- Development of an Environmental Policy;
- Development and implementation of Environmental Objectives and Targets;
- Identification of environmental risks and their management
- Ongoing monitoring and reviewing of environmental performance; and
- Continuous improvement of the EMS to further enhance SP - PoB's environmental performance.

The SP Board sets environmental policy and strategic direction and the EMS is implemented, managed and monitored by SP - PoB's senior management team as part of the commitment to minimise operational environmental impacts.

The Environmental Policy, EMS manual, Risk Register, plans, other registers and procedures are the key EMS documents. They are found within the SP - PoB's Synergy Records Management System (RMS), on the SP - PoB's website and on the MYPORT Intranet.

This EMS manual describes how SP - PoB will implement its environmental management system and monitor its environmental performance. The format of the Plan will be consistent with the AS/NZS ISO 14001:2015 environmental system requirements and describe the systems and processes actioned by the SP - PoB to meet the requirements of this International Standard.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:-

- No particular evidence is needed for this requirement - it will be fulfilled by other requirements included in this document.

5. LEADERSHIP

5.1. Leadership and Commitment

Requirement: *Top management shall demonstrate leadership and commitment with respect to the environmental management system by:*

a) taking accountability for the effectiveness of the environmental management system;

b) ensuring that the environmental policy and environmental objectives are established and are compatible with the strategic direction and the context of the organization;

c) ensuring the integration of the environmental management system requirements into the organization's business processes;

d) ensuring that the resources needed for the environmental management system are available;

e) communicating the importance of effective environmental management and of conforming to the environmental management system requirements;

f) ensuring that the environmental management system achieves its intended outcomes;

g) directing and supporting persons to contribute to the effectiveness of the environmental management system;

h) promoting continual improvement;

i) Supporting other relevant management roles to demonstrate their leadership as it applies to their areas of responsibility.

NOTE: Reference to "business" in this International Standard can be interpreted broadly to mean those activities that are core to the purposes of the organization's existence.

Demonstrating Compliance:

Leadership and commitment within this organization are demonstrated by the following:-

- ***Taking accountability for the effectiveness of the environmental management system: -***

A General Manager Sustainabilty (GM – Sustainabilty) was appointed in 2020. This position is a member of the SP Executive Leadership Team (ELT) and has functional accountability for the Environment function across all SP sites. However, the day to day operational environment function is reported to the Regional Manager - Port of Bunbury

- ***Ensuring that the environmental policy and environmental objectives are established and are compatible with the strategic direction and the context of the organization;***

The environmental policy is reviewed annually and approved by the SP Board Chairman and the SP-CEO.

SP - PoB sets its objectives and targets such that they support the environmental commitments and strategies as set out in the Environmental Policy. Objectives and targets are also set with reference to the high and extreme rated environmental risks identified within the operational and strategic Risk Registers (RiskWare).

- ***Ensuring that the resources needed for the environmental management system are available;***

Functional Accountability Matrix was issued in May 2020 which defines the accountability of the executive leadership team within Southern Ports.

Position descriptions have been developed for all SP - PoB staff which set out responsibilities and authorities to facilitate effective environmental management. Individual position descriptions for SP employees are available from the HR department.

Maintenance and repair of Port Infrastructure is managed by the Maintenance and Operations Superintendent via the Operations & Maintenance Asset Management Procedure.

- ***communicating the importance of effective environmental management and of conforming to the environmental management system requirements;***

EMS Management review meeting occurs once a year unless significant change in the EMS occurs. The Regional Manager, Maintenance and Operations Superintendent, Environment Manager, Environmental Officer are present.

Issues relating to the EMS are included on the agenda for the:

- Monthly HSE and General Staff meeting
- Monthly Operations/Maintenance ‘Tool Box’ meetings
- Quarterly Port User meeting
- Quarterly PCCC meeting

The minutes of the meetings mentioned above and the monthly report to the Health and Safety Environmental committee (HSEC) are recorded in the SP Record Management System – Synergy.

In addition, the HSEC reports to the full Board meeting regarding environmental matters.

- ***ensuring that the environmental management system achieves its intended outcomes;***

Sufficient budget allocations are made each financial year for environmental activities and adequate in-house monitoring equipment is available. External specialist environmental consultancies are engaged as required for environmental monitoring, survey and analysis work plus the provision of ad-hoc advice.

- ***promoting continual improvement;***

Continual Improvements are identified by:

- Annual Minor Works and/or Capex for consideration
- Observations and Hazards raised in the INX System
- ‘Stop and think’ book
- Internal site audits and inspections
- Annual management review
- Risk assessments (RiskWare)
- Incident reports and investigations.
- Emergency drills and Desktop exercises

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Annual budget for minor works program and CAPEX
- Records in the INX data base
- Management review meeting minutes
- Risk registers/RiskWare
- HSE audit and inspection reports
- Incident reporting and investigations
- Meeting Minutes
- Reports to Regulatory Agencies.
- Environmental monitoring reports (dust, noise, water quality, sediment quality and biota sampling)

5.2. Environmental Policy

Requirement:

Top management shall establish, implement and maintain an environmental policy that, within the defined scope of its environmental management system:

a) is appropriate to the purpose and context of the organization, including the nature, scale and environmental impacts of its activities, products and services;

b) provides a framework for setting environmental objectives;

c) includes a commitment to the protection of the environment, including prevention of pollution and other specific commitment(s) relevant to the context of the organization;

NOTE: Other specific commitment(s) to protect the environment can include sustainable resource use, climate change mitigation and adaptation, and protection of biodiversity and ecosystems.

d) includes a commitment to fulfil its compliance obligations;

e) Includes a commitment to continual improvement of the environmental management system to enhance environmental performance.

The environmental policy shall:

- *be maintained as documented information;*
- *be communicated within the organization;*
- *be available to interested parties*

Demonstrating Compliance:

Electronic copy of the Environmental Policy is available within the SP-PoB's Synergy Records Management System (RMS), on the SP website and on the MYPORT intranet.

Hard copies of the policy are available at the following locations:

- Administration Office at Casuarina Drive
- HSE demountable Offices
- Operations and Maintenance Manager's office
- Workshop

The environmental policy is reviewed annually for its effectiveness and relevance by the CEO and delegated staff members and approved by the Board Chairman and the SP-CEO.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Environmental Policy
- Document Control procedure
- HSEC and Board Meeting Minutes

5.3. Organizational roles, responsibilities and authorities

Requirement:

Top management shall ensure that the responsibilities and authorities for relevant roles are assigned and communicated within the organization.

Top management shall assign the responsibility and authority for:

a) ensuring that the environmental management system conforms to the requirements of this International Standard;

b) Reporting on the performance of the environmental management system, including environmental performance, to top management.

Demonstrating Compliance:

SP - PoB has provided adequate staff resources to implement and control the EMS through the employment of personnel with specific competencies and experience in environmental science and port operations, both marine and land based.

SP - PoB employs an Environment Manager and an Environment Officer. The Environment Manager reports directly to the Regional Manager – Port of Bunbury (RM-PoB) who reports directly to the Chief Operating Officer (COO).

The SP - PoB Maintenance and Operations Superintendent and the PoB Harbour Master have specific authorities and responsibilities for ensuring that the port is controlled to ensure loading activities and shipping do not cause adverse environmental impacts.

The RM is the officer with specific responsibilities for emergency management, the most significant part of which is the prevention of and control of oil or chemical spills into the marine environment or onto land.

The RM - PoB also assumes Registered Mine Manager responsibilities under the Mines Safety and Inspection Act.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:-

- Individual position descriptions for SP - PoB employees are available from the HR Department
- Organisation Chart – available from MyPort
- Accountabilty Matrix – available from MyPort

6. PLANNING

6.1. Actions to address risks and opportunities

6.1.1. Requirement: General

The organization shall establish, implement and maintain the process(es) needed to meet the requirements in 6.1.1 to 6.1.4.

When planning for the environmental management system, the organization shall consider:

a) the issues referred to in 4.1;

b) the requirements referred to in 4.2;

c) the scope of its environmental management system;

and determine the risks and opportunities, related to its environmental aspects (see 6.1.2), compliance obligations (see 6.1.3) and other issues and requirements, identified in 4.1 and 4.2, that need to be addressed to:

- *give assurance that the environmental management system can achieve its intended outcomes;*
- *prevent or reduce undesired effects, including the potential for external environmental conditions to affect the organization;*
- *achieve continual improvement.*

Within the scope of the environmental management system, the organization shall determine potential emergency situations, including those that can have an environmental impact.

The organization shall maintain documented information of its:

- *risks and opportunities that need to be addressed;*

– *process(es) needed in 6.1.1 to 6.1.4, to the extent necessary to have confidence they are carried out as planned.*

Demonstrating Compliance:

The Risk Management Framework sets outs a process for identifying actual and potential environmental risks that result in impacts that are non-compliant with legal and SP's requirements.

There is a specific risk assessment context. To set the specific risk context, the activity that is the focus of the risk assessment is defined, and the level at which the activity occurs is determined. These are as follows:

Business Risk – Are those risks associated with the long term planning of SP's future direction. Business risk assessments are normally conducted at the CEO/Board & ELT levels. SP risk information will be maintained within the 'RiskWare' database.

Operational Risk – Arise from the day to day business functions that occur within SP. These are normally conducted at local Management levels of SP, and are assessed by the parties familiar with the particular function or service with which the risks are associated. This would typically include key staff; the identified risks are managed and maintained using the excel register/RiskWare database

Project Risk – Arise from specific projects or discrete undertakings. They tend to be one off venture which contain starting and finishing dates. Project risks exist at every stage and they need to be identified and managed to ensure the successful completion of the project. These are normally conducted at ELT and Management levels of SP and are assessed by the parties familiar with the particular project with which the risks are associated. This would typically include key staff;

Risks are monitored and reviewed on a regular basis to maintain the relevance and usefulness of information.

This Table selects the criteria for the management of risk and the decision base

Risk Level	Risk	Criteria for Risk Management		Decision Base
1-5	Low	Monitor	With adequate controls	N/A
6-9	Medium	Management Control Required	With adequate controls	COO
10-14	High	Urgent Management Attention	Only acceptable with excellent controls	CEO
15-25	Extreme	Unacceptable	Only acceptable with excellent controls	S & SC / Full Board

Table 4 - Risk acceptance and decision base table

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Risk Management Policy - available on the MYPORT intranet
- Risk Management framework - available on the MYPORT intranet
- Risk Registers
- RTAP's
- RiskWare

6.1.2. Requirement: Environmental aspects

Within the defined scope of the environmental management system, the organization shall determine the environmental aspects of its activities, products and services that it can control and those that it can influence, and their associated environmental impacts, considering a life cycle perspective.

When determining environmental aspects, the organization shall take into account:

a) change, including planned or new developments, and new or modified activities, products and services;
b) abnormal conditions and reasonably foreseeable emergency situations.

The organization shall determine those aspects that have or can have a significant environmental impact, i.e. significant environmental aspects, by using established criteria.

The organization shall communicate its significant environmental aspects among the various levels and functions of the organization, as appropriate.

The organization shall maintain documented information of its:

- *environmental aspects and associated environmental impacts*
- *criteria used to determine its significant environmental aspects;*
- *significant environmental aspects.*

NOTE: Significant environmental aspects can result in risks and opportunities associated with either adverse environmental impacts (threats) or beneficial environmental impacts (opportunities).

Demonstrating Compliance:

As required by clause 6.1.2 of the standard, SP–Bun has examined its activities and services to determine which of them have an impact on the environment. The identification of the Environmental aspects (risks) and impacts are identified and recorded by SP - PoB within the Environmental Section of the Risk Register. The Risk Register is a live document and updated on a regular basis and/or as soon as new risks are identified. Periodic Operational Exposure Summary Meeting takes place where existing risks are reviewed, and new identified risk are added.

Safe Working Instruction (SWI) are written to manage day to day operational activities. Non-routine tasks (abnormal conditions) may require a specific Job Safety Analysis (JSA) to be compiled that addresses environmental aspects (risk) and impacts and what controls are needed.

To identify possible environmental impacts of all new trade opportunities, proponents who wish to establish operations and new products are required to complete a New Trade Inquiry Form. This form provides information regarding the nature of the proposed development, product characteristic, storage and loading methods and details of environmental impact issues such as air quality, water quality, noise, odour and visual impact.

Life cycle approach is applied only to the loading of product from ‘Shed to Ship’. The identified environmental impact associated with this activity and management in place to mitigate the risks is shown below:-

INPUT	ACTIVITY	MANAGEMENT IN PLACE	OUTPUT
Labour Natural resources Materials	Approval for new and existing Proponent	Application, consideration and Approval Process – control and manage by commercial team via Southern Ports New Trade Proposals.	Emission to air, Land and Water
Labour Natural resources Materials	Issue of contract/renewal of contract	contractual agreement – control and manage by commercial team	Emission to air, Land and Water
Labour Natural resources Materials	Using existing infrastructure or improving/building new infrastructure	• if required – Process is in place for managing DWER licence amendment • Tender Process • Risk assessment	• Emission to air, Land and Water • Compliance against licence condition • Opportunity for improvement
Labour Natural resources Materials	loading/unloading of Product	• Port Users Management plan and procedures • air monitoring to assess air emission • marine and freshwater monitoring • Land/Ground water monitoring	Emission to air, Land and Water
Labour Natural resources Materials	Maintenance and repair of the infrastructure	• contractor management – permits, JSA and MSIC cards • tender process for supplier selection – control and manage by commercial team • Tender process for services – control and manage by commercial team	Emission to air, Land and Water

INPUT	ACTIVITY	MANAGEMENT IN PLACE	OUTPUT
Labour Natural resources Materials	Provision of electricity	NGERS reporting – synergy invoice and monthly meter readings	Emission to air, Land and Water
Labour Natural resources Materials	Provision of water	Water entitlement – DWER – licence condition	Emission to air, Land and Water
Labour Natural resources Materials	Waste collection	testing, storage and transport – lab reports, waste consignment notes	Emission to air, Land and Water
Labour Natural resources Materials	Regulatory requirements	DWER, DMIRS and DAWR requirements – Licence conditions	Emission to air, Land and Water
Labour Natural resources Materials	End of leased agreement	contractual agreement – available from the Commercial team	Emission to air, Land and Water
Labour Natural resources Materials	Rehabilitation of land and infrastructure	PSI and DSI	Waste disposal - approved Landfill site

Table 5 - Life Cycle Approach of Loading Bulk Products from shed to Chute

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Risk Management Framework
- Risk Register/RiskWare
- Southern Ports New Trade Proposal
- Contractual agreement between SP and Port users
- EP Act Part V licence amendment applications.
- Reports to Regulators
- Annual returns as required by the DWER licence condition
- Laboratory data
- Waste disposal consignment notes
- Tender process
- Monitoring and sampling data
- Work permits
- JSAs
- NGERS calculations
- New Trade Enquiry Form
- SWI

6.1.3. Requirement: Compliance obligations

The organization shall:

a) determine and have access to the compliance obligations related to its environmental aspects;

b) determine how these compliance obligations apply to the organization;

c) take these compliance obligations into account when establishing, implementing, maintaining and continually improving its environmental management system.

The organization shall maintain documented information of its compliance obligations.

NOTE:- Compliance obligations can result in risks and opportunities to the organization.

Demonstrating Compliance:

SP - PoB has access to applicable legal and other compliance requirements relating to its EMS through subscription to the on-line service Environment Essentials (www.enviroessentials.com.au).

This service provides monthly advisories on changes to environmental legislation and is e-mailed to the Environment Manager and Environment Officer. All SP - PoB staff have access to this on-line service via the External Publications section of the MYPORT Intranet.

HSE staff have internet access to the websites of the Department of Water and Environment Regulation (*www.dwer.wa.gov.au*) and the Department of the Environment and Energy (www.environment.gov.au) and visit these periodically to check for notification of legislation changes.

SP - PoB is also a member of Ports Australia (www.portsaustralia.com.au) and receives regular e-mail communications from this organisation with regard to proposed changes to

environmental legislation as it directly affects ports and requests for input during comment periods for proposed legislative change.

SP - PoB has also established a Legal Obligations Register which is maintained by the Environment Officer. Changes to legislative and compliance requirements are noted in the register. Where significant changes to the legislation are noted and applicable to SP - PoB, these are communicated within the monthly HSES Report that is part of the monthly Board meeting agenda. Pertinent changes are also discussed at the SP - PoB weekly Trade and Infrastructure meeting. Changes are also discussed at the monthly HSE and General Staff meeting**.**

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Legal Obligations Register
- Subscription to the on-line service Environment Essentials (www.enviroessentials.com.au)
- Monthly HSES Reports - S:\HSES Business Integration\Quarterly HSES Reports Includes Graphs

6.1.4. Requirement: Planning action

The organization shall plan:

a) to take actions to address its:

1) significant environmental aspects;

2) compliance obligations;

3) risks and opportunities identified in 6.1.1;

b) b)how to:

1) integrate and implement the actions into its environmental management system processes (see 6.2, Clause 7, Clause 8 and 9.1), or other business processes;

2) evaluate the effectiveness of these actions (see 9.1).

When planning these actions, the organization shall consider its technological options and its financial, operational and business requirements.

Demonstrating Compliance:

Environmental aspects (risks) and impacts are identified using the Risk Management Framework –see section 6.1.2 above for more details. The identified aspects are recorded by SP - PoB within the Environmental Section of the Risk Register. The identified risks are managed using the Risk Register. This register is a live document and updated as soon as new risks are identified.

Changes to legislative and compliance requirements are managed as stated in section 6.1.3 above.

The risk management process employed by SP provides a structured and systematic approach to identifying, analysing, evaluating and treating risks and combined with ongoing communication and monitoring, forms a dynamic and iterative risk management process. Risks are monitored and reviewed on a regular basis to maintain the relevance and usefulness of information.

The diagram below represents the key stages within the risk management process:

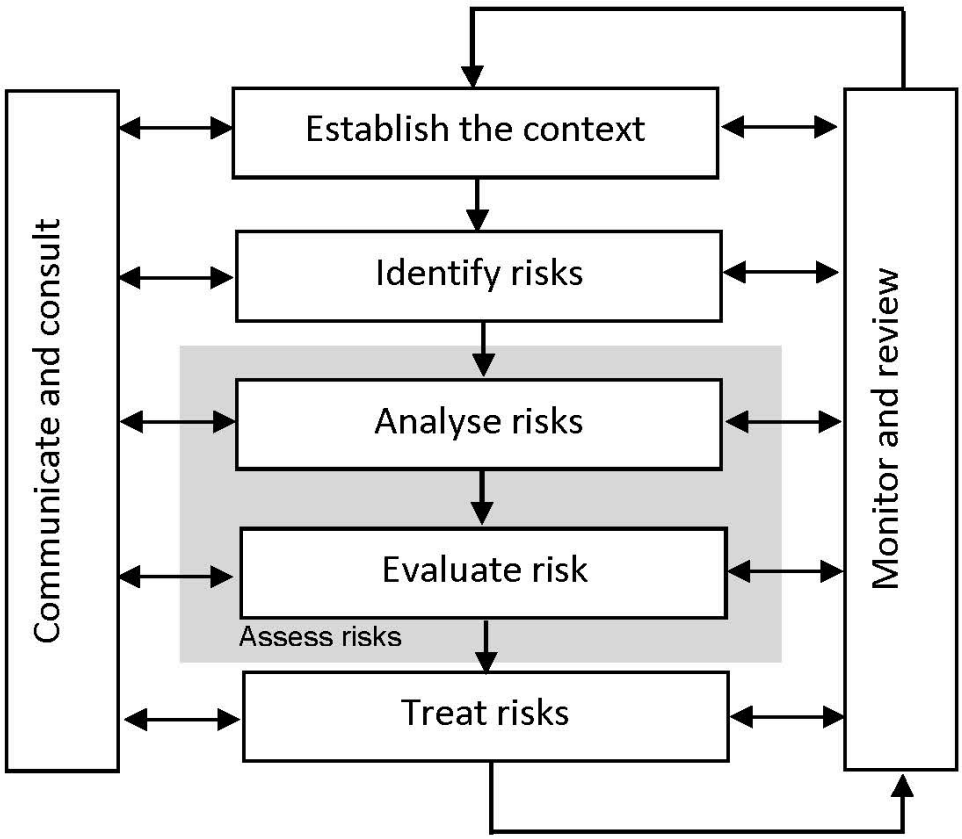

Figure 2 - Risk Management Process

Opportunity for improvement - This stage asks “What else can be done to manage this risk and improve the system?” Continual Improvements are identified by:

- the use of the ‘Observation’ book
- ‘Stop and think’ book
- Observations and hazards raised in the INX system
- Internal site audits and inspections
- Annual management review
- Risk assessments/RiskWare database
- Incident reports and investigations.
- Emergency drills and Desktop exercises

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:-

- Risk Management Framework
- Risk register/RiskWare database
- Risk Treatment Action Plans

- Monthly Operational Exposure Summary Meetings (previously called Risk Meeting)
- Compliance register
- Records in the INX database
- Incident reporting
- Inspection reports
- Internal audit reports
- Meeting minutes

6.2. Environmental objectives and planning to achieve them

6.2.1. Requirement: Environmental objectives

The organization shall establish environmental objectives at relevant functions and levels, taking into account the organization's significant environmental aspects and associated compliance obligations, and considering its risks and opportunities.

The environmental objectives shall be:

a) consistent with the environmental policy;

b) measurable (if practicable);

c) monitored;

d) communicated;

e) Updated as appropriate.

The organization shall maintain documented information on the environmental objectives.

Demonstrating Compliance:

SP - PoB sets its objectives and targets such that they support the environmental commitments and strategies as set out in the Environmental Policy. Objectives and targets are also set with reference to the high and extreme rated environmental risks identified within the Risk Register.

SP - PoB has developed an Objectives and Targets tracking spread-sheet which is updated by the Environment Manager or the Environment Officer.

The spreadsheet also sets out key performance indicators (KPI's) for each objective and target and monitors performance against the KPI's every six months.

Objectives and targets are set for:

- Air Quality
- Preston River – water and sediment quality
- Marine Water and sediment quality
- Noise
- Land and groundwater contamination
- Groundwater abstraction
- Biosecurity

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:-

- Objectives and Targets tracking register

6.2.2. Requirement: Planning actions to achieve environmental objectives

When planning how to achieve its environmental objectives, the organization shall determine:

a) what will be done;

b) what resources will be required;

c) who will be responsible;

d) when it will be completed;

e) how the results will be evaluated, including indicators for monitoring progress toward achievement of its measurable environmental objectives (see 9.1.1).

The organization shall consider how actions to achieve its environmental objectives can be integrated into the organization's business processes.

Demonstrating Compliance:

Environmental Management Plans (EMPs) have been written to outline the processes for the various monitoring programs to achieve the objectives and targets as follows:

- Air Quality Management Plan
- Biosecurity incident response
- Invasive Marine Species (IMS) Management Plan
- Long Term Dredge Materials Management Plan
- Noise Management Plan
- Waste Management Plan
- Risk Management Framework

The environmental management program has been developed to ensure legal compliance with but not limited to the requirements of the Ports Legislation Amendment Act 2014, the Environmental Protection Act 1986, the Environmental Protection (Sea Dumping) Act 1981 and subsequent amendments and the conditions set out in the SP - PoB's Berth 8/5 part V Environmental Licence and its 10 Year Sea Dumping Permit.

In addition, the program is also designed to achieve the objectives and targets described in the Environmental Objectives and Targets. The progress of the environmental management program is tracked on the *Objectives and Targets* tracking spread sheet maintained by the Environmental Officer.

Senior Management and other staff are informed of progress of the environmental management program at the weekly Trade and Infrastructure meeting. Changes are also discussed at the monthly HSE and General Staff meeting.

In addition, monthly reports prepared by the COO go to the Board's Health, Safety and Environment Committee (HSEC) which in turn provide feedback to the full Board.

Responses from the Board on the environmental management program are communicated to the relevant Bunbury senior managers by the COO or RM -PoB.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:-

- Environmental Management Plans – see MYPORT intranet
- Weekly Trade and Infrastructure meeting minutes
- Monthly HSES reports
- Monthly COO reports

- Monthly RM reports
- Monthly HSE and General Staff Meeting minutes

7. SUPPORT

7.1. Resources

Requirement:

The organization shall determine and provide the resources needed for the establishment, implementation, maintenance and continual improvement of the environmental management system.

Demonstrating Compliance:

Position descriptions have been developed for all SP - PoB staff which set out responsibilities and authorities to facilitate effective environmental management.

The SP - PoB has provided adequate staff resources to implement and control the EMS through the employment of personnel with specific competencies and experience in environmental science and port operations, both marine and land-based.

The SP - PoB employs an Environment Manager and an Environment Officer. The Environment Manager reports directly to the RM - PoB who reports directly to the COO. The COO is a member of the SP Executive Leadership Team (ELT).

The PoB Maintenance and Operations Superintendent and the Harbour Master have specific authorities and responsibilities for ensuring that the port is controlled to ensure that loading activities and shipping do not cause adverse environmental impacts.

The RM - PoB is the officer with specific responsibilities for emergency management and response, the most significant part of which is the prevention of and control of oil or chemical spills into the marine environment or onto land. The Regional Manager also assumes the Registered Mine Manager responsibilities under the Mines Safety and Inspection Act.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Individual Job descriptions – available from the HR Manager
- Organisation Chart – available in MYPORT
- Accountability Matrix – available in MyPort
- Maintenance plan via MEX system
- Emergency Management Plan
- Oil spill Management Plan
- Air Quality Management Plan
- Invasive Marine Species (IMS) Management Plan
- Long Term Dredge Materials Management Plan
- Noise Management Plan
- Waste Management Plan
- Risk Management Framework
- Odour Management Plan

7.2. Competence

Requirement:

The organization shall:

a) determine the necessary competence of person(s) doing work under its control that affects its environmental performance and its ability to fulfil its compliance obligations;

b) ensure that these persons are competent on the basis of appropriate education, training or experience;

c) determine training needs associated with its environmental aspects and its environmental management system;

d) where applicable, take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken.

NOTE: Applicable actions can include, for example, the provision of training to, the mentoring of, or the re-assignment of currently employed persons; or the hiring or contracting of competent persons.

The organization shall retain appropriate documented information as evidence of competence.

Demonstrating Compliance:

The GM Sustainabilty through the HR Manager maintains SP – Bun training records and competency that relate to the EMS.

Sufficient budget allocations are made each financial year for environmental activities and adequate in-house monitoring equipment is available. External specialist environmental consultancies are engaged as required for environmental monitoring, survey and analysis work plus the provision of ad-hoc advice.

Training needs are identified when circumstances dictate the need for new or further training and awareness. Training, Conference & Seminars Procedure outlines how a Staff can apply for training approval, for access to external training and development programs to maintain or increase skills in environmental management or environmental technical skills.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Training, Conference & Seminars Procedure – available in MYPORT
- Training records – maintained by HR department
- Training certificates
- Position descriptions

7.3. Awareness

Requirement:

The organization shall ensure that persons doing work under the organization's control are aware of:

a) the environmental policy;

b) the significant environmental aspects and related actual or potential environmental impacts associated with their work;

c) their contribution to the effectiveness of the environmental management system, including the benefits of enhanced environmental performance;

d) the implications of not conforming with the environmental management system requirements, including not fulfilling the organization's compliance obligations.

Demonstrating Compliance:

The Environmental Policy is available on the MYPORT intranet and the SP website. Hardcopies are displayed in the main admin office and the HSE/operations demountable and Workshop.

Environmental aspects (risks) and impacts are recorded in the Risk Register/RiskWare. The Risk register is currently periodically reviewed/validated by the COO in the first instance.

Further review of high and extreme ranked risks (significant environmental aspects) is regularly undertaken by the COO, CEO and at S & SC (Board sub-committee) meetings (and full Board meetings if necessary).

SP - PoB personnel are encouraged to report near misses and opportunity for improvements (Observations). These findings are captured in INX database. The reviews of the completed report are carried out by the H&SS Advisor in consultation with the RM -PoB and/or HSE personnel. They identify the corrective and / or preventative actions required to prevent a recurrence of the event and develop an agreed time frame for the corrective actions to be implemented.

Issues relating to the EMS and environmental compliance in general are included on the agenda for the monthly HSE and General Staff meeting, the weekly Trade and Infrastructure Meeting and the quarterly Port User meetings. Environmental issues are also included in the Management Report for the monthly Board meeting.

Environmental management issues are also included in the bimonthly Port Community Consultation Committee agenda.

A section of the SP - PoB on-line induction video is devoted to environmental and biosecurity awareness and other requirements for working within the port. The induction video can be viewed at the SP - Bun website (www.southerportsauthority.com.au).

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- HSE and General Staff meeting minutes
- Monthly HSES Reports for the Board
- Port users Meeting minutes
- INX Data base system

7.4. Communication

7.4.1. Requirement: General

The organization shall establish, implement and maintain the process(es) needed for internal and external communications relevant to the environmental management system, including:

a) on what it will communicate;

b) when to communicate;

c) with whom to communicate;

d) how to communicate.

When establishing its communication process(es), the organization shall:

- *take into account its compliance obligations;*
- *ensure that environmental information communicated is consistent with information generated within the environmental management system, and is reliable.*

The organization shall respond to relevant communications on its environmental management system.

The organization shall retain documented information as evidence of its communications, as appropriate.

Demonstrating Compliance:

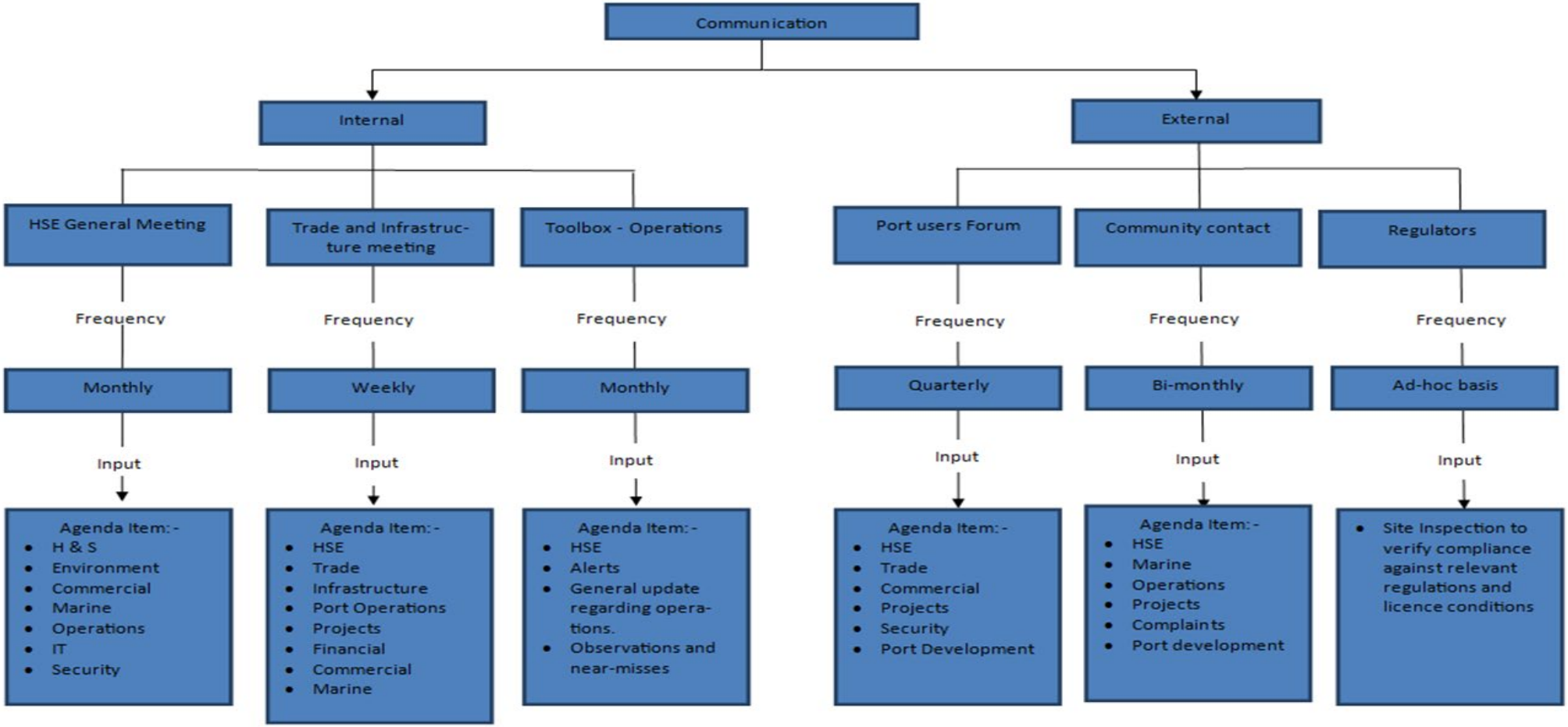

Figure 3 - Communication

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Outlook calendar
- meeting minutes
- MyPort
- Port Talk
- Annual Report
- Reports to Regulators

7.4.2. Requirement: Internal Communication

The organization shall:

a) internally communicate information relevant to the environmental management system among the various levels and functions of the organization, including changes to the environmental management system, as appropriate;

b) ensure its communication process(es) enable(s)persons doing work under the organization's control to contribute to continual improvement.

Demonstrating Compliance:

Issues relating to the EMS and environmental compliance in general are included on the agenda for the monthly HSE and General Staff meeting, the weekly Trade and Infrastructure Meeting and the quarterly Port User meeting. Environmental issues are also included in the Management Report for the monthly Board meeting and the monthly report to the HSES.

Toolbox meetings for Operational/ Maintenance personnel occurs once a month as well as the daily pre-start meeting. Environmental compliance is an agenda item during this meeting.

Management review also occurs once a year where the environmental management system is discussed in detail.

MYPORT, Port talk and Annual report are also available as communication media for all internal and external stakeholders.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Meeting minutes
- Reports to Regulatory agencies
- Outlook calendar
- MYPORT
- Port Talk
- Annual report

7.4.3. Requirement External communication

The organization shall externally communicate information relevant to the environmental management system, as established by the organization's communication process(es) and as required by its compliance obligations

Demonstrating Compliance:

External interested parties communicate through either hard copy, electronic (email or phone) or in-person at SP - PoB's Administration Office.

Quarterly Port User meetings at which environmental issues are an agenda item, include representatives from SP - PoB, lease holders, transport companies, emergency services, shipping agents, stevedores, towage companies, Boarder Force, and the federal Department of Agriculture and Water Resources for biosecurity.

The Environment Manager is the key SP -Bun contact for external regulatory agencies such as the Department of Environment and Water Resources (DWER), the Department of Agriculture and Water Resources (DAWR) and the Department of the Environment and Energy)DoEE)

Records of external contacts are maintained within the Synergy Records Management System to record community or other interested party communications regarding port operations, in particular, environmental aspects (risk) and impacts such as noise or dust.

The Environment Manager or delegate is the officer responsible for maintaining the contacts records and responding to external interested parties.

Environmental management issues are also included in the bimonthly Port Community Consultation Committee agenda.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Meeting minutes
- Outlook calendar
- Synergy records

7.5. Document Information

7.5.1. Requirement: General

The organization's environmental management system shall include:

a) documented information required by this International Standard;

b) documented information determined by the organization as being necessary for the effectiveness of the environmental management system.

NOTE: The extent of documented information for an environmental management system can differ from one organization to another due to:

- *the size of organization and its type of activities, processes, products and services;*
- *the need to demonstrate fulfilment of its compliance obligations;*
- *the complexity of processes and their interactions;*
- *the competence of persons doing work under the organization's control.*

Demonstrating Compliance:

SP - PoB has established a record management system to electronically store all documents related to Port operations.

The Document Controller ensures that electronic copies of approved EMS documents are authorised and registered into the RMS with unique record number identifier. Approved documents are available through the Document Hub on the MYPORT Intranet site

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- SP-Bun Record Keeping Plan 2020
- Controlled Document Guideline

Policy and procedures MYPORT

7.5.2. Requirement: Creating and Updating

When creating and updating documented information, the organization shall ensure appropriate:

a) identification and description (e.g. a title, date, author, or reference number);

b) format (e.g. language, software version, graphics) and media (e.g. paper, electronic);

c) review and approval for suitability and adequacy.

Demonstrating Compliance:

All EMS documentation is readily identifiable and dated and authorised. Retention, revision, suspension and archive of EMS documents are managed in accordance with the Controlled Document Guideline.

Retention of vital records in electronic record management system are managed in accordance with the State Records Act requirements and the SP - PoB Record Keeping Plan.

SP - PoB applies a document hierarchy system, a document lower in the hierarchy must relate to, and be consistent with, documents higher in the hierarchy.

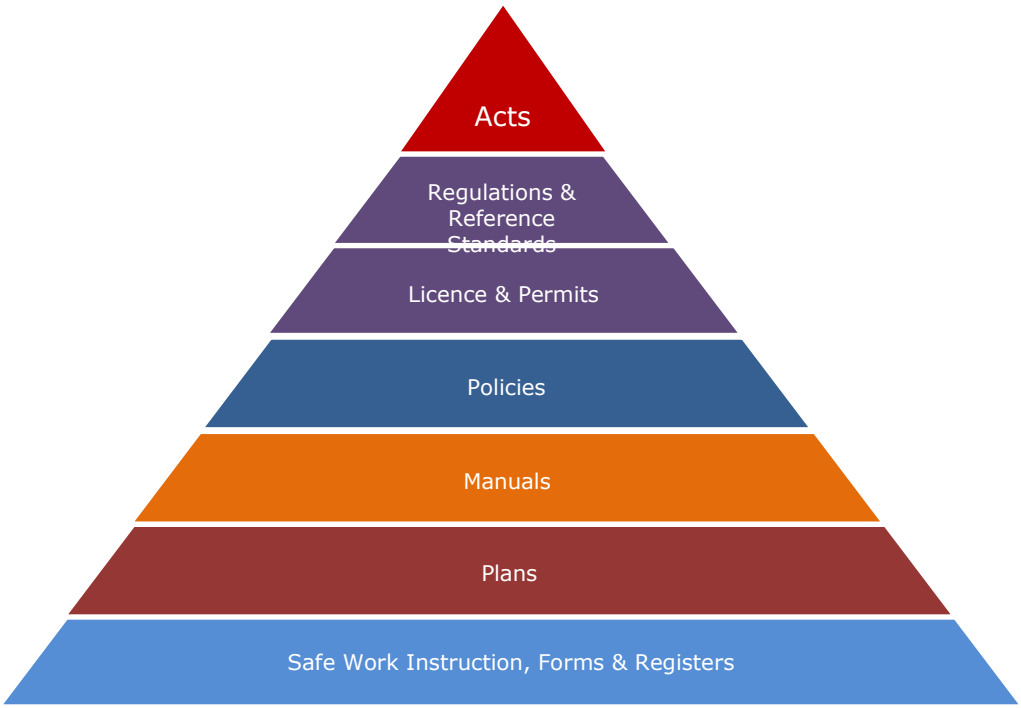

Figure 4 - Document Hierarchy System

Details for each document type are described in Table below.

Type	Description
Act	An act means Australian common law, federal laws enacted by the Parliament of Australia, and laws enacted by the Parliaments of the Australian states and territories. The Ports Legislation Amendment Act 2014 has obvious and specific relevance to SP - Bun operations. The Act specifies the requirements for; Annual Strategic Development Plan (SDP), Evidence of consideration of environmental management in strategic development of the port, the Authority's organisational structure, roles and responsibilities.
Regulations and Referenced Standards	Regulations and Referenced Standards means subsidiary regulations made under the Ports Legislation Amendment Act 2014 (the Act) governing specific internal affairs of the SP.
Licence and Permits	Licence and permits means a formal statement of the conditions which must apply to the conduct of key aspects of the port operations. These are usually issued by government regulators such as DIMRS, DDER, EPA, Department of Transport (DoT) and the DotE.
Policies	A policy is a broad statement of commitment and expectations which creates the accepted principles and rules governing the day to day activities and is aligned to the strategic objectives of Southern Ports. Policy is used as a basis for making decisions, e.g. Human Resources Policy, Risk Management Policy. A policy is implemented through Standards, Systems, Procedures and Manuals
Manuals	A manual is a detailed overview of SP– PoB's Environmental Management System. It is a written account of existing and intended future courses of action (scheme) aimed at achieving compliance against relevant standards, i.e. ISO 14001:2015 standard.
Plans	A plan is a subsidiary document to Manual
Procedures	A Safe Work Instruction (SWI) is a written document or instruction detailing all steps and activities of a process or procedure.
Guidelines	Guideline means non-mandatory approaches to the implementation of licence/permit conditions, policies or procedures. Guidelines provide flexible "good practice" recommendations and advice to assist those responsible for implementing by-laws, rules, policies, or procedures and may include codes of conduct guiding behaviour.

Table 6 - Description of Document Types

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Synergy records
- SP MYPORT intranet

Controlled Document Guideline

7.5.3. Requirement: Control of Document Information

Documented information required by the environmental management system and by this International Standard shall be controlled to ensure:

a) it is available and suitable for use, where and when it is needed;

b) it is adequately protected (e.g. from loss of confidentiality, improper use, or loss of integrity).

For the control of documented information, the organization shall address the following activities as applicable:

- *distribution, access, retrieval and use;*
- *storage and preservation, including preservation of legibility;*
- *control of changes (e.g. version control);*
- *retention and disposition.*

Documented information of external origin determined by the organization to be necessary for the planning and operation of the environmental management system shall be identified, as appropriate, and controlled.

NOTE: Access can imply a decision regarding the permission to view the documented information only, or the permission and authority to view and change the documented information.

Demonstrating Compliance:

SP - PoB staff has access to the EMS documents either in electronic form through the RMS and MYPORT Intranet. Hard copy documents can be printed if required. Printed copies of EMS documents are identified with “UNCONTROLLED WHEN PRINTED” in the document footer.

All EMS documentation is readily identifiable and dated and authorised. Retention, revision, suspension and archive of EMS documents are managed in accordance with

Controlled Document Guideline.

To ensure obsolete documents are not inadvertently used, the following requirements apply:

- Versions of documents on the MYPORT Intranet are the latest version of the documents and the Intranet is used to verify the currency of documents.
- All hard copies of documents, emailed versions of documents and electronic copies retained outside of the processes defined in this procedure are uncontrolled.
- Departmental Managers are responsible for ensuring that superseded or obsolete versions of documents are removed from all points of use.
- Superseded documents are removed from the MYPORT Internet and replaced with the Current Copy. An email is sent to all staff alerting them of the new revision requesting staff members to destroy any copies they may have either in hard copy or electronically.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- SP- PoB Record Keeping Plan 2012 (Synergy Ref. File No. SMT1/11).
- Documents on the MYPORT intranet
- Electronic documents in Record Management System
- Controlled Document Guideline

8. OPERATIONS

8.1. Operational planning and control

Requirement:

The organization shall establish, implement, control and maintain the processes needed to meet environmental management system requirements, and to implement the actions identified in 6.1 and 6.2, by:

- *establishing operating criteria for the process (es);*
- *implementing control of the process (es), in accordance with the operating criteria.*

NOTE: Controls can include engineering controls and procedures. Controls can be implemented following a hierarchy (e.g. elimination, substitution, administrative) and can be used individually or in combination.

The organization shall control planned changes and review the consequences of unintended changes, taking action to mitigate any adverse effects, as necessary.

The organization shall ensure that outsourced processes are controlled or influenced. The type and extent of control or influence to be applied to the process(es) shall be defined within the environmental management system.

Consistent with a life cycle perspective, the organization shall:

a) establish controls, as appropriate, to ensure that its environmental requirement(s) is (are) addressed in the design and development process for the product or service, considering each life cycle stage;

b) determine its environmental requirement(s) for the procurement of products and services, as appropriate;

c) communicate its relevant environmental requirement(s) to external providers, including contractors;

d) consider the need to provide information about potential significant environmental impacts associated with the transportation or delivery, use, end-of-life treatment and final disposal of its products and services.

The organization shall maintain documented information to the extent necessary to have confidence that the processes have been carried out as planned.

Demonstrating Compliance:

SP - PoB has established a Risk Register in compliance with the Risk Management Framework that identifies normal operational activities and their associated environmental aspects (risk) and impacts. Risk assessments are also conducted for new operations and for export proposals that have the potential for increased risk. Risk assessments are either conducted in-house or by the regulatory agency DWER in relation to environmental licence amendments for new export proposals that are deemed to be prescribed activities under the Environmental Protection Act.

SP - PoB requires all new proponents who wish to establish operations within the Port to contact the SP commercial team and provide information regarding the nature of the proposed development, product characteristic, storage and loading methods and details of environmental impact issues such as air quality, water quality, noise, odour and visual impact.

This information is provided in the ‘Southern Ports New Trade Proposal’ Form. The commercial team assesses the application in consultation with the relevant Departmental Managers before a decision is made to allow a new proponent to establish at the Port.

HSE Management Plans and Safe Working Instructions (SWI) are written to manage day to day operational activities. Non-routine tasks may require a specific Job Safety Analysis (JSA) to be compiled that addresses environmental aspects (risk) and impacts and what controls are needed.

'Stop & Think' form was also implemented recently for new tasks or during the task when there is a change in work or environment conditions.

The 'Stop & Think' booklet will prompt an employee to identify risks to themselves, their workmates, equipment and the environment.

The 'Stop & Think' process involves the five following steps:

- Think through the task
- Spot the hazard
- Assess the risks
- Make the changes
- Do the task safely

Works undertaken at the Port by contractors are controlled through a Contractor Authorisation to Work process.

Change management process at SP-Bun is defined below:-

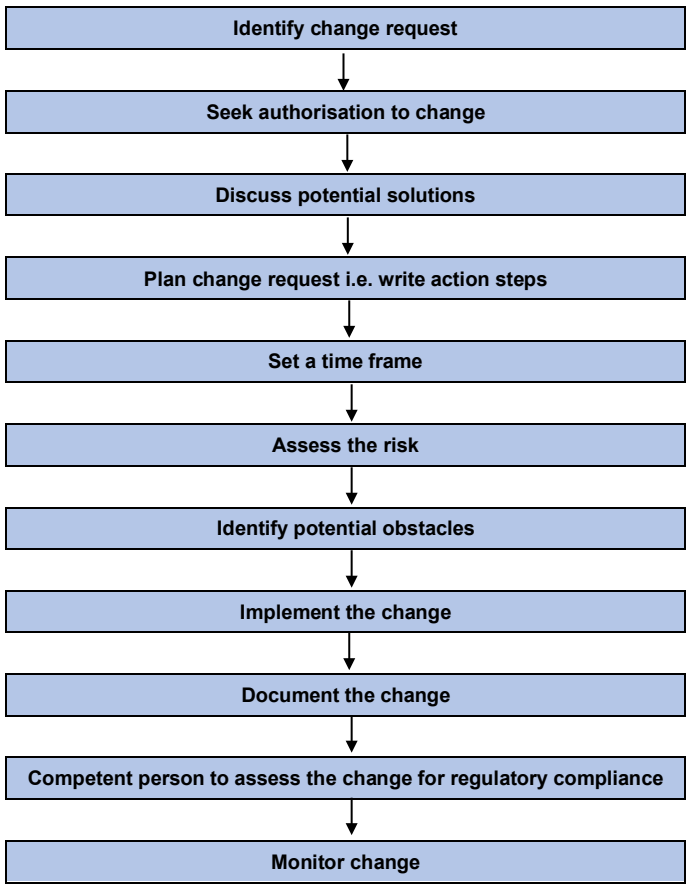

Figure 5 - Change Process Flow

Project tender conditions require the tenderer, during tender preparation, to take particular account of the requirements of Clause 14 of the 'General Conditions of Contract' which includes reference to all relevant environmental laws.

Inspections of loading equipment is undertaken prior to and during loading activities to ensure that plant and equipment controlling potential emissions to the environment such as dust control equipment is in working condition.

Maintenance of operational infrastructure is scheduled through the MEX Maintenance Software system and work is overseen by the Operations and Maintenance Manager or delegate.

At SP - PoB, the Life Cycle approach is applied only to the loading of product from 'Shed to Ship'. The process is summarised in **Table 5** of this document.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- SWI available from the RMS and SP Intranet
- Risk assessments
- Lease Holder lease agreement
- Port Access Licence
- New Trade Inquiry Form
- Project Management Plans (HSE Management Plans and Procedures)
- Operations & Maintenance Asset Management Procedure (including MEX system)
- Project tender process

8.2. Emergency preparedness and response

Requirement:

The organization shall establish, implement and maintain the process(es) needed to prepare for and respond to potential emergency situations identified in 6.1.1.

The organization shall:

a) prepare to respond by planning actions to prevent or mitigate adverse environmental impacts from emergency situations;

b) respond to actual emergency situations;

c) take action to prevent or mitigate the consequences of emergency situations, appropriate to the magnitude of the emergency and the potential environmental impact;

d) periodically test the planned response actions, where practicable;

e) periodically review and revise the process(es) and planned response actions, in particular after the occurrence of emergency situations or tests;

f) provide relevant information and training related to emergency preparedness and response, as

g) Appropriate, to relevant interested parties, including persons working under its control.

The organization shall maintain documented information to the extent necessary to have confidence that the process (es) is (are) carried out as planned.

Demonstrating Compliance:

An Emergency Management Plan has been developed for SP-PoB. This Emergency Management Plan applies to the entire SP - PoB operations covering all emergencies involving the SP - PoB and surrounding areas for which it has legal, ethical or community responsibilities. The plan is deliberately concise so that it actually assists the Incident Management Team (IMT) in a stressful situation. Business priorities in any emergency situation are firstly people, followed by environment and property including information.

The Emergency Management Plan serves as the initial document to be consulted whenever a significant issue is encountered which falls outside the parameters of Business as Usual (BAU) at the PoB. These parameters are described in Section 1.6 of the Emergency Management Plan. This document forms part of and can be used in conjunction with a series of documents as detailed in **Figure 6**.

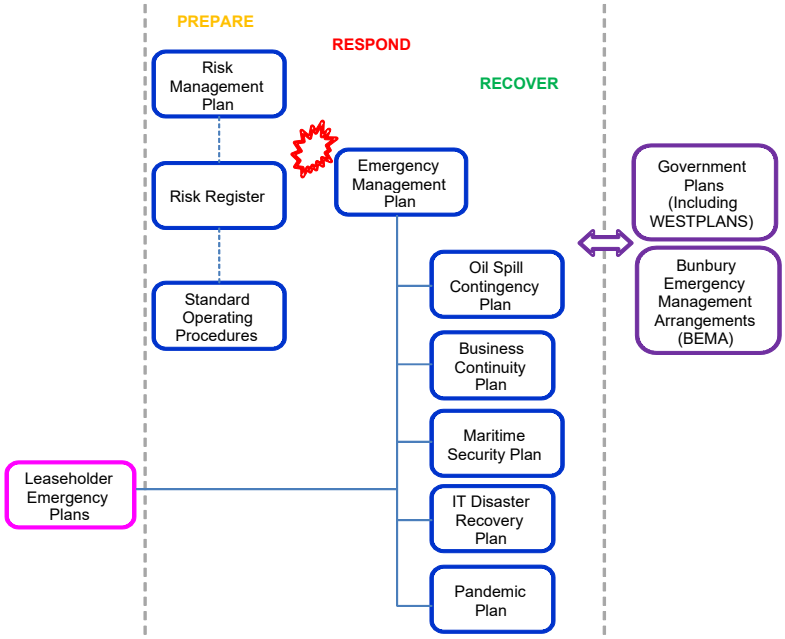

Figure 6 - SP - PoB Emergency Preparedness and Response Framework

In addition, the Marine Oil and Chemical Spill Contingency Plan Action Plan (Synergy File Ref. No. SMT1/11) has been established to provide rapid access to essential information for personnel who are nominated for response roles or who may be required to report or respond to spills.

The Action Plan contains key procedures from SP - PoB Marine Oil Spill Contingency Plan (MOSCP). The Marine Manager/Harbour Master is the officer responsible for the implementation and review of both of these plans.

Emergency exercises are conducted periodically to test SP - PoB's preparedness for dealing with emergency events that may affect the Port and its environment.

In addition, a SP Emergency Planning Committee has been established and meets periodically to review and improved emergency management processes across all of SP.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:-

- SP - PoB Emergency Management Plan
- Marine oil and Chemical Spill Contingency Plan
- Business Continuity Plan
- Maritime Security Plan – available from the Bun Security Officer
- IT Disaster Recovery Plan
- Pandemic Plan
- Emergency Exercise reports – available from GM-HSES
- Emergency Planning Committee meeting minutes

9. PERFORMANCE EVALUATION

9.1. Monitoring, measurement, analysis and evaluation

9.1.1. Requirement: General

The organization shall monitor, measure, analyse and evaluate its environmental performance. The organization shall determine: what needs to be monitored and measured; the methods for monitoring, measurement, analysis and evaluation, as applicable, to ensure valid results; the criteria against which the organization will evaluate its environmental performance, and appropriate indicators; when the monitoring and measuring shall be performed; when the results from monitoring and measurement shall be analysed and evaluated.

The organization shall ensure that calibrated or verified monitoring and measurement equipment is used and maintained, as appropriate.

The organization shall evaluate its environmental performance and the effectiveness of the environmental management system.

The organization shall communicate relevant environmental performance information both internally and externally, as identified in its communication process (es) and as required by its compliance obligations.

The organization shall retain appropriate documented information as evidence of the monitoring, measurement, analysis and evaluation results.

Demonstrating Compliance:

SP - PoB has established a comprehensive program of environmental monitoring for the marine, terrestrial, riverine and estuarine areas of the port. Monitoring records are retained in the RMS.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Synergy records – consultants' technical sampling and analysis reports.
- Synergy records **–** weekly verified particulate (dust) data reports.
- Synergy Records – Reports to regulatory agencies.
- Calibration Certificates

9.1.2. Requirement: Evaluation Compliance

The organization shall establish, implement and maintain the process (es) needed to evaluate fulfilment of its compliance obligations. The organization shall:

a) determine the frequency that compliance will be evaluated;

b) evaluate compliance and take action if needed;

c) Maintain knowledge and understanding of its compliance status.

The organization shall retain documented information as evidence of the compliance evaluation result(s).

Demonstrating Compliance:

SP - PoB has established a Legal Obligations Register and monitors EMS compliance against the obligations set out in the Register. The Environment Manager or delegate is responsible for ensuring that compliance is evaluated and reviewed.

Compliance is also monitored when reports from external consultants are submitted in relation to SP-PoB's environmental monitoring program as described in the Monitoring and Measurement element of this EMS Plan.

In addition, compliance is monitored during the SP - PoB's mandatory Internal and External audit program.

State regulatory agencies such as the DWER and Department of Mines, Industry Regulation and Safety (DIMRS) undertake either ad hoc or planned audits of SP operations for compliance against regulations or licences. Federal regulatory agencies such as the Department of the Environment and Energy (DotEE) and the Department of Agriculture and Water Resources (DAWR) also conduct audits.

Compliance with respect to the conditions in licences issued by Western Australian regulatory agencies such as DWER is monitored and reported annually to the agency through Annual Audit Compliance Reports (AACR). Compliance with respect to permits issued by Federal regulatory Agencies such as the DotEE for sea dumping of dredged materials is monitored by the Harbour Master and reported through the Environment Manager or delegate as required by the Sea Dumping Permit conditions.

The Risk Management Framework sets outs a process for identifying actual and potential environmental risks that result in impacts that are non-compliant with legal and SP's requirements.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Synergy Records

9.2. Internal audit

9.2.1. Requirement: General

The organization shall conduct internal audits at planned intervals to provide information on whether the environmental management system:

a) conforms to:

1) the organization's own requirements for its environmental management system;

2) the requirements of this International Standard;

b) is effectively implemented and maintained.

Demonstrating Compliance:

Internal environmental audits are carried out to determine that the EMS has been properly implemented and maintained and that it conforms to the requirements of the standard.

Every element in the Environmental management systems is audited on a regular basis. Activities are audited more frequently if there are significant changes taking place or considered high risk (i.e. if there is a history of problems/incidents in that area).

Audit reports are written and recommendations for corrective or preventive action are made and agreed when necessary which are recorded and tracked via an 'Activity Register'.

Audit findings and action taken are reported to the annual environmental management review meeting.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance:-

- SWI Internal Audit
- Audit reports
- Activity register

9.2.2. Internal Audit Programme

The organization shall establish, implement and maintain (an) internal audit programme(s), including the frequency, methods, responsibilities, planning requirements and reporting of its internal audits.

When establishing the internal audit programme, the organization shall take into consideration the environmental importance of the processes concerned, changes affecting the organization and the results of previous audits.

The organization shall:

a) define the audit criteria and scope for each audit;

b) select auditors and conduct audits to ensure objectivity and the impartiality of the audit process;

c) ensure that the results of the audits are reported to relevant management.

The organization shall retain documented information as evidence of the implementation of the audit programme and the audit results.

Demonstrating Compliance:

An internal audit schedule has been developed and the audits are conducted by the HSE Department. The Environment Manager is responsible for ensuring the audit schedule is met.

Only competent personnel may perform internal auditing activities. These competent personnel are classified as “Internal Auditors” and have received as a minimum the following training:

- 2 day accredited training on internal auditing techniques relating to the Standards.

Audits will be carried out to a defined scope and shall be as follows:

- Planned as per the internal audit schedule
- Unplanned: arising as a result of:
    - Customer/community complaints.
    - An incident that has environmental or health and safety impacts.
    - Following the implementation of actions outlined in the ‘Activity Register’
    - Following the identification of additional or amended procedures for products and services.

Auditors will not rely solely upon verbal confirmation but will seek documentary and actual visual evidence to support conclusions.

Auditors may make any appropriate recommendations and discuss them with the responsible person in the department.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Audit reports
- Audit Schedule
- Activity Register
- Training records (Internal Auditor)

9.3. Management review

Requirement:

Top management shall review the organization's environmental management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness.

The management review shall include consideration of:

a) the status of actions from previous management reviews;

b) changes in:

1) external and internal issues that are relevant to the environmental management system;

2) the needs and expectations of interested parties, including compliance obligations;

3) its significant environmental aspects;

4) risks and opportunities;

c) the extent to which environmental objectives have been achieved;

d) information on the organization's environmental performance, including trends in:

1) nonconformities and corrective actions;

2) monitoring and measurement results;

3) fulfilment of its compliance obligations;

4) audit results;

e) adequacy of resources;

f) relevant communication(s) from interested parties, including complaints;

g) opportunities for continual improvement

The outputs of the management review shall include:

- *conclusions on the continuing suitability, adequacy and effectiveness of the environmental management system;*
- *decisions related to continual improvement opportunities;*
- *decisions related to any need for changes to the environmental management system, including resources;*
- *actions, if needed, when environmental objectives have not been achieved;*
- *opportunities to improve integration of the environmental management system with other business processes, if needed;*
- *any implications for the strategic direction of the organization.*

The organization shall retain documented information as evidence of the results of management reviews.

Demonstrating Compliance:

As required by Clause 9.3 of the Standard the RM – PoB, Maintenance and Operations Superintendent and other Senior Managers meet every 12 to 15 months unless a significant change or changes in the EMS occurs to review the EMS to ensure its continuing suitability for the needs and objectives of the organisation and its adequacy and effectiveness. The meeting also sets and progresses environmental objectives and targets.

The agenda includes the following items:

- the status of actions from previous management reviews;

- changes in:
  - external and internal issues that are relevant to the environmental management system;
  - the needs and expectations of interested parties, including compliance obligations;
  - its significant environmental aspects;
  - risks and opportunities;
- the extent to which environmental objectives have been achieved;
- information on the organization's environmental performance, including trends in:
  - nonconformities and corrective actions;
  - monitoring and measurement results;
  - fulfilment of its compliance obligations;
  - audit results;
- adequacy of resources;
- relevant communication(s) from interested parties, including complaints;
- opportunities for continual improvement

the meeting minutes is distributed to relevant personnel and notes of action points are added to the action register and followed-up to completion.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Activity Register
- Management Review Meeting Minutes

10. IMPROVEMENT

10.1. Requirement: General

Requirement:

The organization shall determine opportunities for improvement (see 9.1, 9.2 and 9.3) and implement necessary actions to achieve the intended outcomes of its environmental management system.

Demonstrating Compliance:

Opportunities for Improvement at SP–Bun is driven by a number of processes including:

- Risk assessments – using the Risk Management Framework
- Internal and external audits
- Internal and external inspections
- Incident reports and investigations
- Observations/Hazard reports
- Community and customer complaints/feedback
- Customer satisfaction
- Market research and analysis
- Inputs from employees, suppliers and other interested parties
- Records of product or process non-conformances

- Data from process and product characteristics and their trends
- Emergency drills and desktop exercises

For example, 'opportunities for improvement' at Berth 8 conveyor system are considered in the 'Shed to Chute' assessment carried out by GHD.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Risk Management Framework – section 5 and 5.3.4
- Risk Treatment Action Plans
- Audit/Inspection reports
- Incident investigation Reports
- Survey reports
- Community and customer complaints/feedback records
- Customer satisfaction surveys
- Market research and analysis reports
- Inputs from employees, suppliers and other interested parties
- Records of product or process non-conformances
- Data from process and product characteristics and their trends

10.2. Requirement: Non-conformity and corrective action

Demonstrating Compliance:

When nonconformity occurs, the organization shall:

a) react to the nonconformity and, as applicable:

1) take action to control and correct it;

2) deal with the consequences, including mitigating adverse environmental impacts;

b) evaluate the need for action to eliminate the causes of the nonconformity, in order that it does not recur or occur elsewhere, by:

1) reviewing the nonconformity;

2) determining the causes of the nonconformity;

3) determining if similar nonconformities exist, or could potentially occur;

c) implement any action needed;'

d) review the effectiveness of any corrective action taken;

e) make changes to the environmental management system, if necessary.

Corrective actions shall be appropriate to the significance of the effects of the nonconformities encountered, including the environmental impact(s).

The organization shall retain documented information as evidence of:

- *the nature of the nonconformities and any subsequent actions taken;*
- *the results of any corrective action.*

Demonstrating Compliance

In addition, inspections and audits of Port operations and administrative processes identify non-conformances that are corrected by line management. The non-conformance is recorded in the 'Action Register' and usually communicated via internal email and the records of corrective and preventative actions taken held on the RMS.

Non-compliances identified by regulatory agencies are communicated to the SP - PoB in either hard copy or electronic form. In the case of the DMIRS, environmental non-conformances are recorded in the Mines Record Book (and the DMIRS on-line SRS) which is held by SP - PoB's Registered Mine Manager.

Non-conformances identified by the DWER can be communicated either by a hard copy Environmental Field Notice (EFN), email or by letter.

Actions taken by SP - PoB to correct the non-conformance are communicated to the Regulator by email or by letter. Copies are held in the SP-PoB's RMS.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Records held in the RMS
- Records held in the on-line DMIRS SRS
- EMS Management Review meeting minutes
- Incident Investigation Reports

10.3. Requirement: Continual Improvement

Requirement:

The organization shall continually improve the suitability, adequacy and effectiveness of the environmental management system to enhance environmental performance.

Demonstrating Compliance:

The SP–Bun Environment Team through its internal audit and inspection process identifies opportunities to improve the suitability, adequacy and effectiveness of the EMS. In addition, environmental monitoring reports are reviewed to identify opportunities for improvement. External consultancies are engaged to peer review the environmental monitoring systems to assess data quality, data capture % and cost effectiveness and make recommendations for improvement if deemed necessary.

External consultancies also recommend changes to the sampling methodologies and sampling frequencies to ensure that the monitoring program provides the necessary environmental due diligence outcomes and legal compliance based on environmental impact risk potential.

Changes to legislation are continuously assessed to verify compliance and identified opportunity for continual improvement.

New trade is risk assessed to ensure the EMS is sufficiently structured to take into account any new environmental impacts identified. In addition, the licence amendment process through DWER also employs a risk assessment process to set appropriate conditions for new products to ensure environmental impacts are mitigated.

Ongoing review of the EMS is essential to ensure its associated management plans remain relevant and any opportunity for improvement is identified.

Supporting documents to demonstrate Compliance – the following documented information are available to demonstrate compliance: -

- Review of risk register

- Review of TAPS
- Risk assessments provided by DWER and licence condition compliance reports
- Monitoring reports (dust, noise)

APPENDIX A – ENVIRONMENTAL POLICY

The current Version of the Southern Ports Environmental Policy is available on the Southern Ports Website and on MyPort - Environmental Policy.pdf

SOUTHERN PORTS
ALBANY BUNBURY ESPERANCE

Environmental Policy

Southern Ports strive to minimise the impacts from Port operations on the environment and the community from Southern Ports controlled areas.

This Policy is relevant to all Southern Ports controlled activities within the land and marine operational areas at the Ports of Albany, Bunbury, Esperance and the West Perth office.

COMMITMENT STATEMENT

Southern Ports is committed to:

- identifying and managing environmental and community health and amenity risks to reduce or eliminate impacts.
- ensuring sustainable development is a goal that is included in all decisions.
- recognising the on-going custodianship of port lands and waters where practicable.
- recognising that the ports responsibility for their activities extends beyond the ports boundaries to the adjacent communities and environment.
- being guided by ISO 14001 Environmental Management Systems and complying with all applicable environmental legislation.
- providing resources, training and support to meet environmental objectives.
- jointly setting and reviewing meaningful environmental targets with Southern Ports staff to ensure continual improvement.
- ensuring this Policy is displayed, communicated, implemented and periodically updated to reflect changes that may impact upon the environment.
- engaging with employees, contractors, port users, the community, government, and other stakeholders on actions to reduce risks to the environment.
- reporting all environmental risks and incidents.

RESPONSIBILITIES & EXPECTATIONS

The Chief Executive Officer and delegated staff members of each Southern Ports site are responsible for ensuring compliance with this Policy.

REVIEW AND UPDATE

This Policy will be reviewed at least every two years or when a change is identified through strategic intent or legislation.

Approved by the Board at the Board meeting held on 23 July 2020.

Chair

Chief Executive Officer

BUREAU VERITAS
Certification

Certification

Awarded to

SOUTHERN PORTS PORT OF BUNBURY

54 CASUARINA DRIVE, BUNBURY, WA 6230
AUSTRALIA

Bureau Veritas certify that the Management System of the above organisation has been audited and found to be in accordance with the requirements of the management system standards indicated below

STANDARD

ISO 14001:2015

SCOPE OF SUPPLY

PROVISION OF ADMINISTRATION, OPERATION AND MAINTENANCE OF PORT OF BUNBURY FACILITIES

Original Approval Date: **10 April 2013**

Subject to the continued satisfactory operation of the organisation's Management System, this certificate is valid until: **9 April 2022**

To check the validity of this certificate please call tel. **1800 855 190**

Further clarification regarding the scope of this certificate and the applicability of the Management System requirements may be obtained by consulting the organisation.

Certificate Number: **AU003482-1**

Date: **5 April 2019**

Andrew Mortimore
Vice President – I&F Pacific Region

Managing office: Bureau Veritas Pty Ltd, 3/435 Williamstown Road, Port Melbourne, Victoria, 3207

Issuing office: Bureau Veritas Pty Ltd, 3/435 Williamstown Road, Port Melbourne, Victoria, 3207

JAS-ANZ
www.jas-anz.org/register

BUREAU VERITAS

Appendix B **Protected Matters- MNES layers**

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 12-Jul-2021

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	55
Listed Migratory Species:	44

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	68
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	5
Key Ecological Features (Marine):	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Zanda baudinii listed as Calyptorhynchus baudinii Baudin's Black-Cockatoo, Long-billed Black-cockatoo [87736]	Endangered	Breeding known to occur within area
Zanda latirostris listed as Calyptorhynchus latirostris Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat known to occur within area
FISH		
Nannatherina balstoni Balston's Pygmy Perch [66698]	Vulnerable	Species or species habitat may occur within area
Thunnus maccoyii Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
MAMMAL		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
[Pseudocheirus occidentalis](#) Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat known to occur within area
PLANT		
[Austrostipa bronwenae](#) [87808]	Endangered	Species or species habitat may occur within area
[Banksia nivea subsp. uliginosa](#) Swamp Honeypot [82766]	Endangered	Species or species habitat may occur within area
[Caladenia huegelii](#) King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat may occur within area
[Diuris drummondii](#) Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat may occur within area
[Diuris micrantha](#) Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
[Diuris purdiei](#) Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
[Drakaea micrantha](#) Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat may occur within area
[Eleocharis keigheryi](#) Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat may occur within area
[Lambertia echinata subsp. occidentalis](#) Western Prickly Honeysuckle [64528]	Endangered	Species or species habitat may occur within area
[Synaphea sp. Fairbridge Farm (D. Papenfus 696)](#) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
REPTILE		
[Caretta caretta](#) Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
[Chelonia mydas](#) Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
[Dermochelys coriacea](#) Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area

Scientific Name	Threatened Category	Presence Text
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Foraging, feeding or related behaviour likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat may occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Anous stolidus Common Noddy [825]		Species or species habitat may occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Foraging, feeding or related behaviour known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Foraging, feeding or related behaviour likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Stercorarius skua as Catharacta skua Great Skua [823]		Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Dotterel, Hooded Plover [87735]		Species or species habitat likely to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area overfly marine area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Breeding likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

EPBC Act Referrals [Resource Information]

Controlled action			
Title of referral	Reference	Referral Outcome	Assessment Status
Bunbury Port Berth 14A Expansion & Coal Storage & Loading Facility, WA	2014/7200	Controlled Action	Post-Approval

Not controlled action			
Title of referral	Reference	Referral Outcome	Assessment Status
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed

Not controlled action (particular manner)			
Title of referral	Reference	Referral Outcome	Assessment Status
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval

Referral decision			
Title of referral	Reference	Referral Outcome	Assessment Status
Bunbury Port Berth 14 Development, Bunbury Port Inner Harbour	2011/6023	Referral Decision	Completed

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix C **Spoil Ground Dispersion Investigation report**

Spoil Ground Dispersal Investigation

Prepared for the Southern Ports Authority

Marine and Freshwater
Research Laboratory
Environmental Science

Environmental and Conservation Sciences
College of Science, Health, Engineering & Education
(Report No. MAFRL 20-2)
Murdoch University
June 2020

F-S-A Reference: GOVE-1688532262-1168

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Executive Summary

The Marine and Freshwater Research Laboratory (MAFRL) on behalf of the Southern Ports Authority - Port of Bunbury, carried out an investigation to identify the source of sludge-like material discovered on recreational craypots which had been set along the inshore reef 100-300 m offshore from the Binningup town beach during the summer of 2018/2019 as was reported by local fisherman from the town. Speculation by locals as to the source of the "sludge" said it was possibly from hydrocarbons and metals in sediment that had been transported from annual maintenance dredging activities routinely conducted between October and February each year by the Port of Bunbury. The spoil ground is situated some 12.5 kilometres to the south of Binningup township.

Water quality and sediment quality indicators were measured seasonally across seven sites stretching 26 kilometres of coastline from Bunbury Port in the south to the Harvey River Diversion Drain in the north to see if there were any trends occurring of consistently high phytoplankton and nutrient concentrations. Metal toxicants and hydrocarbons were also measured to identify any areas of potential contaminants from anthropological sources. Profiles of physical and chemical parameters; depth, temperature, salinity, dissolved oxygen, pH, turbidity were measured *in situ* and water samples were collected for the laboratory analysis of ammonium, nitrate-nitrite, total nitrogen, filterable reactive phosphorus, total phosphorus, chlorophyll a and total suspended solids (TSS).

Settlement plates were deployed 0.5 m above the seabed in three locations (the spoil ground and the two Binningup sites) to replicate if any sludge material could be collected over time, any macroalgal growth identified and any settled material analysed for chemical composition (metals and hydrocarbons). In addition, visual (video) transects were undertaken seasonally of selected sites.

During the SPA dredging campaign, that occurred over the period 29 February to 21 March 2020, MAFRL monitored water quality parameters at increasing distances from the dredge plume resulting from dumping of spoil on the designated spoil ground. Drone aerial photos of this event were also taken.

A synopsis of the findings is as follows:

Water quality

- Nutrients and metal/metalloid concentrations at all sampling sites were below the ANZG (2018) guideline values for marine water with a 95% level of species protection for slightly disturbed ecosystems during each sampling occasion.

- This was by no means an exhaustive water quality sampling regime and other influences, that occurred outside of the sampling occasions for this project, could introduce higher metal and nutrient concentrations to inshore marine waters. For example, other studies have found higher nutrient and metal concentrations in the Binningup area after high winter rainfall caused by terrestrial runoff from agricultural, industrial and residential areas and influence of exports from rivers and estuaries.
- During the April 2020 sampling occasion an extensive *Trichodesmium* (a blue-green microalga that fixes nitrogen) bloom was observed floating on the water surface of the majority of sites. *Trichodesmium* is commonly found in oligotrophic (nutrient poor) waters, often when waters are calm, the mixed layer depth is shallow (Capone *et al*. 1997) and the water temperature is above 20°C (Bergman *et al.* 2013).
- Physico-chemical parameters (salinity, dissolved oxygen, temperature, pH and turbidity) were typical of the well mixed inshore marine water in this area.

Sediment quality

- All metals/metalloids in sediment were below the Simpson et al. (2013) sediment quality guidelines (SQG) where guidelines were available, at all sites sampled (Bin_Lag, Bin_Reef and SG) and all sampling occasions.
- Some metal concentrations and total phosphorus concentrations were higher in the sediment at site Bin_Lag compared to Bin_Reef and SG. Bin_Lag also had a higher percentage of small particle size fractions. Contaminants (such as metals and phosphorus) are most often associated with fine sediment because this fraction consists of particles with relatively large surface to volume ratios.
- Total petroleum hydrocarbon concentrations were measured in sediments during the last sampling occasion (April 2020) for the sites Bin_Lag, Bin_Reef and SG. All results were below the Simpson et al. (2013) SQG and the laboratory LORs.

Settlement Plates

- The macroalgal growth on the settlement plates differed over time and between sites with the November 2019 – February 2020 deployment showing the highest macroalgal biomass and species types and sites Bin_Lag and Bin_Reef higher biomass and species diversity than other sites. This is not unusual as the summer period provides increased light and temperature and calmer conditions more conducive for algal growth. In addition, the Binningup sites being close to reef had a larger number of different types of algal propagules to settle on the plates as

opposed to sites HRD and SG which were mainly comprised of large sandy areas.

- Metal concentrations were generally higher in the macroalgae/sediment attached to the settlement plates, than in the sediment or water. There are no metal guidelines for settlement on plates but in comparison to the sediment guidelines; all the values were below the guidelines. Hydrocarbon analysis of the material on the plates determined that the main compounds were plant waxes, biogenic fatty acids or other biogenic organic carbons. The only non-biogenic source detected was from the plasticiser from the PVC settlement plates. Petroleum hydrocarbons were not identified.
- The November 2019 – February 2020 deployment coincided with high algal growth and highly mobile sand movement and the resultant material on the plates from Bin_Reef and Bin_Lag had a definite sludge-like appearance. In addition, the mucilage associated with macroalgal propagules may have contributed to capturing sediment and contributed to the visual sludge-like appearance of material on the plates.

Visual Transects

- The macroalgae of the Bin_Lag and Bin_Reef sites changed over the seasons as part of the dynamic, diverse and highly competitive intertidal reef community.

Monitoring of Spoil Dumping

- The spoil ground is located in an area of considerable hydrodynamic activity which results in sediment erosion. Seabed sediments in this area are transported shoreward and northwards, although northwest winter storms may reverse the net pattern of transport.
- The principal sources of sediment being moved along the coast include sediment moved landward off the continental shelf, modern bioproduction of material in the seagrass meadows and reefs of Geographe Bay, erosion of dunes south of Bunbury as well as seasonal reworking of beach material.
- Seasonal changes take place on beaches from summer to winter resulting in localised sediment transport. Generally, sediment is removed from beaches during winter. The sand is taken into the surf zone where it forms a sand bar. As the season changes and lighter southerly breezes take over, the sand bar migrates back to the beaches.
- The extent of the dredge plume was very small and localised and concentrations of contaminants on the spoil ground low. Although net sediment transport is northward, the contribution of sediment from the spoil ground to Binningup would be very low relative to other sediment

sources. Therefore, the impact of sediment from the spoil ground to the Binningup area would be considered low.

Conclusion

Concentrations of nutrients and metals were low and petroleum hydrocarbons were not detected in the water, sediment and on the settlement plates at sites in the study area over the sampling period. The extent of the dredge plume during the dumping of spoil on the spoil ground was very localised. The November 2019 – February 2020 settlement plate deployment coincided with high algal growth and highly mobile sand movement and the resultant algal/sediment material on the plates from Bin_Reef and Bin_Lag had a definite sludge-like appearance. In addition, the mucilage associated with macroalgal propagules that settled on the plates may have contributed to capturing sediment and contributed to the visual sludge-like appearance of material on the plates. Therefore, it was determined that the formation of material on the settlement plates was due to natural processes.

1.0 Introduction

The Marine and Freshwater Research Laboratory (MAFRL) on behalf of the Southern Ports Authority, Port of Bunbury carried out an investigation to identify the source of sludge-like material discovered on recreational craypots. The craypots had been set along the inshore reef 100-300 m offshore from the Binningup town beach during the summer of 2019 as was reported by local fisherman from the town. Speculation by locals as to the source of the "sludge" said it was possibly from hydrocarbons and metals in sediment that had been transported from annual maintenance dredging activities routinely conducted between October and February each year by the Port of Bunbury and dumped on the spoil ground some 12.5 km to the south.

1.1 Location and human influences

Binningup is a coastal town located approximately 30 km north of Bunbury in the South West of Western Australia. It recorded a local population of 1,227 with 692 private dwellings during the 2016 census. It is located within the Shire of Harvey, with the Harvey River Diversion Drain approximately 5 km to the north and Leschanault Estuary 26 kms to the south. The stretch of coastline between Binningup and Bunbury is fringed with inshore shallow reefs and it is exposed to Westerly winds and swells from the Indian Ocean. The beach extends both to the north and south.

Just to the north of the town is the Southern Seawater Alliance Binningup Desalination Plant for which construction was completed in June 2011 and commercial operation began in March 2012. It produces some 100 gigalitres of potable water (33% of Perth's water supply) and returns 140 gigalitres of brine discharge via an ocean outfall diffuser to the receiving environment (Water Corporation 2008). The ocean outfall diffuser is located in approximately 10 m of water, some 1100 m west of the shoreline.

Further to the north (approximately 5 km) is the Harvey Diversion Drain outlet to the sea, built to reclaim land for agriculture by reducing flooding downstream. Once enough rainfall occurs, riverine water is discharged to the ocean.

Approximately half way between Binningup townsite and Bunbury are Tronox's Kemerton treated effluent ocean outfall along the Leschenault Peninsula and the Collie Power Station cooling water ocean outfall.

Further to the south and just north of Bunbury is mouth of the Leschenault Estuary. The Collie and Preston Rivers are the main catchment rivers, which enter the estuary from the southern end and in addition to catchment runoff, discharge to the ocean via the cut in the peninsula. Other rivers in the catchment area include the Brunswick River, Ferguson and Wellesley as well as numerous other creeks, streams and irrigation drains.

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The Port of Bunbury is located in Koombana Bay on the south-western coast of Western Australia, 175 kilometres south of Perth and is operated by the Southern Ports Authority (SPA). The Port is divided into two primary commercial areas: the older Outer Harbour and the man-made Inner Harbour constructed in the 1970s. The Port services the farming, mining and timber industries of the south west.

Approximately 7 km to the south of Bunbury is the Water Corporation's Bunbury Wastewater Treatment Plant Ocean Outfall. The ocean outfall is 1.7 km offshore in approximately 10 m of water and discharged 4.25 billion litres in 2018 with average 354ML per month (from national outfall database website https://www.outfalls.info/).

Another source of nutrients to the Binningup inshore reef environment is from direct groundwater discharge and land runoff from the agricultural, light industrial, recreational and housing areas in the near catchment surrounding the Binningup area. Beneath the Binningup townsite the average annual groundwater level is higher than surrounding coastal areas; this could indicate groundwater recharge is enhanced in the township area. Groundwater flow is towards the ocean where discharge occurs above a saline water interface (Rockwater 2009).

1.2 SPA-Bunbury maintenance dredging requirements

Historically the volume of material requiring dredging, principally from the Outer Harbour and Approach Channel, has been in the order of 200,000–300,000 m^3 per year but undertaken triennially (Southern Ports 2017). The most recent maintenance dredging programs took place during two days in early November 2019 with approximately 34,000 m^3 material being dredged and over a three-week period in March 2020, with approximately 228,000 m^3 of material being dredged and disposed to the existing offshore Spoil Ground, to maintain the Port's declared depths.

The sand and wrack inundation of the Port's Outer Harbour and shipping channel appears to be as a result of increased coastal processes transporting sand around Point McKenna due to the sand traps created by groynes being full and thus being bypassed. At present there appears to be no solution to this other than to regularly remove the sand by dredging and transporting it to the spoil ground.

1.3 Dredging methods

Maintenance dredging of the fine to coarse sand sediments of the Outer Harbour and the Shipping Channel is achieved using a trailer suction hopper dredge (TSHD). The method has been employed on all maintenance dredging programs in the past and will be used for all future programs. In addition, a "sweep bar" has been used to remove any high spots left after dredging. In recent times, the shipping channel has been cleared of accumulated wrack prior to dredging using a net trawling method.

1.4 Objectives

The specific objectives of the sludge monitoring program were to:

- Investigate the potential for dredge spoil from the Port of Bunbury to contribute to the occurrence of a sludge-like deposition on crayfish pots near Binningup township, 12.5 km North of the Port's spoil ground location.
- Locate any consistently high areas of nutrient, phytoplankton, metal toxicants and hydrocarbon concentrations along the coastline from the Harvey River Diversion Drain north of Binningup to just south of the Bunbury Port.
- Measure the spatial extent and physical dispersion characteristics of the sediment plume generated whilst sea dumping is taking place at the Port's spoil ground.
- If possible, identify the sludge-like material and the cause of its formation.

2.0 Methods

2.1 Sampling locations and timing

The Marine and Freshwater Research Laboratory (MAFRL) monitored eight locations from the Harvey River Diversion Drain, to the north of Binningup, to reference sites south of the Bunbury Port (Table 1, Figure 1 and Figure 2). Sampling occurred over five occasions on the 16 July 2019, 8 November 2019, 26 February 2020, 13 March 2020 and 23 April 2020. Not all methods were the same each time. Dredging and disposal of spoil of the SPA_Bunbury Harbour occurred during 8-10 November 2019 and 29 February – 21 March 2020.

Table 1: Sampling site coordinates (Datum GDA 94 Zone 50H)

Site	Location	Easting	Northing
HRD	Harvey River Diversion Drain	377329	6335974
SSDP	200 m offshore Southern Seawater Desalination Plant diffuser	377524	6333422
Bin -Reef	Binningup 200 m offshore (reported crayfish pot location on western side of reef)	377190	6331342
Bin- Lag	Binningup Lagoon (Eastern side of reef)	377200	6331231
KEM	Kemerton – near Tronox Pigment diffuser and Collie Power Station diffuser outfalls	376971	6325758
SG	Dredge Spoil Ground	375003	6317924
Ref 1	Reference Site 1	372514	6313340
Ref 2	Reference Site 2	372387	6313178

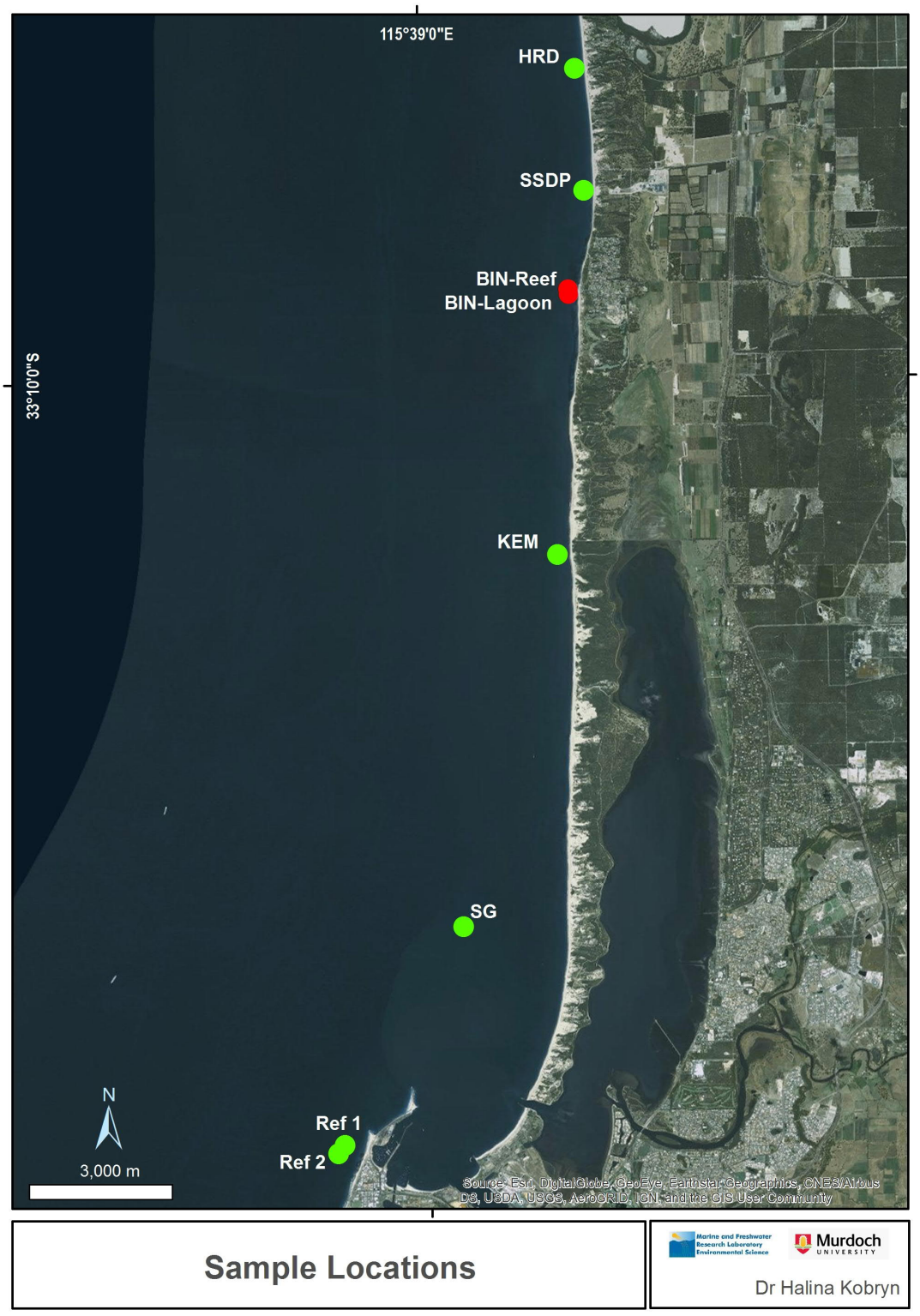

Figure 1: Locations of the sampling sites

Figure 2: Closeup detail of the Binningup reef sampling sites

2.2 Field Sampling

Field sampling encompassed the following procedures:

- Seawater quality sampling.
- Sediment quality sampling.

- PVC settlement plates deployed at 0.5 m above seabed.
- Binningup reef visual inspection for presence of sludge material.
- Monitoring the dumping of spoil during the March dredging campaign.

The field sampling procedures and which sites and dates the sampling was undertaken are shown in Table 2. The methods outlined in this section follow the Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (EPA, 2005).

Table 2: Sampling procedures undertaken at various sites over time

Sampling Procedure	16 July 2019	8 November 2019	26 February 2020	13 March 2020	23 April 2020
Water Quality					
Nutrients, TOC, metals, chlorophyll a and TSS	All sites	All sites	All sites	-	All sites
Profiles	All sites	All sites	All sites		All sites
LOI, turbidity, TSS, filtered and unfiltered Cu and Zn	-	-	-	SG	-
Sediment Quality					
PSD, metals and TOC	Bin_Lag and SG	Bin_Lag and SG	Bin_Lag and SG	-	Bin_Lag, Bin_Reef and SG
Hydrocarbons	-	-		-	Bin_Lag, Bin_Reef and SG
Plates					
Deployed/Retrieved	Deployed at HRD, Bin_Reef, Bin_Lag and SG	Retrieved and deployed at HRD, Bin_Reef, Bin_Lag and SG	Retrieved and deployed at HRD, Bin_Reef, Bin_Lag and SG	-	Retrieved at HRD, Bin_Reef, Bin_Lag and SG
Total dry weight, LOI	-	HRD, Bin_Reef, Bin_Lag and SG	HRD, Bin_Reef, Bin_Lag and SG	-	HRD, Bin_Reef, Bin_Lag and SG
Algal IDs	-		HRD, Bin_Reef, Bin_Lag and SG	-	HRD, Bin_Reef, Bin_Lag and SG
TPH and metals	-		HRD, Bin_Reef, Bin_Lag and SG	-	HRD, Bin_Reef, Bin_Lag and SG
Visual Inspection (video transects)	Bin_Reef, Bin_Lag and SG	Bin_Reef, Bin_Lag and SG	Bin_Reef, Bin_Lag and SG	Drone footage at SG	Bin_Reef, Bin_Lag and SG

2.2.1 Seawater quality sampling

The following field parameters were profiled throughout the water column at each site; water depth (± 0.1 m), salinity (± 0.01 psu), temperature (± 0.01°C), pH (± 0.1), turbidity (± 0.1 NTU) and dissolved oxygen (± 1.0% saturation) using a Sea-Bird Electronics SBE19plusV2 vertical profiling CTD fitted with a SBE43 oxygen sensor, SBE18 pH sensor and a Turner Designs SCUFA combination fluorometer-turbidity sensor. The profiling CTD was checked and calibrated prior to the commencement of each sampling event.

Depth integrated water samples were collected using a submersible pump with an extendable hose. Initially, water was pumped to flush the hose until it was sufficiently rinsed with water from the site. The hose was then lowered at a constant rate through the water column to approximately 0.5 m above the seabed and then raised again at constant rate to just below the surface collecting two vertical integrations of the water column. The sample water was pumped into a cleaned and sample rinsed bucket with a total volume of approximately 20 litres collected during sampling.

Nutrient samples (total nitrogen (TN) and total phosphorus (TP)) and total organic carbon (TOC) samples were subsampled from the unfiltered water and stored in sterile polyethylene “Whirl-Paks” (NASCO). Dissolved inorganic nutrient samples (ammonium (NH4), nitrate-nitrite (NOx) and orthophosphate (PO4)) were taken from sample water filtered with 0.45 μm polyethersulfone (PES) disposable syringe filters and stored in polypropylene tubes.

Dissolved metal/metalloid samples (aluminum (Al), silver (Ag), arsenic (As), boron (B), barium (Ba), beryllium (Be), bismuth (Bi), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), lithium (Li), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), strontium (Sr), vanadium (V) and zinc (Zn)) were taken from sample water filtered with 0.45 μm PES disposable syringe filters and stored in polypropylene tubes. Mercury (Hg) samples were stored in amber glass bottles.

Mixed unfiltered sample water (2 to 6 litres) was filtered through glass fibre GF/C filters (pore size 1.2 μm, Whatman Ltd. England) to obtain chlorophyll *a*. Chlorophyll *a* samples retained on GF/C filter papers were folded into quarters and placed into a 10 ml polypropylene tube marked with the volume filtered and the site details before storing on ice in the dark.

Mixed unfiltered sample water (2 to 6 litres) was filtered through pre-weighed GF/C filters to obtain total suspended solid (TSS) samples. After filtering the TSS sample, three 50 ml aliquots of deionised water were passed through the filter paper sample to remove any traces of salt residue that could add to the weight of sample during the laboratory drying process causing an overestimation. TSS sample filters were folded and wrapped inside a second filter paper and stored in an envelope with the volume filtered and site details recorded. Loss on ignition (LOI) was performed on the same filters used to collect TSS sample.

All samples were stored on ice for transport to the laboratory. Nutrients, chlorophyll a and TSS samples were stored frozen for preservation in the laboratory prior to analysis. Metal samples were preserved with nitric acid and mercury with nitric acid and potassium dichromate, once received at the laboratory.

Visual indicators such as the presence of nuisance organisms, faunal deaths, surface films, debris and odours (EPA, 2017) were assessed at each site.

2.2.2 Sediment quality sampling

At each site (see Table 2), sediment cores were collected by a van Veen grab. Upon the return of the grab to the surface, the top 2 cm of sediment was subsampled using a plastic spoon from the undisturbed sediment and each sample was placed directly into containers provided by the analytical laboratory and placed on ice. Between sites the sampling equipment was thoroughly cleaned using Decon 90 and rinsed with seawater from the site. Following sampling, sediment samples were frozen and consigned to the laboratory using a chain of custody.

Sediment samples were analysed for chemical characterisation of nutrients (total nitrogen and total phosphorus), metal toxicants (Hg, Al, Ag, As, B, Ba, Be, Bi, Cd, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, Pb, Sb, Se, Sr, V and Zn), particle size distribution, total organic carbon and organics (total petroleum hydrocarbons) present.

2.2.3 Settlement plates

In order to replicate the conditions of a submerged crayfish pot, eight PVC plates were deployed at selected sites (see Table 2) and attached to a plastic frame, suspended off the bottom by a sub-surface float. Plates (150 x 150 mm) were deployed 0.5 m above the seabed, to determine if the sludge forms or attaches to the plates over time. Growth on the plates were analysed for presence of macroalgae (Dr. John Huisman identified any macroalgae attached to the plates), nutrients, metal toxicants and hydrocarbons. Plates were deployed over three periods including:

- 16 July to 8 November 2019 (16 weeks)
- 8 November 2019 to 26 February 2020 (16 weeks)
- 26 February to 23 April 2020 (8 weeks)

Once retrieved, plates were removed from the setup and each plate placed in a plastic bag and then placed on ice. On return to the laboratory, plates were frozen before consignment to various laboratories.

2.2.4 Visual inspection

Visual inspection (including video footage) at three sites (see Table 2) to determine if there was any visual presence of sludge material and if present, quantitatively collect sludge material samples for biological identification.

2.2.5 *Monitoring dumping of spoil*

Water quality samples and water column physical parameters were collected and measured along a trajectory in the direction of the sediment plume immediately following the dumping of spoil. Sample site locations were determined with the aid of a drogue to determine direction of current and from visual inspection of the plume from a vessel on site. The number of samples collected along the trajectory were determined by the size of the plume created and the distance travelled before it is no longer visible or detectable.

At each site the following samples were collected and parameters measured:

- An integrated water sample (representing the entire water column) was collected with the aid of a pump and measured for total suspended solids (TSS), turbidity (NTU) and metal toxicants (copper and zinc).

2.3 *Chemical Analyses*

The Marine and Freshwater Research Laboratory carried out all water quality analyses in accordance with its quality system (AS ISO/IEC 17025:2017) and the terms of the National Association of Testing Authorities, Australia (NATA 10603) accreditation held by the laboratory. All laboratory results can be found in Appendix A of this report.

Chlorophyll *a* was extracted from glass fibre GF/C (0.8 -1.2 µm) filter papers kept for 24 hours in the dark at 4°C, after grinding in cold 90% acetone and measured spectrophotometrically (Varian Cary 60 Spectrophotometer; Greenberg *et al.*, 1992). The LOR for chlorophyll *a* is < 0.1 µg/L when a minimum volume of two liters of sample water is filtered as part of the method. The method does not detect all the chlorophyll *a* in pico-plankton, which are generally less than 0.8 µm in diameter and may pass through the 1.2 µm GF/C filter paper.

Filterable reactive phosphorus with a LOR of < 2 µg/L was analysed by the ascorbic acid method (Johnson, 1982), nitrate plus nitrite (< 2 µg/L) by copper-cadmium reduction (Johnson, 1983) and ammonium (< 3 µg/L) using the alkaline phenate method (Switala, 1993). Total nitrogen (< 50 µg/L) and total phosphorus (< 5 µg/L) were determined from autoclave digests with potassium persulphate (Valderrama, 1981). All nutrient analyses were carried out on a Lachat Quick-Chem 8500 Automated Flow Injection Analyser in accordance with documented procedures and under the laboratory's scope of NATA accreditation.

Total suspended solids samples (TSS) were filtered onto dried, desiccated, pre-weighed glass fibre filter papers (pore size 1.2 µm, Whatman Ltd. England) using a minimum sample volume of two litres. The filters were rinsed three times with distilled deionised water to remove all traces of salts and then the TSS filter papers were dried at 103-105°C overnight, cooled in a

desiccator to ambient temperature and weighed. This cycle was repeated until the weight change was less than 4% of the previous weight or less than ± 0.5 mg (APHA, 2005). This method does not detect particles less than 1.2 µm diameter, therefore TSS can be slightly underestimated. The LOR is < 0.5 mg/L when a minimum of two litres of sample water is used. Loss on ignition (LOI) which is a measure of percent organic matter was performed on dried TSS papers by ashing at 550°C for 1 hour in a furnace and then desiccating, cooling and measuring the weight loss. Total organic carbon (TOC) (unfiltered water sample) was measured as non-purgeable organic carbon (NPOC) following acidification using the high temperature combustion non-dispersive infrared gas analysis method using a Shimadzu Corporation TOC-V-CSH Organic Carbon Analyser.

Seawater dissolved metals were analysed as follows:

- ICP-MS (inductively coupled plasma mass spectrometry) for Ag, Al, As, Be, Bi, Cd, Co, Cr, Cu, Fe, Pb, Sb, Se, Sn, Mo, Mn, Ni, V and Zn.
- CV-ICP-AES (cold vapour generation inductively coupled plasma atomic emission spectrometry) for Hg
- ICP-AES (inductively coupled plasma atomic emission spectrometry) for B, Li and Sr

Sediment total metals were prepared and analysed as follows:

- Sub-samples of sediments were digested in an aqua regia (1:3 HNO3/HCl mixture).
- ICP-AES (inductively coupled plasma atomic emission spectrometry) for Al, Sb, As, Ba, Be, Bi, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, Ag, Se, Sr, V and Zn.
- CV-ICP-AES (cold vapour generation inductively coupled plasma atomic emission spectrometry) for Hg.

Sediment TOC was analysed using a Shimadzu TOC-V-CSH Organic Carbon Analyser and Solid Sample Module SSM 5000. A known mass of sample material was pre-treated with hydrochloric acid for complete removal of inorganic carbon prior to analysis for organic carbon. The sample was placed into a furnace for combustion using a platinum catalyst with pure oxygen as the carrier gas and burnt at 990°C. The CO_2 evolved was measured quantitatively by an infrared detector.

Particle size distribution (PSD) was analysed in sediment by laser diffraction for size fractions <500 µm and by wet sieving for size fractions >500 µm. For laser diffraction, sediment sub-samples were dispersed in filtered water and passed through a beam of monochromatic light. The light scattered by the particles at various angles is measured by a multi-element detector and numerical values relating to the scattering pattern are then recorded for analysis. These numerical scattering values are then transformed, using an appropriate optical model and mathematical procedure, to yield the proportion

of total volume to a discrete number of size classes forming a volumetric particle size distribution. These results are then combined with the sieving particle size results, to produce the complete particle size distribution.

Sediments for total phosphorus and total kjeldahl nitrogen were digested in a kjeldahl/sulfuric acid digest followed by analysis on the Lachat Quick-Chem 8500 Automated Flow Injection Analyser.

ChemCentre (NATA accreditation No: 8) analysed sediment for total petroleum hydrocarbons (TPH) and total recoverable hydrocarbons (TRH). Sediments were extracted with methanol, and a portion of methanol was diluted in ultra-pure water, and analysed by purge and trap gas chromatography – mass spectrometry (GC-MS). Samples were prepared and analysed using the ChemCentre methods ORG007SPTC - C6-C10 by purge and trap and ORG015S - BTEX and C6-C10 in soil. A sub-sample of sediment was extracted using three aliquots of 1:1 DCM/methanol. The extracts were combined and partitioned in water to remove the methanol and any excess water from the sample. The solvent extracts were chemically dried with sodium sulphate and concentrated by rotary evaporator. The extracts were analysed by gas chromatography – flame ionisation detection (GC-FID), using programmed temperature vapourising (PTV) with large volume injection. Preparation and analysis used the ChemCentre methods ORG007S – total recoverable hydrocarbons in soil and ORG007SlegC – total petroleum hydrocarbons in soil (legacy fractions).

Rigorous laboratory analysis and field sampling techniques minimise the potential for sample contamination that could result in unexplained outliers in the data.

2.4 Data Analysis

2.4.1 Seawater quality

Nutrients and physico-chemical parameters were compared to Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000a) default trigger values for physical and chemical stressors for south-west Australia for slightly disturbed ecosystems (inshore marine environment).

Chemical seawater results were compared to ANZG (2018) guideline values for marine water with a 95% level of species protection where available. Australian and New Zealand Guidelines for Fresh and Marine Water Quality were revised in 2018 and presented in an online platform. As of June 2020, none of the values from ANZECC/ARMCANZ (2000a) have changed however they have been reassessed under the new reliability categories (ANZG, 2018). Where no moderate, high or very high reliability guideline value was available, low, very low or unknown reliability guideline values were used as indicative working levels (ANZG 2018). Revised guidelines for aluminium (Golding 2015) and manganese (Stauber et al., 2008) have been submitted to

the Council of Australian Governments Standing Council on Environment and Water, for consideration, these have been used as guideline values in this report. For analytes without an ANZG (2018) guideline value or low reliability trigger value, such as boron, barium and strontium, background concentrations have been suggested as low reliability trigger values. As they are considered to be average background concentrations, any concentrations slightly different to this will not constitute a threat to the marine environment.

2.4.2 Sediment quality

All sediment results were compared to Simpson *et al.* (2013) which have updated the ANZECC/ARMCANZ (2000a) sediment guidelines in the Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. The recommended application of the revised sediment quality guidelines involves a tiered, decision tree approach, in which the total concentrations of contaminants are compared to the sediment quality guideline values and if exceeded further investigations should be initiated to determine if there is an environmental risk associated with the exceedance.

3.0 Results

3.1 Seawater quality

3.1.1 Profiles of physico-chemical parameters

Dissolved oxygen

The lower limit default trigger value (ANZECC/ARMCANZ 2000a) for dissolved oxygen in surface water of inshore marine environments is 90%. The dissolved oxygen concentrations of all sites were above 90% during the first three sampling occasions but below this on the fourth (April 2020) (Figure 3). On the day of sampling (23rd April 2020) there was a *Trichodesmium* bloom noted in the surface water of the majority of sites (see also Section 3.1.2 chlorophyll *a*). *Trichodesmium* is commonly found in oligotrophic (nutrient poor) waters, often when waters are calm, the mixed layer depth is shallow (Capone *et al*. 1997) and the water temperature is above 20°C (Bergman *et al.* 2013). For still unknown reasons, large segments of the *Trichodesmium* population are suddenly trapped at the surface forming easily observed pigmented layers of dying and decomposing cells (‘blooms’) (Capone *et al*. 1998). It is thought that this decomposition may have contributed to the lower dissolved oxygen concentrations in the study area at this time. Generally, the deeper sites had similar dissolved oxygen concentrations and the shallower inshore sites had similar concentrations, while concentrations of all sites were similar from the surface water to the bottom.

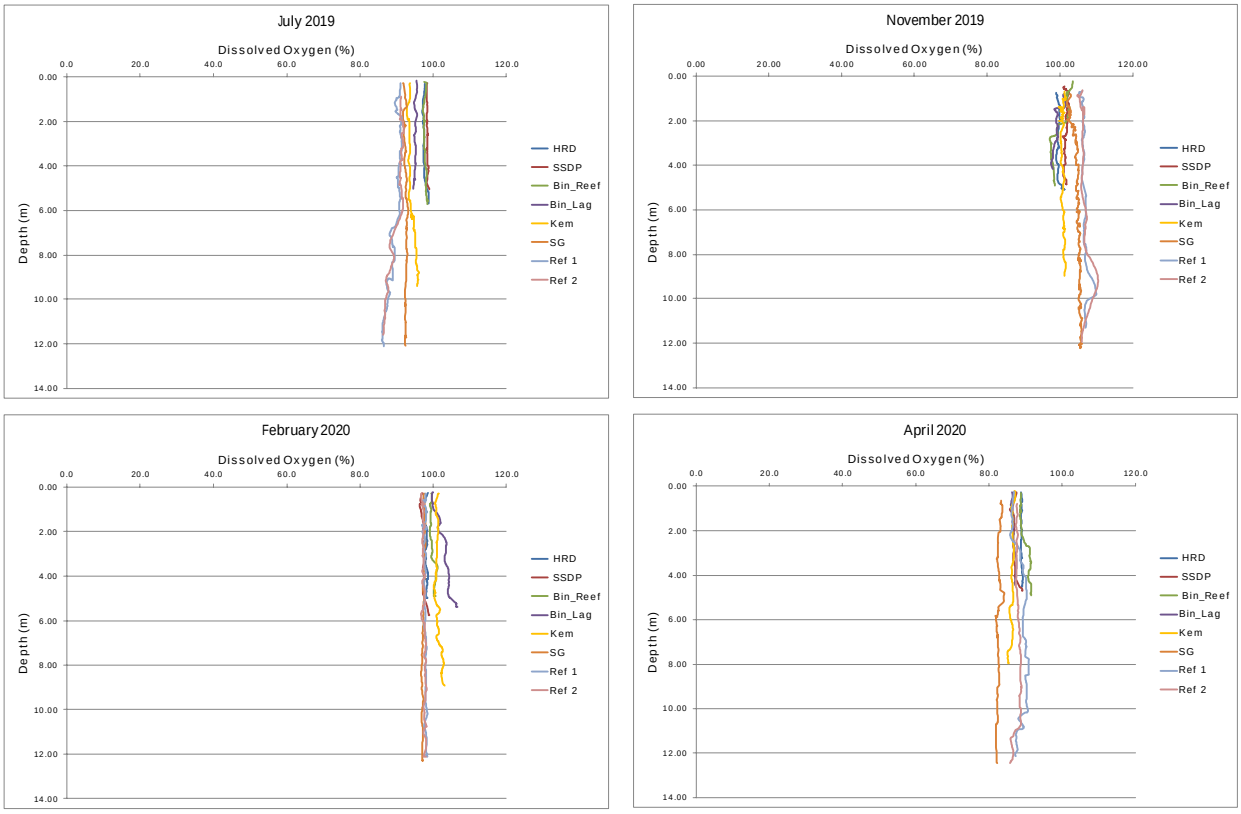

Figure 3: Dissolved oxygen at each of the sites during July 2019 (top left), November 2019 (top right), February 2020 (bottom left) and April 2020 (bottom right)

Salinity

The salinity of marine water, close to land, is usually very constant and only slight changes occur with freshwater input during winter or evaporation during summer. These slight differences are shown in the graphs below (Figure 4). The winter (July 2019) salinity concentrations are approximately 35.3 PSU, with the Ref 1 and Ref 2 salinity concentrations being slightly lower in the surface water, indicating a freshwater input source. In summer (February 2020) the salinity concentrations are higher (36.3 PSU); with the sites closer to shore, where evaporation is highest, having the highest salinities (36.8 PSU).

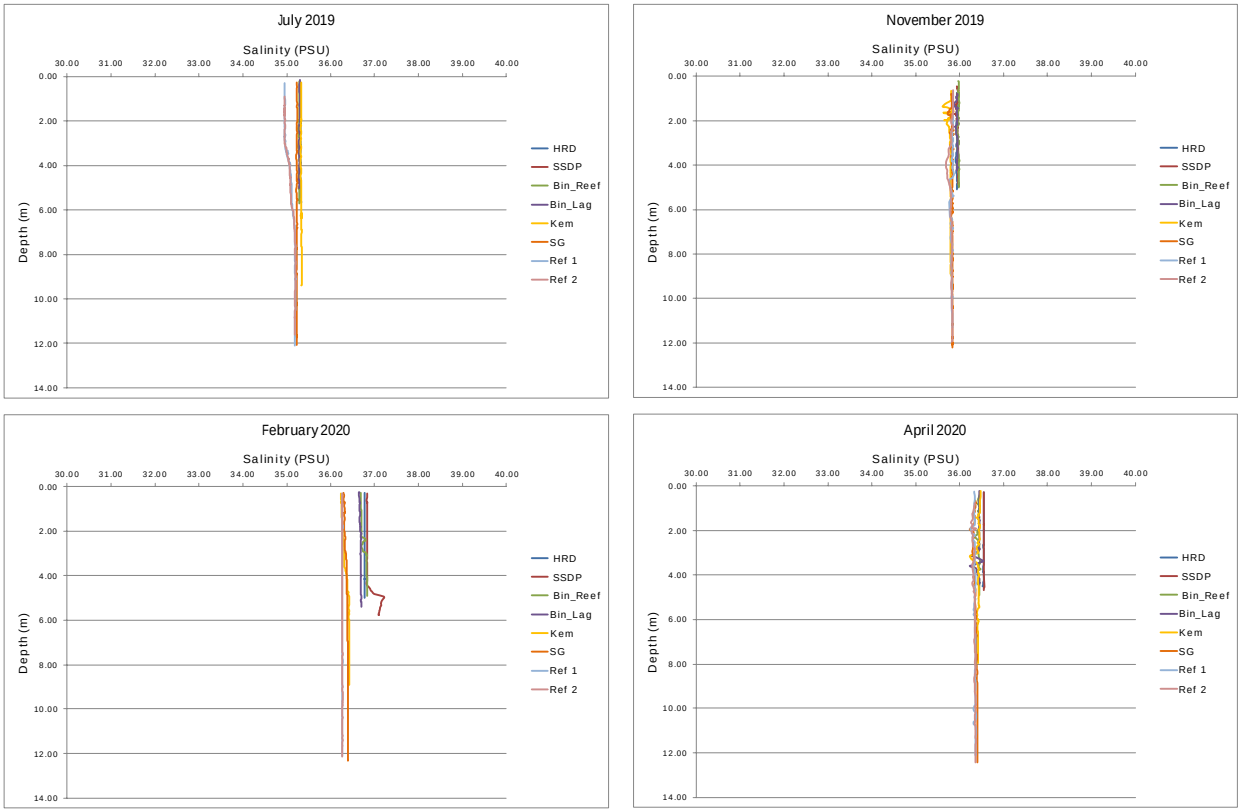

Figure 4: Salinity at each of the sites during July 2019 (top left), November 2019 (top right), February 2020 (bottom left) and April 2020 (bottom right)

Temperature

Water temperature follows a similar pattern to air temperature, being lower in winter and higher in summer. This is shown in the graphs below (Figure 5), with the lowest temperatures occurring in winter (approximately 15.4°C) and the highest temperatures occurring in summer (approximately 23°C). Temperature is constant from the surface water to the bottom water for all sites over all sampling occasions, with very slight decreases in the deeper sites during the transitional seasons.

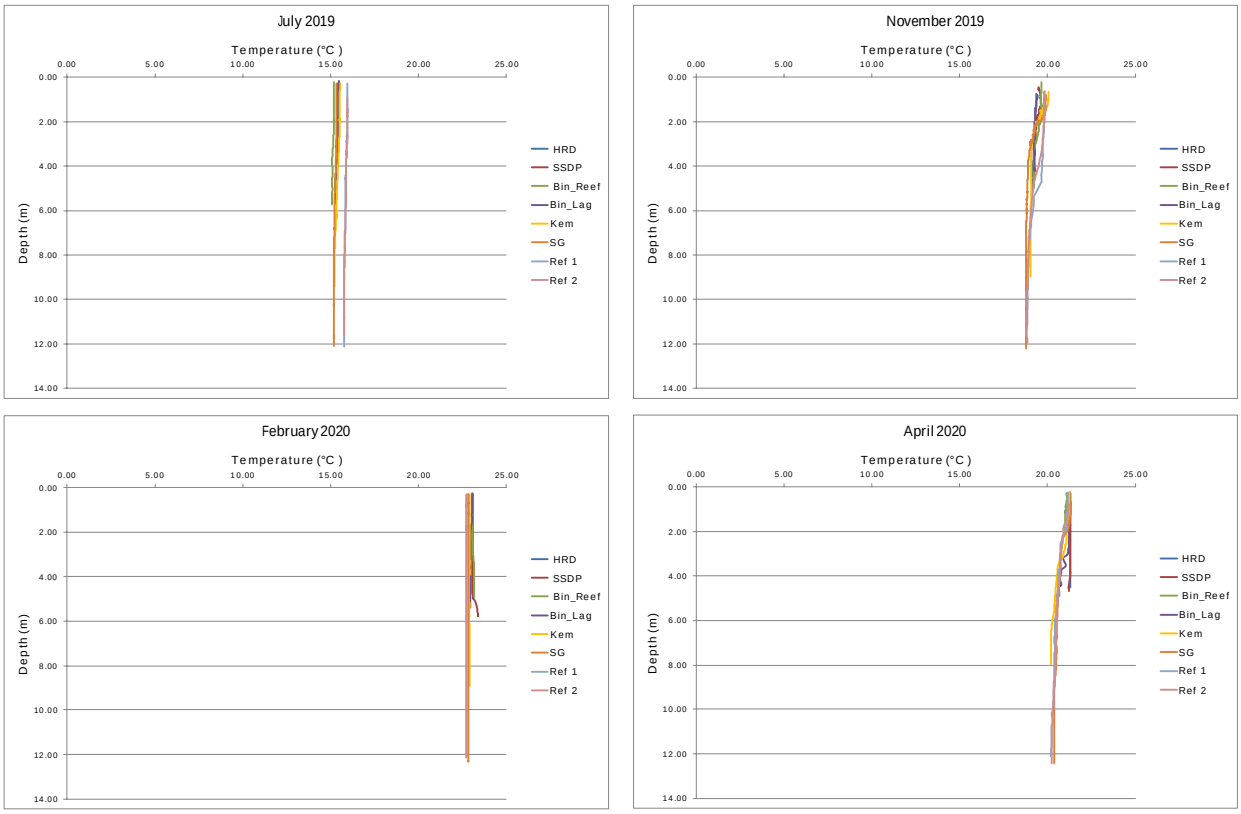

Figure 5: Temperature at each of the sites during July 2019 (top left), November 2019 (top right), February 2020 (bottom left) and April 2020 (bottom right)

pH

The lower limit default trigger value (ANZECC/ARMCANZ 2000a) for pH in surface water of inshore marine environments is 8.0 and the upper limit is 8.4. The pH of the surface water of all sites, over all sampling occasions ranged between 8.1 and 8.16 (Figure 6). This is considered to be normal as seawater is well buffered and resists changes to pH.

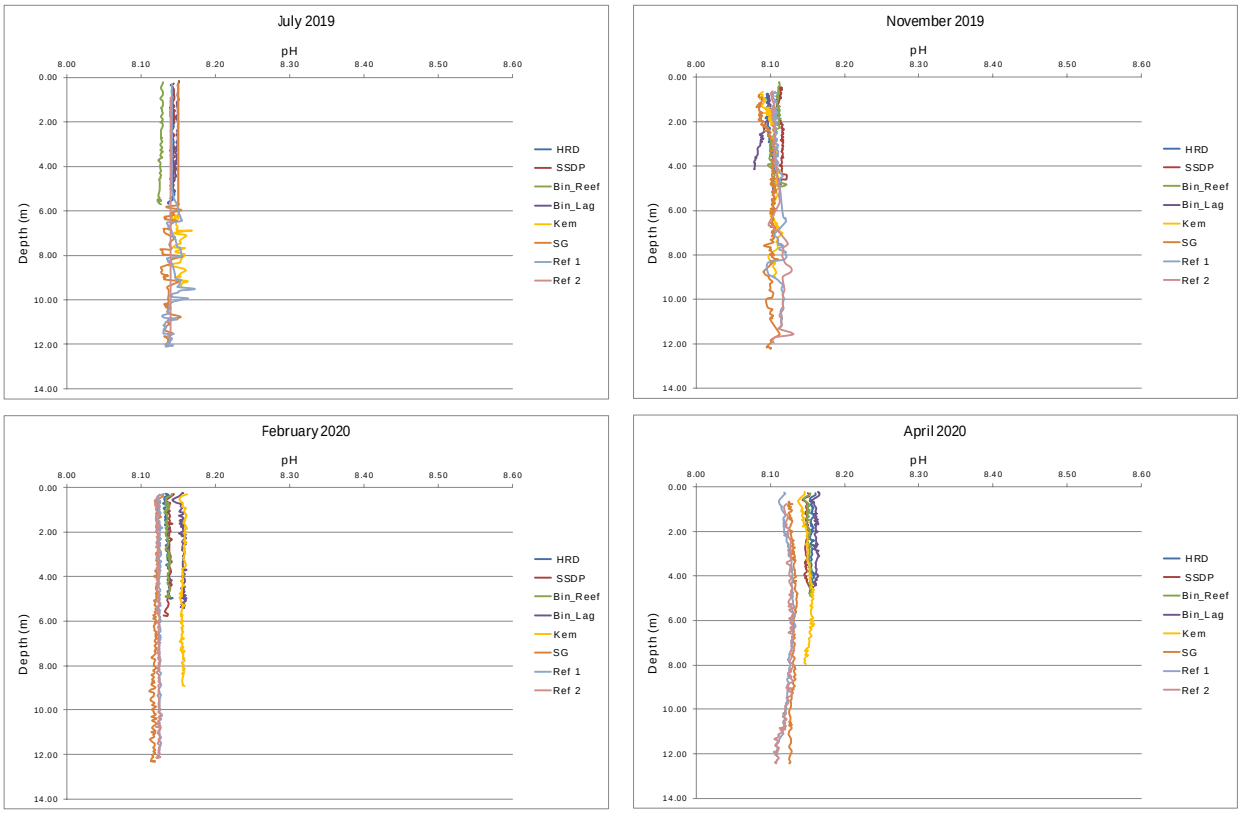

Figure 6: pH at each of the sites during July 2019 (top left), November 2019 (top right), February 2020 (bottom left) and April 2020 (bottom right)

Turbidity

Turbidity varied markedly between sites, depths and day of sampling (Figure 7). Wave heights (sea and swell) can be a large influence on turbidity. Generally, if the wave heights are high enough to resuspend sediments, there is an increase in turbidity in the bottom water of deeper sites and to the whole water column of shallower sites. During the February 2020 sampling occasion, turbidity was very low <1 NTU from surface water to bottom water at all sites. Wave heights for the day of sampling and the previous six days before sampling were less than 0.5 m, the lowest of the sampling occasions (Appendix B). Generally, site SG had the lowest surface water turbidity while the highest concentrations were found in the bottom water of sites Ref 1 and Ref 2 during the July 2019 sampling occasion, with concentrations of 23 NTU.

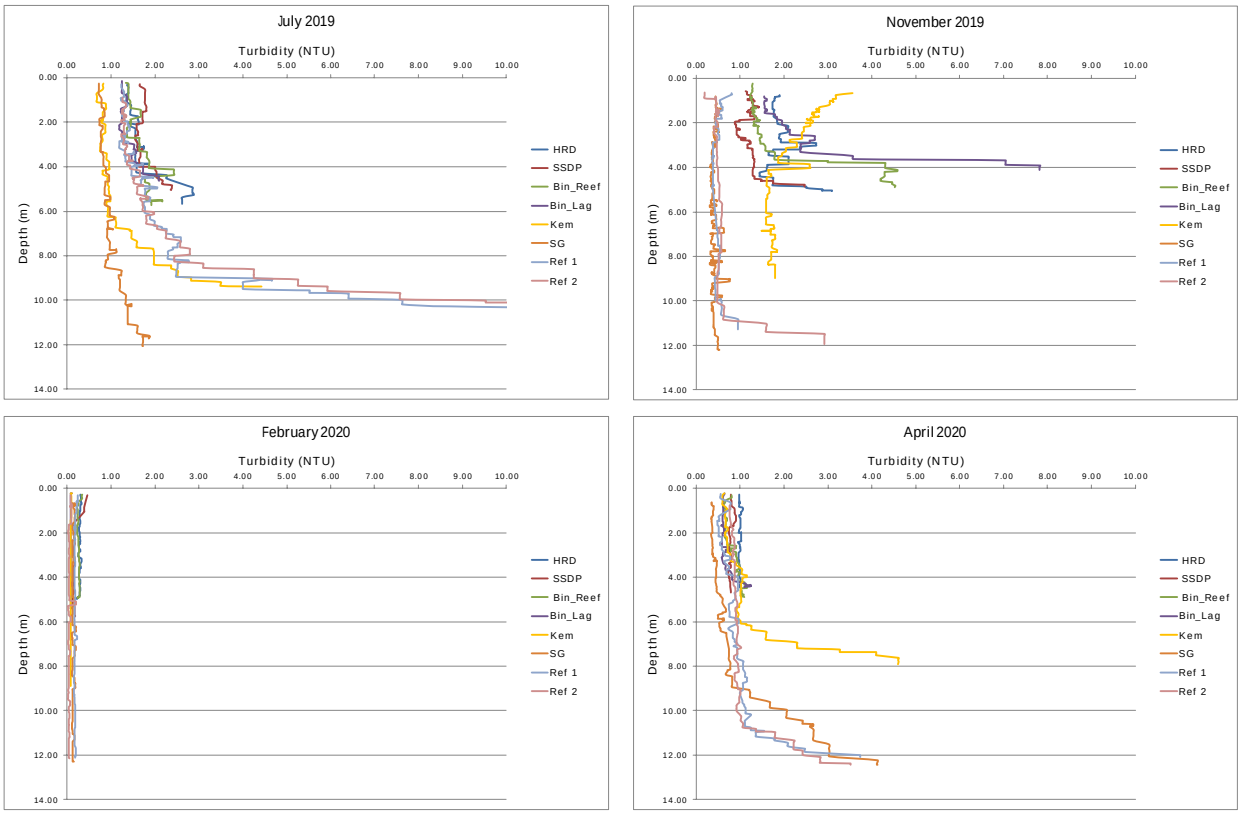

Figure 7: Turbidity at each of the sites during July 2019 (top left), November 2019 (top right), February 2020 (bottom left) and April 2020 (bottom right). Note the top left graph has been truncated at 10 NTU, readings went to 23 NTU for Ref 1 and Ref 2.

3.1.2 Nutrients, TSS, chlorophyll a and NPOC

All nutrients were below the ANZECC/ARMCANZ (2000a) default trigger values for physical and chemical stressors for south-west Australia for slightly disturbed ecosystems (inshore marine environment) (Table 3 and Table 4). Ammonium concentrations were below the laboratory limit of reporting (LOR) for all sites and all occasions. Nitrate-nitrite was also below the laboratory LOR for all sites during the November 2019 and February 2020 sampling occasions. During winter (July 2020) nitrate-nitrite concentrations were above LOR at sites Bin_Reef, Bin_Lag, Ref 1 and Ref 2 and during April 2020 at sites Bin_Reef, SG and Ref 2. Nitrate-nitrite concentrations may occur as a consequence of groundwater intrusion. As the samples were taken as an integrated sample (mix of all water in the water column) these concentrations possibly would have been higher if separate surface and bottom water was taken instead.

Non-purgeable organic carbon (NPOC) was usually highest at site Bin_Lag. NPOC represents all the organic carbon present after the sample has been acidified and purged with purified air to remove inorganic carbon. Note that volatile organics such as volatile fatty acids (VFA), light hydrocarbons (e.g.

petrol) and some solvents (e.g. acetone) will be lost during the purging. Therefore, NPOC is measuring dissolved or particulate organic carbon, in terms of humic substances from rivers or groundwater or plant or animal matter.

Chlorophyll *a* concentrations were higher than the default trigger value of 0.7 µg/L at sites Ref 1 and Ref 2 during the July 2019 sampling period; at site Bin_Lag during the November 2019 sampling period; at Ref 2 during the February 2020 sampling period and most of the sites during the April 2020 sampling period (the exception being Bin_Reef). During the April 2020 sampling occasion *Trichodesmium* (a blue-green microalgae that fixes nitrogen) was observed floating on the water surface.

Total suspended solids (TSS) is a measurement similar to turbidity in that it is a measure of water clarity. The TSS of Ref 1 and Ref 2 during the July 2019 sampling occasion was higher than the other sites and other sampling occasions and was a reflection of the high particulate matter in the bottom water of these sites (Figure 7). TSS was lowest for all sites during the February 2020 sampling period, also reflected in the turbidity concentrations.

3.1.3 Metals/metalloids

The metal/metalloids concentrations of all sites, on all occasions, were low, much lower than the ANZG (2018) guideline values for marine water with a 95% level of species protection for slightly disturbed ecosystems and generally lower than the 99% species protection levels (Table 5, Table 6 Table 7 and Table 8). The exceptions being aluminum, in which the laboratory LOR (5 µg/L) was higher than the 99% species protection value of 2.1 µg/L and cobalt and beryllium for the same reason. In addition, the copper concentration at site SG during the February 2020 sampling occasion was 0.4 µg/L, slightly higher than the 99% species protection guideline value of 0.3 µg/L.

For the most part, however, the laboratory LORs were much lower than the guideline values and with the exceptions above; antimony, bismuth, cadmium, chromium, copper, iron, lead, nickel, mercury, silver, selenium and zinc were below the laboratory LORs at all sites, on all occasions. Other metals such as arsenic, barium, boron, molybdenum, strontium and vanadium were at normal background concentrations for these metals in marine water.

Table 3: Seawater nutrients, total organic carbon, chlorophyll a and total suspended solid concentrations for July 2019 and November 2019

Sites	Date	Ammonium	Orthophosphate	Nitrate nitrite	Total phosphorus	Total nitrogen	NPOC	Chlorophyll a	TSS
Guidelines*		5	5-10#	5	20-40#	230	-	0.7-1.0#	-
Units		µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L
HRD	16/07/2019	<3	3	<2	14	90	1.2	0.3	2.5
SSDP	16/07/2019	<3	3	<2	13	90	1.3	0.4	3.0
Bin-Reef	16/07/2019	<3	3	4	14	120	1.4	0.3	3.6
Bin-Lag	16/07/2019	<3	4	3	14	110	1.7	0.3	2.8
Kem	16/07/2019	<3	2	<2	14	120	1.6	0.4	1.7
SG	16/07/2019	<3	3	<2	14	100	1.6	0.7	2.5
Ref-1	16/07/2019	<3	2	2	17	120	1.5	**1.8**	5.8
Ref-2	16/07/2019	<3	3	3	18	120	1.6	**2.0**	6.9
HRD	8/11/2019	<3	3	<2	14	110	1.3	0.5	3.3
SSDP	8/11/2019	<3	3	<2	13	100	1.3	0.4	2.4
Bin-Reef	8/11/2019	<3	4	<2	16	110	1.2	0.7	3.7
Bin-Lag	8/11/2019	<3	3	<2	17	160	1.6	**1.0**	5.6
Kem	8/11/2019	<3	3	<2	13	110	1.3	0.6	3.2
SG	8/11/2019	<3	3	<2	11	90	1.1	0.2	1.5
Ref-1	8/11/2019	<3	3	<2	11	90	1.4	0.5	1.2
Ref-2	8/11/2019	<3	4	<2	12	110	1.2	0.4	1.0

* Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000a) default trigger values for physical and chemical stressors for south-west Australia for slightly disturbed ecosystems (inshore marine environment).
# lower values denote summer values (during periods of low rainfall and no riverine input to the ocean), while the higher values denotes winter values.
— Indicates no value available or cannot be calculated.
Bold values indicate exceedance of the ANZECC/ARMCANZ (2000a) trigger value

Table 4: Seawater nutrients, total organic carbon, chlorophyll a and total suspended solid concentrations for February 2020 and April 2020

Sites	Date	Ammonium	Orthophosphate	Nitrate nitrite	Total phosphorus	Total nitrogen	NPOC	Chlorophyll a	TSS
Guidelines*		5	5-10#	5	20-40#	230	-	0.7-1.0#	-
Units		µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L	mg/L
HRD	26/02/2020	<3	<2	<2	13	100	0.8	0.2	0.8
SSDP	26/02/2020	3	3	<2	12	130	1.0	0.2	1.3
Bin-Reef	26/02/2020	<3	2	<2	12	100	0.9	0.2	0.6
Bin-Lag	26/02/2020	<3	2	<2	12	100	0.9	0.2	0.7
Kem	26/02/2020	<3	<2	<2	11	100	0.8	0.2	0.6
SG	26/02/2020	<3	2	<2	10	100	0.9	0.3	<0.5
Ref-1	26/02/2020	<3	2	<2	10	90	0.9	0.3	<0.5
Ref-2	26/02/2020	<3	3	<2	10	90	0.8	**2.0**	<0.5
HRD	23/04/2020	<3	3	<2	12	100	1.0	**1.0**	2.4
SSDP	23/04/2020	<3	<2	<2	14	110	1.0	**0.9**	2.4
Bin-Reef	23/04/2020	<3	4	4	14	110	0.8	0.5	4.3
Bin-Lag	23/04/2020	<3	3	<2	17	130	1.3	**1.0**	2.5
Kem	23/04/2020	<3	3	<2	15	110	1.0	**1.3**	3.9
SG	23/04/2020	<3	4	4	13	120	1.0	**1.7**	3.9
Ref-1	23/04/2020	<3	3	<2	15	120	0.8	**2.3**	2.9
Ref-2	23/04/2020	<3	3	5	16	140	0.9	**1.8**	2.5

* Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000a) default trigger values for physical and chemical stressors for south-west Australia for slightly disturbed ecosystems (inshore marine environment).
# lower values denote summer values (during periods of low rainfall and no riverine input to the ocean), while the higher values denote winter values.
— Indicates no value available or cannot be calculated.
Bold values indicate exceedance of the ANZECC/ARMCANZ (2000a) trigger value

Table 5: Seawater dissolved metals chemistry for 16 July 2019

Metal	Units	Environmental Guideline[1]			Sites							
		IWL[2]	99%	95%	HRD	SSDP	Bin-Reef	Bin-Lag	Kem	SG	Ref 1	Ref 2
Aluminium[3]	µg/L	—	2.1	24	<5	<5	<5	<5	<5	<5	<5	<5
Antimony	µg/L	270	—	—	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic	µg/L	4.5	—	—	1.6	1.6	1.5	1.6	1.6	1.5	1.6	1.6
Barium	µg/L	6.2*	—	—	5.4	5.3	5.5	5.5	5.6	*6.6*	5.8	5.8
Beryllium	µg/L	0.13	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Bismuth	µg/L	0.7	—	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	mg/L	5.1*	—	—	4.7	4.8	4.9	4.9	4.9	4.8	4.8	4.9
Cadmium	µg/L		0.7	5.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	µg/L		7.7	27.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt	µg/L		0.005	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	µg/L		0.3	1.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Iron	µg/L	300	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Lead	µg/L		2.2	4.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lithium	mg/L		—	—	0.15	0.15	0.15	0.16	0.15	0.15	0.15	0.16
Manganese[4]	µg/L	—	130	390	0.6	0.6	0.8	0.8	0.6	0.6	0.9	0.9
Mercury	µg/L		0.1	0.4	-	-	-	-	-	-	-	-
Molybdenum	µg/L	23	—	—	11	11	11	11	10	11	10	11
Nickel	µg/L		7	70	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Selenium	µg/L	3	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Silver	µg/L		0.8	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Strontium	mg/L	8.2*	—	—	7.9	8.0	7.7	7.8	8.0	7.8	7.9	7.8
Vanadium	µg/L		50	100	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.5
Zinc	µg/L		7	15	<1	<1	<1	<1	<1	<1	<1	<1

1 Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) species protection levels.
2 Indicative working level (ANZECC/ARMCANZ 2000b).
3 Golding et al. (2015) and draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW).
4 Draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW 2014). Guidelines applicable where corals are absent.
— Indicates no value available or cannot be calculated.
*Background concentrations in marine water for barium (Bowen 1959), boron (ANZECC/ARMCANZ 2000b), strontium average value (Bernat et al 1972, Brass and Turekian 1974)
Bold values indicate exceedance of the ANZECC/ARMCANZ (2000a) 95% species protection level.
Italicised values indicate exceedance of the ANZECC/ARMCANZ (2000b) low reliability trigger value.

Table 6: Seawater dissolved metals chemistry for 8 November 2019

Metal	Units	Environmental Guideline[1]			Sites							
		IWL[2]	99%	95%	HRD	SSDP	Bin-Reef	Bin-Lag	Kem	SG	Ref 1	Ref 2
Aluminium[3]	µg/L	—	2.1	24	<5	<5	<5	<5	<5	<5	<5	<5
Antimony	µg/L	270	—	—	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic	µg/L	4.5	—	—	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8
Barium	µg/L	6.2*	—	—	6.0	6.1	6.0	*6.3*	*6.6*	5.9	5.6	5.9
Beryllium	µg/L	0.13	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Bismuth	µg/L	0.7	—	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	mg/L	5.1*	—	—	4.9	5.0	5.1	*5.2*	5.0	5.1	5.0	4.9
Cadmium	µg/L		0.7	5.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	µg/L		7.7	27.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt	µg/L		0.005	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	µg/L		0.3	1.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Iron	µg/L	300	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Lead	µg/L		2.2	4.4	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Lithium	mg/L		—	—	0.16	0.16	0.16	0.17	0.17	0.16	0.16	0.16
Manganese[4]	µg/L	—	130	390	0.7	0.7	0.7	0.9	0.9	<0.5	0.6	0.6
Mercury	µg/L		0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	µg/L	23	—	—	11	11	11	10	11	10	10	10
Nickel	µg/L		7	70	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Selenium	µg/L	3	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Silver	µg/L		0.8	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Strontium	mg/L	8.2*	—	—	7.8	8.0	7.9	8.0	7.9	7.9	7.9	7.5
Vanadium	µg/L		50	100	1.7	1.6	1.6	1.7	1.7	1.7	1.7	1.8
Zinc	µg/L		7	15	<1	<1	<1	<1	<1	<1	<1	<1

1 Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) species protection levels.
2 Indicative working level (ANZECC/ARMCANZ 2000b).
3 Golding et al. (2015) and draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW).
4 Draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW 2014). Guidelines applicable where corals are absent.
*Background concentrations in marine water for barium (Bowen 1959), boron (ANZECC/ARMCANZ 2000b), strontium average value (Bernat et al 1972, Brass and Turekian 1974)
— Indicates no value available or cannot be calculated.
Bold values indicate exceedance of the ANZECC/ARMCANZ (2000a) 95% species protection level.
Italicised values indicate exceedance of the ANZECC/ARMCANZ (2000b) low reliability trigger value.

Table 7: Seawater dissolved metals chemistry for 26 February 2020

Metal	Units	Environmental Guideline[1]			Sites							
		IWL[2]	99%	95%	HRD	SSDP	Bin-Reef	Bin-Lag	Kem	SG	Ref 1	Ref 2
Aluminium[3]	µg/L	—	2.1	24	<5	<5	<5	<5	<5	<5	<5	<5
Antimony	µg/L	270	—	—	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic	µg/L	4.5	—	—	1.8	1.8	1.7	1.7	1.7	1.8	1.8	1.9
Barium	µg/L	6.2*	—	—	6.2	*6.5*	*6.9*	*7.0*	*8.0*	6.2	5.5	5.6
Beryllium	µg/L	0.13	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Bismuth	µg/L	0.7	—	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	mg/L	5.1*	—	—	4.7	4.8	4.9	4.8	4.8	4.7	4.8	4.8
Cadmium	µg/L		0.7	5.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	µg/L		7.7	27.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt	µg/L		0.005	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	µg/L		0.3	1.3	<0.2	<0.2	0.3	0.3	0.3	0.4	<0.2	0.2
Iron	µg/L	300	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Lead	µg/L		2.2	4.4	<0.1	0.3	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Lithium	mg/L		—	—	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Manganese[4]	µg/L	—	130	390	1.1	1.3	1.7	1.4	1.5	1.3	0.8	0.9
Mercury	µg/L		0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	µg/L	23	—	—	11	11	11	11	11	11	11	11
Nickel	µg/L		7	70	<0.3	0.6	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Selenium	µg/L	3	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Silver	µg/L		0.8	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Strontium	mg/L	8.2*	—	—	7.6	7.7	7.9	7.7	7.8	7.6	7.7	7.7
Vanadium	µg/L		50	100	1.4	1.3	1.2	1.1	1.3	1.3	1.3	1.3
Zinc	µg/L		7	15	<1	1	<1	<1	<1	<1	<1	<1

1 Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) species protection levels.
2 Indicative working level (ANZECC/ARMCANZ 2000b).
3 Golding et al. (2015) and draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW).
4 Draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW 2014). Guidelines applicable where corals are absent.
*Background concentrations in marine water for barium (Bowen 1959), boron (ANZECC/ARMCANZ 2000b), strontium average value (Bernat et al 1972, Brass and Turekian 1974)
— Indicates no value available or cannot be calculated.
Bold values indicate exceedance of the ANZECC/ARMCANZ (2000a) 95% species protection level.
Italicised values indicate exceedance of the ANZECC/ARMCANZ (2000b) low reliability trigger value.

Table 8: Seawater dissolved metals chemistry for 23 April 2020

Metal	Units	Environmental Guideline[1]			Sites							
		IWL[2]	99%	95%	HRD	SSDP	Bin-Reef	Bin-Lag	Kem	SG	Ref 1	Ref 2
Aluminium[3]	µg/L	—	2.1	24	<5	<5	<5	<5	<5	<5	<5	<5
Antimony	µg/L	270	—	—	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Arsenic	µg/L	4.5	—	—	1.9	2.0	1.8	1.8	1.7	1.9	1.8	1.8
Barium	µg/L	6.2*	—	—	5.8	6.7	6.1	5.9	*9.2*	6.0	6.1	6.1
Beryllium	µg/L	0.13	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Bismuth	µg/L	0.7	—	—	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Boron	mg/L	5.1*	—	—	5.1	5.1	5.1	5.0	4.9	5.0	5.1	5.0
Cadmium	µg/L		0.7	5.5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	µg/L		7.7	27.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt	µg/L		0.005	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	µg/L		0.3	1.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Iron	µg/L	300	—	—	<1	<1	1	<1	<1	<1	<1	<1
Lead	µg/L		2.2	4.4	<0.1	0.3	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Lithium	mg/L		—	—	0.19	0.20	0.19	0.18	0.18	0.18	0.18	0.18
Manganese[4]	µg/L	—	130	390	1.0	1.1	1.0	0.9	2.8	0.6	0.9	0.7
Mercury	µg/L		0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	µg/L	23	—	—	11	12	12	11	11	11	11	12
Nickel	µg/L		7	70	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Selenium	µg/L	3	—	—	<1	<1	<1	<1	<1	<1	<1	<1
Silver	µg/L		0.8	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Strontium	mg/L	8.2*	—	—	8.0	8.1	*8.3*	8.2	*8.4*	8.1	8.2	8.0
Vanadium	µg/L		50	100	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5
Zinc	µg/L		7	15	<1	<1	<1	<1	<1	<1	<1	<1

1 Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) species protection levels.
2 Indicative working level (ANZECC/ARMCANZ 2000b).
3 Golding et al. (2015) and draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW).
4 Draft submission paper to the Council of Australian Government's Standing Council on Environment and Water (SCEW 2014). Guidelines applicable where corals are absent.
*Background concentrations in marine water for barium (Bowen 1959), boron (ANZECC/ARMCANZ 2000b), strontium average value (Bernat et al 1972, Brass and Turekian 1974)
— Indicates no value available or cannot be calculated.
Bold values indicate exceedance of the ANZECC/ARMCANZ (2000a) 95% species protection level.
Italicised values indicate exceedance of the ANZECC/ARMCANZ (2000b) low reliability trigger value

3.2 Sediment quality

3.2.1 Metals/metalloids and nutrients

All metals/metalloids were below the Simpson *et al.* (2013) sediment quality guidelines (SQG) where guidelines were available, at all sites sampled (Bin_Lag, Bin_Reef and SG) and all sampling occasions (Table 9). A number of metals were below the laboratory LOR or did not vary between sites including; antimony, bismuth, cadmium, cobalt, copper, lead, lithium, mercury, molybdenum, selenium, silver and vanadium. For the other metals: aluminium, arsenic, barium, beryllium, boron, chromium, iron, manganese, nickel, strontium and zinc, concentrations were similar within a site over time but were quite different between sites. Generally, these metal concentrations in the sediment at Bin_Lag were two to three times higher than those at SG and these metal concentrations in the sediment at Bin_Reef were more like SG, than Bin_Lag. The only exception being barium, which was consistently higher at site SG.

Nutrient concentrations were measured in sediments during the last sampling occasion (April 2020) for the sites Bin_Lag, Bin_Reef and SG. Total Kjeldahl nitrogen (TKN) concentrations were not detectable at sites SG or Bin_Reef (<0.1 mg/g; Table 9). TKN was detectable at Bin_Lag (0.2 mg/g). Total phosphorus (TP) concentrations were 2.3 times higher at Bin_Lag than at SG or Bin_Reef.

3.2.2 Hydrocarbons

Total petroleum hydrocarbon concentrations were measured in sediments during the last sampling occasion (April 2020) for the sites Bin_Lag, Bin_Reef and SG. All results were below the Simpson *et al.* (2013) SQG and the laboratory LORs (Table 10).

3.2.2 Particle size distribution

The particle size distribution of the sediments at sites SG and Bin_Lag were similar within sites over time but very different between sites (Figure 8 and Figure 9). PSD at site SG was composed of approximately 60% medium sand and approximately 20% fine sand and 20% coarse sand. While site Bin_Lag sediment was comprised of nearly 80% fine sand, approximately 10% silt and the remainder of medium and coarse sand. The PSD of Bin_Reef was also examined in the last survey and was closer in particles size distribution to SG, rather than Bin_Lag.

Table 9: Sediment total metals and total nitrogen and total phosphorus

Metal	Units	Environmental Guideline[1]		16 July 2019		8 November 2019		26 February 2020		24 April 2020		
		SQG	SQG - high	SG	Bin_Lag	SG	Bin_Lag	SG	Bin_Lag	SG	Bin_Lag	Bin_Reef
Aluminium	mg/kg	—	—	670	840	390	820	450	820	410	740	440
Antimony	mg/kg	2	25	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg	20	70	7	12	4	13	5	15	8	10	6
Barium	mg/kg	—	—	18	9.9	14	8.5	11	8.9	11	8.5	7.2
Beryllium	mg/kg	—	—	0.03	0.05	0.02	0.05	0.02	0.05	0.03	0.05	0.03
Bismuth	mg/kg	—	—	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron	mg/kg	—	—	11	25	5	27	8	30	11	26	8
Cadmium	mg/kg	1.5	10	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1
Chromium	mg/kg	80	370	5.5	8.2	5.8	8.2	5.6	8.7	5.5	8.7	7.2
Cobalt	mg/kg	—	—	1.0	1.6	0.4	0.3	0.4	0.4	0.5	0.6	0.3
Copper	mg/kg	65	270	0.4	0.4	0.4	0.4	0.4	0.5	0.3	0.4	0.2
Iron	mg/kg	—	—	2000	3300	2100	3500	2000	3600	2200	3300	1900
Lead	mg/kg	50	220	2	2	1	1	1	2	1	2	1
Lithium	mg/kg	—	—	<1	2	<2	2	<2	2	<2	2	<2
Manganese	mg/kg	—	—	31	110	32	100	31	130	48	100	33
Mercury	mg/kg	0.15	1	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	mg/kg	—	—	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	mg/kg	21	52	<0.7	1.4	<0.7	0.9	<0.7	0.9	<0.7	0.9	<0.7
Selenium	mg/kg	—	—	3	3	<2	<2	<2	<2	<2	2	<2
Silver	mg/kg	1	4	<1	<1	<1	<1	<1	<1	<1	<1	<1
Strontium	mg/kg	—	—	640	1600	210	1800	340	1900	540	1600	400
Vanadium	mg/kg	—	—	9.3	8.6	8.9	8.7	8.8	8.7	9.5	8.8	6.9
Zinc	mg/kg	200	410	1.6	2.5	1.3	2.6	1.5	2.6	1.2	2.9	1.6
TKN	mg/g	—	—							<0.1	0.2	<0.1
TP	mg/g	—	—							0.12	0.28	0.12

Data for each site presented as single samples.

1 Simpson et al. (2015) Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines.

— Indicates no value available or cannot be calculated.

Bolded values indicate exceedance of guideline value.

Table 10: Sediment total petroleum hydrocarbon concentrations

Analyte	Units	Environmental Guideline[1]		24 April 2020		
		SQG	SQG - high	SG	Bin_Lag	Bin_Reef
TPH C6-C9	mg/kg			<25	<25	<25
TPH C10-C14	mg/kg			<25	<25	<25
TPH C15-C28	mg/kg			<100	<100	<100
TPH C29-C36	mg/kg			<100	<100	<100
Total TPH	mg/kg	280	550	<250	<250	<250

Data for each site presented as single samples.
1 Simpson et al. (2015) Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines.
— Indicates no value available or cannot be calculated.
Bolded values indicate exceedance of guideline value.

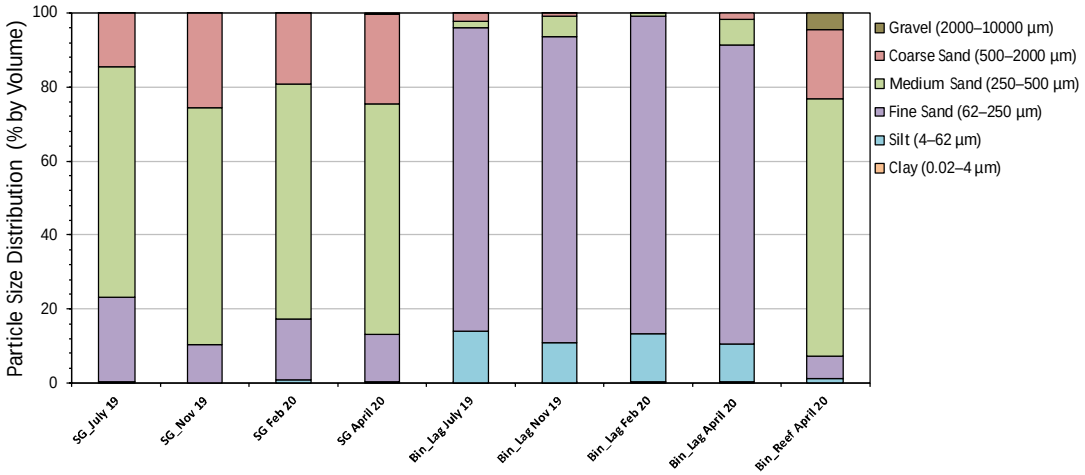

Figure 8: Particle size distribution of the sediments of sites SG and Bin_Lag over the four sampling occasions and Bin_Reef in April 2020 as a stacked column graph.

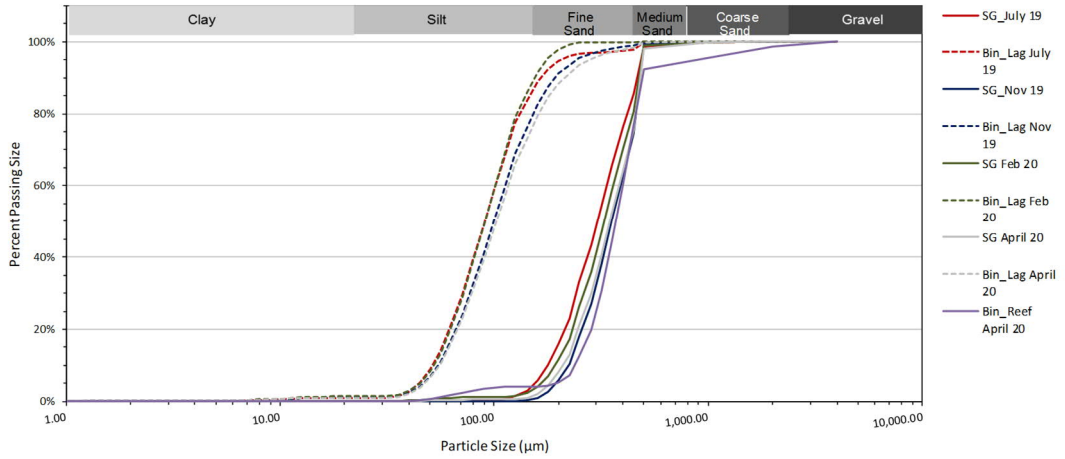

Figure 9: Particle size distribution of the sediments of sites SG and Bin_Lag over the four sampling occasions and Bin_Reef in April 2020 as a line graph.

3.3 Settlement Plates

Over time there was a marked difference in algal growth and the amount of sediment captured on the settlement plates at each site, particularly at sites Bin_Lag and Bin_Reef. To illustrate this a montage of photos for each site (HRD, Bin_Reef, Bin_Lag and SG) at the end of each of the three different deployments is shown in Figure 10, Figure 11, Figure 12 and Figure 13. Keeping in mind that the length of time that the plates were deployed varied from 16 weeks for the first two occasions (16 July to 8 Nov 2019 and 8 November 2019 to 26 February 2020) to 8 weeks for the third occasion (26 February to 24 April 2020). The photos of the plates from Bin_Reef and Bin_Lag at the end of the 8 November 2019 to 26 February 2020 period have a greater increase of algal growth and associated sediment and a definite sludge-like appearance.

Figure 10: Settlement plates at site HRD at the end of the July-November 2019 deployment (top left), November 2019 – February 2020 (top right) and February-April 2020 (bottom left).

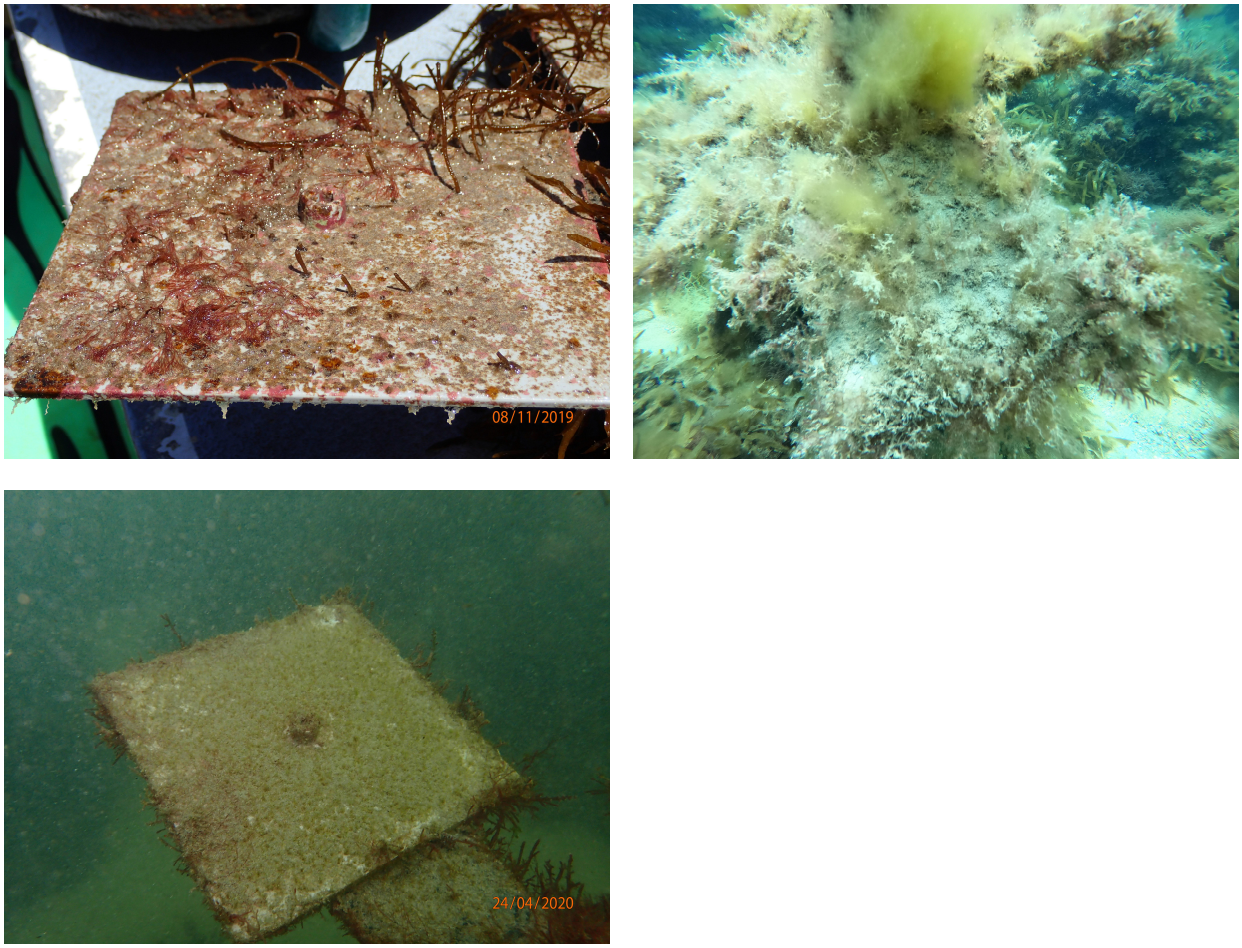

Figure 11: Settlement plates at site Bin_Reef at the end of the July-November 2019 deployment (top left), November 2019 – February 2020 (top right) and February-April 2020 (bottom left).

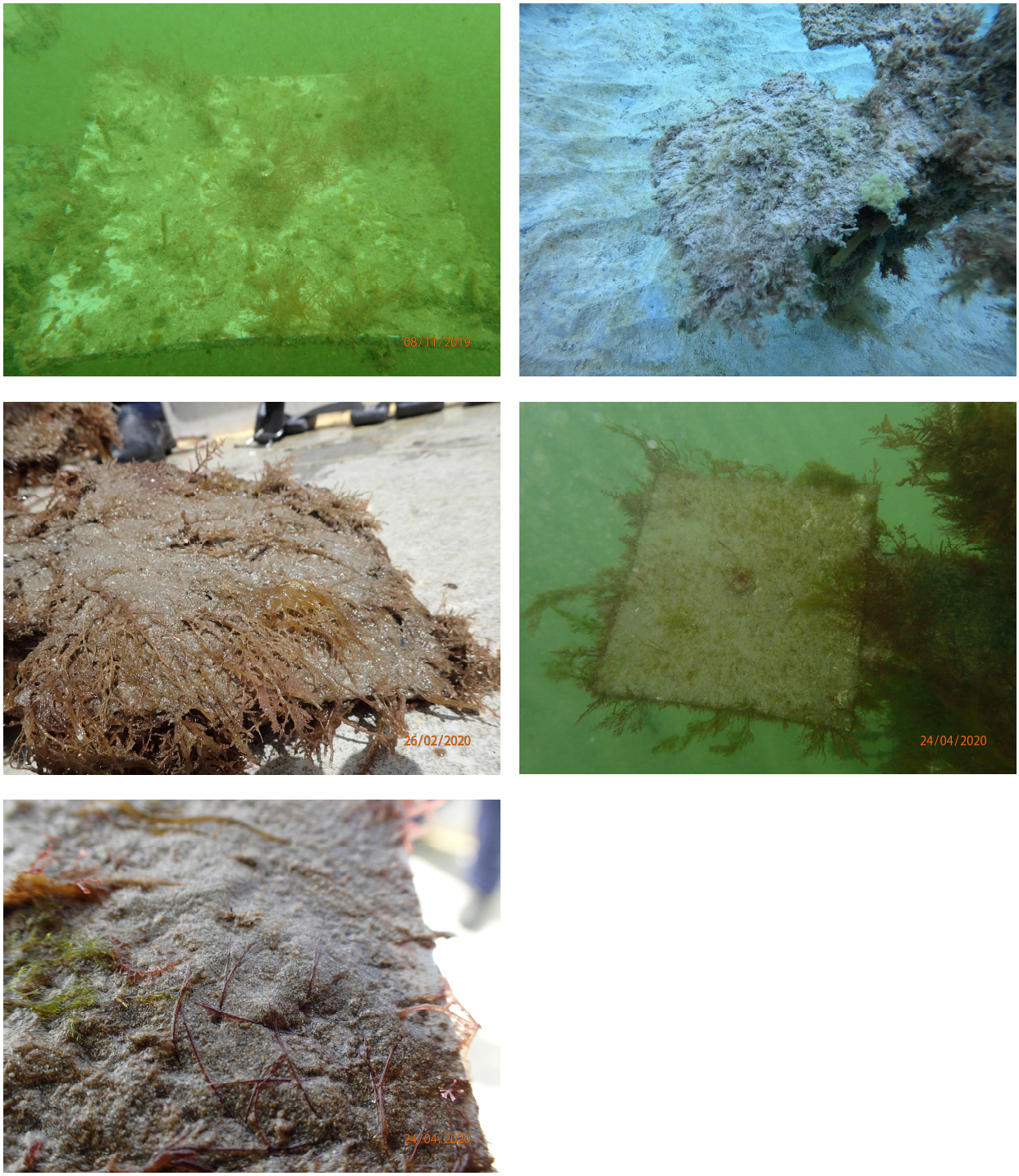

Figure 12: Settlement plates at site Bin_Lag at the end of the July-November 2019 deployment (top left), November 2019 – February 2020 (top right and middle left) and February-April 2020 (middle right). The bottom photo shows a close up of the algae trapping the sediment to the plate.

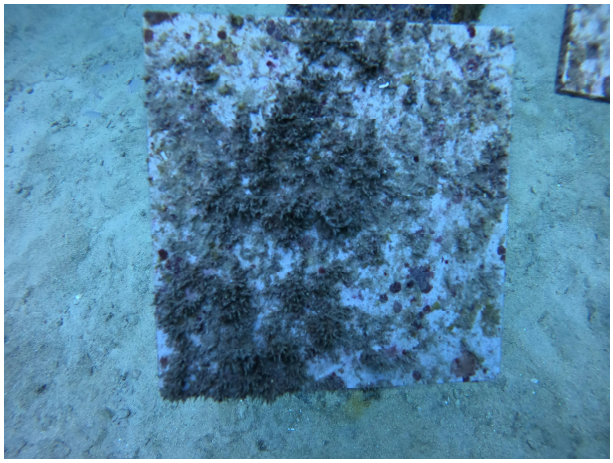

Figure 13: Settlement plates at site SG at the end of the July-November 2019 deployment (top left), November 2019 – February 2020 (top right) and February-April 2020 (bottom left).

3.3.1 Dry weights and loss on ignition

As can be expected after drying at 103-105°C, the weight of algae would be much reduced, so the dry weights are more accurately giving the weight of sediment attached to the plates. There was a much greater increase in weight on the Bin_Lag and Bin_Reef plates during the second deployment compared to other sites and other deployment periods (Table 11 and photos above Figure 11 and Figure 12).

Percentage loss on ignition gives an estimate of organic matter lost after ignition at 550°C of the material scrapped of the plates. Comparatively it shows that the amount of organic matter on the plates (including algae) to sediment was higher during the first period compared to the second period. The exception to this was at site SG during the second deployment, where the organic matter was high and total weight low, similar to the first deployment. During the third deployment HRD had mainly algae attached to the plate, hardly any sediment (low dry weight, higher LOI). Bin_Reef and Bin_Lag had

low algal growth and low sediment, while SG had very little of anything attached to the plates.

Table 11: Total dry weight and percentage loss on ignition from settlement plates deployed at various sites

Site	Deployment date	Retrieval date	Total dry weight (g)*	% loss on ignition*
HRD	16 July 2019	8 Nov 2019	9.5	15
Bin_Reef			2.3	18
Bin_Lag			2.3	12
SG			4.8	17
HRD	8 Nov 2019	26 Feb 2020	8.6	9
Bin_Reef			34	6
Bin_Lag			22	12
SG			2.5	22
HRD	26 Feb 2020	24 April 2020	3	12
Bin_Reef			5.2	6
Bin_Lag			6.9	4
SG			0.3	6

* Average of the results from three plates

3.3.2 Total metals/metalloids

Metal concentrations were generally higher in the macroalgae/sediment attached to the settlement plates, than in the sediment or water (Table 12). For example, aluminium, although not detectable in water was detectable in sediments on average about 620 mg/kg, while for the algae/sediment attached to the plates was approximately 2.5 times more. For metals such as bismuth, selenium, silver or antimony which were below detection limits in water and sediment were also below detection in the algae/sediment. It didn't seem to matter that the last round of plates were deployed for half the time, the metal concentrations were similar between deployments, except for site SG in which the algal growth and sediment accumulation on the plates was much lower during the last deployment and resulting metals concentration also lower. Macroalgae have the ability to accumulate high levels of various metals in their cell walls (Burdin and Bird, 1994; Salgado et al., 2005).

The marine grade stainless steel nuts and bolts that connected the plates to the frames, caused a contamination issue to the metal concentrations at site Bin_Reef and SG during the last deployment. Marine grade stainless steel (type 316) contains chromium, nickel and molybdenum and concentrations of these were much higher during the last deployment compared to the previous deployment. There are no metal guidelines for settlement on plates but in comparison to the sediment guidelines; all the values were below the guidelines (not including the contamination issues described above) except

for the arsenic concentration at site HRD (21 mg/kg) which was slightly above the guideline value of 20 mg/kg.

3.3.3 Macroalgal identification

The majority of macroalgal species which settled on the plates were of a filamentous variety (Table 13), the much branching filaments enabling the trapping of sediment to the plate. Site SG had the least amount of species during the November 2019 to February 2020 deployment and HRD the least during the February to April 2020 deployment. Site Bin_Lag has the most varieties of macroalgal species during both deployments and included *Cladophora vagabunda*. All of the *Cladophora* species are opportunistic settlers that respond to environmental variation. Nutrient loading, water temperature fluctuations, and downwelling illumination all influence the growth rates and longevity of these alga. In areas of eutrophication, opportunistic species like *C. vagabunda* may play an important role in reef community shifts (http://www.botany.hawaii.edu/reefalgae/greenskey.htm).

3.3.4 Hydrocarbons

The material on the plates from sites HRD, Bin_Lag, Bin_Reef and SG, were examined for total recoverable hydrocarbons (TRH). There was no BTEX (benzene, toluene, ethylbenzene and xylenes) detected on any of the plates on either deployment (Table 14). There were hydrocarbons associated with the other carbon chain fractions especially the >C16-C34 fraction. The laboratory that analysed the TRH's (ChemCentre) undertook a number of measures to determine if the hydrocarbons were petrogenic (such as those in petroleum) or biogenic (produced by living organisms or by biological processes – naturally occurring hydrocarbons) in nature. The first step was to undertake silica gel clean up. Silica gel is used for the cleanup because it is a polar substance and therefore adsorbs the polar non-hydrocarbons, the "cleaned up" extract is collected and then analyzed for TRH. This method did not change the results of the >C10-C16 or >C16-C34 fractions for any of the samples.

The next measure was to analyse one of the samples (HRD) using GS-MS chromatogram to identify the main peaks and their possible sources (Figure 14 and Table 15). The main compounds were determined to be plant waxes, biogenic fatty acids or other biogenic organic carbons. The only non-biogenic source detected was phthalate a plasticiser which was most likely derived from the PVC settlement plates. Therefore, petroleum hydrocarbons were not identified.

Table 12: Total metals/metalloid results of material settled on plates

Metal	Units	Deployed from 8 November 2019 to 26 Feb 2020				Deployed from 26 February 2020 to 24 April 2020			
		HRD	Bin_Reef	Bin_Lag	SG	HRD	Bin_Reef	Bin_Lag	SG
Aluminium	mg/kg	1567	1167	1367	3467	1133	1367	917	1100
Antimony	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	mg/kg	17	16	17	18	21	14	10	6
Barium	mg/kg	12	11	11	20	13	14	14	19
Beryllium	mg/kg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Bismuth	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Boron	mg/kg	47	38	38	313	54	42	29	87
Cadmium	mg/kg	0.2	<1	<1	0.2	0.3	0.1	0.2	0.1
Chromium	mg/kg	30	31	12	40	11	212	13	93
Cobalt	mg/kg	0.9	0.8	0.8	1.8	0.7	1.4	0.7	0.7
Copper	mg/kg	1.5	1.0	1.1	4.8	1.4	3.3	1.2	2.3
Iron	mg/kg	4533	4367	4433	7667	4333	5200	4600	2767
Lead	mg/kg	1.7	2.0	2.0	3.3	2.0	3.0	5.0	1.0
Lithium	mg/kg	3.7	3.0	3.0	6.0	3.0	3.3	2.3	2.0
Manganese	mg/kg	106	143	150	193	123	157	187	63
Mercury	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	mg/kg	2.8	2.1	<0.4	4.9	0.8	25	<0.4	8
Nickel	mg/kg	3.6	3.3	2.0	3.3	2.2	13	1.3	7
Selenium	mg/kg	<2	<2	<2	<2	<2	<2	<2	<2
Silver	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1
Strontium	mg/kg	2133	1767	2000	1367	1833	1600	1400	467
Vanadium	mg/kg	20	23	19	22	31	16	20	8
Zinc	mg/kg	8	4	5.3	10	7	5	4	4

Data for each site is the average of three plates
Shaded results are those thought to have arisen from stainless steel contamination.

Table 13: Identification of macroalgae attached to plates

Macroalgae	Deployed from 8 November 2019 to 26 Feb 2020				Deployed from 26 February 2020 to 24 April 2020			
	HRD	Bin_Reef	Bin_Lag	SG	HRD	Bin_Reef	Bin_Lag	SG
Rhodophyta (red)								
Vertebrata constricta	XXX	XXX	X			XX	XXX	
Polysiphonia sertularioides	XX		XX				X	
Polysiphonia subtilissima	XX							
Ceramium macilentum	X		X				X	
Dasya sp.	X					X	X	X
Melanothamnus infestans		XXX	XXX			XX	X	
Acanthophora dendroides		XXX	XX			XX	XX	
Spyridia filamentosa			X			X		
Jania sp.			X					
Gayliella sp.			X			X	X	
Laurencia sp.		XXX	XX			X	XX	
Herposiphonia sp.			X	X		X	X	X
Asparagopsis (tetrasporophyte)						X	X	X
Crustose coralline								X
Polysiphonia decipiens					X		XX	
Chondria sp.						XXX		
Lophocladia kuetzingii						X		
Wrangelia sp.							XX	
Ochrophyta (brown)								
Rosenvingea orientalis	XX				X		X	
Sphacelaria sp.	X		X	X				
Feldmannia sp.	X		XX					
Feldmannia mitchelliae					XXX	X	XX	
Dictyota sp.							X	
Chlorophyta (green)								
Cladophora vagabunda			XX					
Entocladia sp.				X				X

Note: The X denotes presence of the algae and the more X's represent increased abundance.

Table 14: Settlement plate total recoverable hydrocarbon concentrations before and after silica gel clean-up

Metal	Units	Deployed from 8 November 2019 to 26 Feb 2020				Deployed from 26 February 2020 to 24 April 2020			
		HRD	Bin_Reef	Bin_Lag	SG	HRD	Bin_Reef	Bin_Lag	SG
TPH C6-C10	mg/kg	<25	<25	<25	<25	<25	<25	<25	<25
TPH >C10-C16	mg/kg	140	51	140	380	160	40	46	450
TPH >C16-C34	mg/kg	1200	280	970	2500	1600	120	<100	1200
TPH >C34-C40	mg/kg	<100	<100	<100	<100	<100	<100	<100	370
Total TRH	mg/kg	1300	330	1100	2900	1800	<250	<250	2000
TPH >C10-C16 (silica gel)	mg/kg	110	40	89	280	120	<25	<25	250
TPH >C16-C34 (silica gel)	mg/kg	1200	340	1100	2500	1600	130	<100	860
TPH >C34-C40 (silica gel)	mg/kg	<100	<100	<100	<100	<100	<100	<100	<100

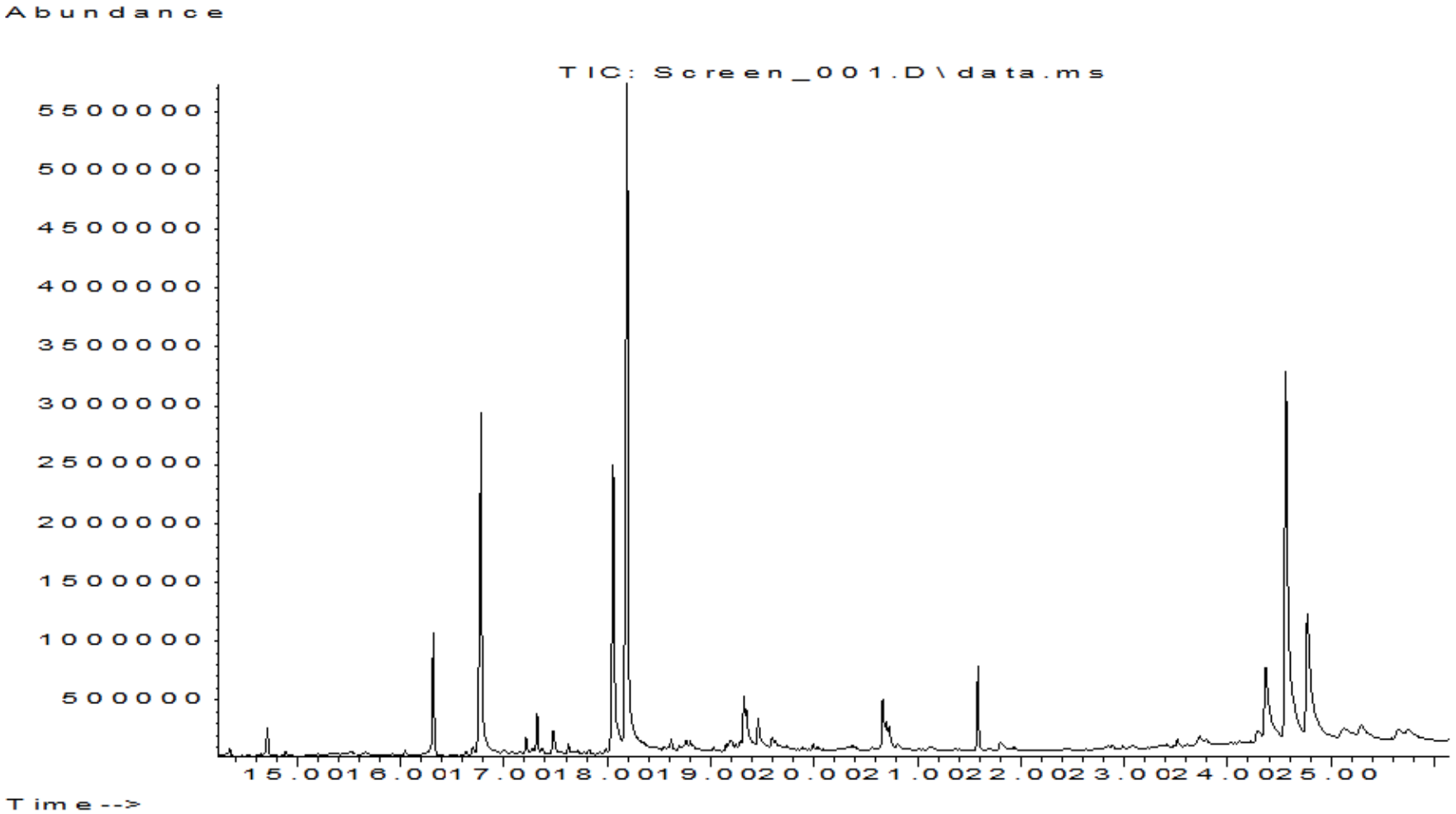

Figure 14: GS-MS chromatogram of the HRD sample

Table 15: Interpretation of the main peaks from the GS-MS chromatogram

Ret time (min)	Tentative ID	Possible source
14.7	Pentadecane	Plant wax
16.3	Heptadecane	Plant wax
16.8	Tetradecanoic acid (14:0)	Biogenic fatty acid
18.1	Hexadecenoic acid (16:1)	Biogenic fatty acid
18.2	Hexadecanoic acid (16:0)	Biogenic fatty acid
19.3	Octadecenoic acid (18:1)	Biogenic fatty acid
19.3	Octadecenoic acid (18:1)	Biogenic fatty acid
19.5	Octadecanoic acid (18:0)	Biogenic fatty acid
20.7	Octadecenamide	unknown
21.6	Phthalate	Plasticiser
24.4	unknown sterol	Biogenic
24.6	Cholesterol	Biogenic
24.8	Desmosterol	Biogenic

3.4 Visual Transects

Video transects were taken of sites Bin_Lag, Bin_Reef and SG on four occasions. Site SG was comprised of sandy substrates with very little macroalgal growth, not surprising as macroalgae require hard substrate to attach to. The macroalgae of the Bin_Lag and Bin_Reef sites changed over the seasons as part of the dynamic, diverse and highly competitive intertidal reef community.

For Bin_Reef the transect covered all hard reef substrate. The macroalgal types and condition changed during each of the four sampling occasions including:

- July 2019 (winter season) – swell and surge were high with an abundance of macerated algae in the water column. The most common macroalgae were coralline and encrusting reds and turfing algae. This area was very exposed and the direct effect of winter storms including effects of waves, strong surge, currents or abrasion by sand, caused damage to macroalgal communities, often detaching fragments or entire plants.
- November 2019 (end of spring) – conditions were calmer, and more sediment was present. An increase in the diversity of macroalgal species were seen including Sargassum, Caulerpa, Codium, Thalassadendron (seagrass).
- February 2020 (summer season) – there was an increase in the number of filamentous brown and green algae and also epiphytic algae.
- April 2020 (autumn) – swell was high and many of the filamentous macroalgae had disappeared.

For Bin_Lag the transects covered an area of sand (offshore) for approximately 20 m before the reef started. The reef types and condition of the macroalgae were similar to Bin_Reef described above but the first 10 m of reef area changed dramatically including:

- July 2019 (winter season) –hard reef surface could be seen. The most visual macroalgae growing was *Polysiphonia sertularioides* with very long branches approximately 50 cm long (see Figure 15). Other macroalgae included encrusting reds.
- November 2019 (end of spring) – sediment had covered the first 10 m of the reef (up to 50 cm deep) and only the top 10-15 cm of *Polysiphonia sertularioides* branches were showing (see Figure 15).
- February 2020 (summer season) – only sandy substrate showing, no macroalgae present.
- April 2020 (autumn) – only sandy substrate showing, no macroalgae present.

Therefore, in addition to the changes in macroalgal assemblages over time there was a large deposition of sand at all sites during the spring period. Judging from the burial of weights and/or settlement plates, sand deposition was approximately 50 cm deep at Bin_Lag (see Figure 16) and 30 cm deep at HRD.

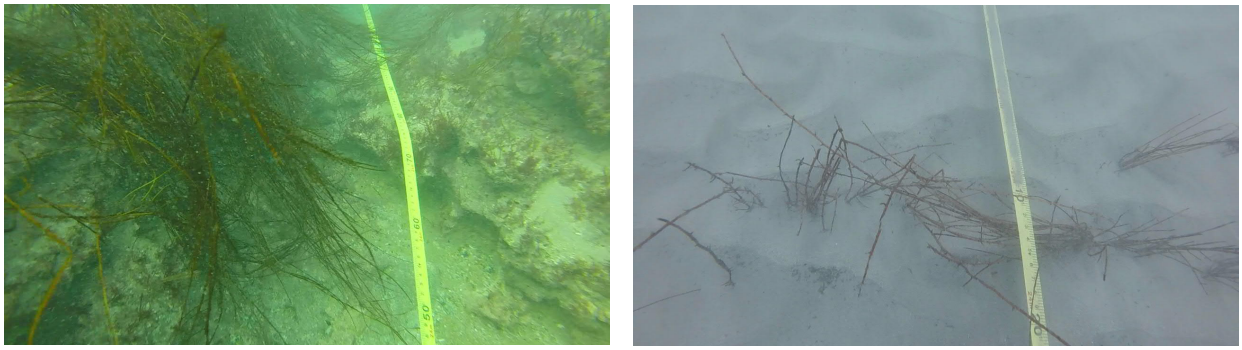

Figure 15: The 24 m mark on the transect at Bin_Lag in July 2020 (left) showing reef and *Polysiphonia sertularioides* growing on top of the reef and in November 2020 (right) with the reef completely buried and only the tops of *P. sertularioides* visible.

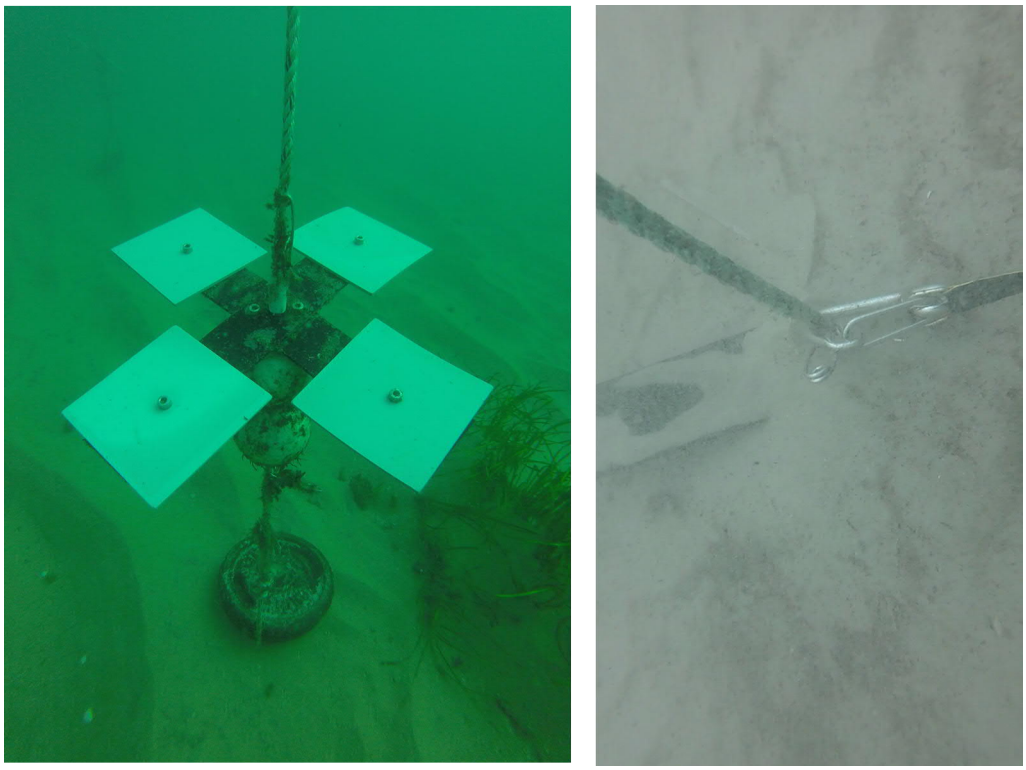

Figure 16: Typical settlement plate arrangement (left) and settlement plates at Bin_Lag in November 2020 (right) with the weights and plates completely buried and only part of the crosspiece visible.

3.5 Monitoring dumping of spoil

On the 13 March 2020, while dredging of the Bunbury Port was occurring, MAFRL monitored the dredge plume at the Spoil Ground (SG) while dumping was in progress, to determine the extent of the plume. A drogue was deployed at 9:24 am and retrieved at 10:11 am to determine the direction of current drift. This was determined to be in a west northwesterly direction. Subsequent data retrieved from the Bunbury Ports Weather Beacon 3 confirmed that at the time of sampling (between 10:44 and 11:58 am) that the current direction was generally westerly, and heading away from shore (Figure 17).

Samples of the integrated water column were collected along a transect line in the direction of the drift of the plume for turbidity, total suspended solids and total and filtered metals (copper and zinc). The first four sites were approximately 70 m apart and the fifth sample approximately 140 m from the fourth sample. The sixth site was sampled to act as a background site and was approximately 1.4 km distance from the first site (Figure 18). The analysis of the water column samples shows that by approximately 350 m distance from the initial disposal of the plume (sample T-5) turbidity, TSS and total and filtered metals were back to background concentrations (T-6; Table 16).

Turbidity, TSS and total metals (copper and zinc) were highest at the site closest to the spoil dump, which reduced at increasing distances from the

dump. Total copper concentrations were below the ANZG (2018) guideline value for copper in marine water with a 95% level of species protection of 1.3 µg/L at all sites and below the laboratory LOR (<0.2 µg/L) at sites T5 and T6. Total zinc concentrations were below the ANZG (2018) guideline value for zinc in marine water with a 95% level of species protection of 15 µg/L at all sites except for the closest site T-1 (45 µg/L) and below the laboratory LOR (<2 µg/L) at sites T-3, T-4, T-5 and T-6. The filtered copper and zinc concentrations were below the laboratory LORs at all sites. Therefore, the copper and zinc concentrations were associated with the sediment particles and not bioavailable in the water column.

Arial drone photographs were taken of the plume (Figure 19 and Appendix C).

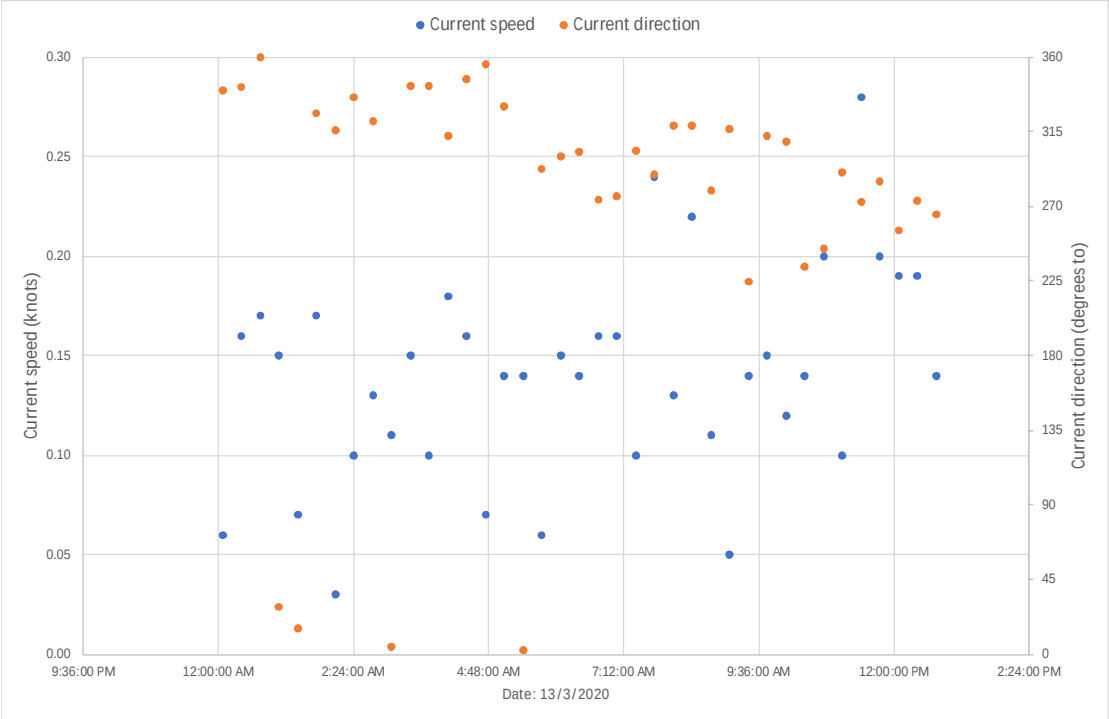

Figure 17: Current speed and direction measured from Beacon 3 on the date of sampling

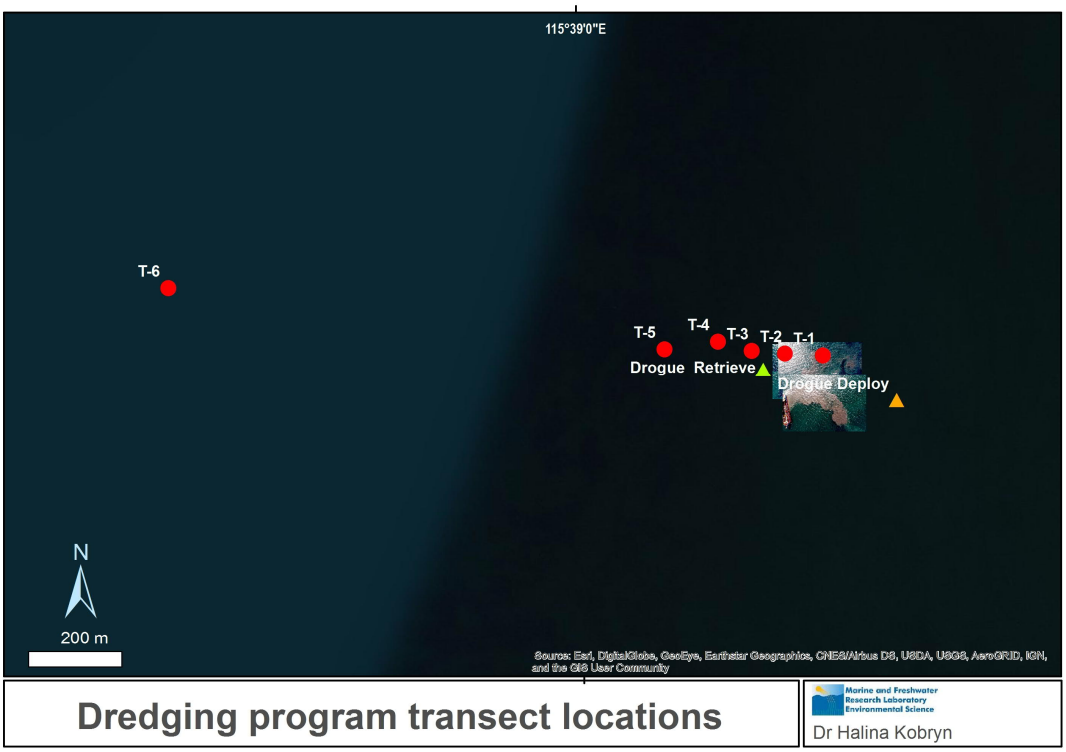

Figure 18: Dredge plume sampling locations

Table 16: Results of the water quality sampling of the dredge plume

Site	Turbidity (NTU)	TSS (mg/L)	%LOI	Filtered copper (ug/L)	Filtered zinc (ug/L)	Total copper (ug/L)	Total zinc (ug/L)
T-1	4.8	16	31	<0.2	<1	0.7	45
T-2	2.7	8.3	32	<0.2	<1	0.6	3
T-3	0.8	2.8	29	<0.2	<1	0.5	<2
T-4	0.6	2.2	37	<0.2	<1	0.5	<2
T-5	0.5	0.9	46	<0.2	<1	<0.2	<2
T-6	0.4	1.4	33	<0.2	<1	<0.2	<2

Figure 19: Dredge plume with the MAFRL sampling vessel in the foreground and the dredge moving off site in the background.

4.0 Discussion

4.1 Seawater quality

Nutrients and metal/metalloid concentrations at all sampling sites were below the ANZG (2018) guideline values for marine water with a 95% level of species protection for slightly disturbed ecosystems during each sampling occasion. However, the sampling occasions were just a snapshot of the nutrient and metal concentrations in time, and other influences, that occurred outside of the sampling occasions for this project, could introduce higher concentrations to the inshore marine waters. For example, samples taken in the Binningup area for the Southern Seawater Desalination Project (Water Corporation 2008), determined that nutrient concentrations of ammonia, nitrate-nitrite and orthophosphate were higher than guideline values during the winter sampling event and attributed this to rainfall runoff being discharged to the ocean as a result of increased rainfall prior to the winter sampling event and citing the main source as being from the Harvey River diversion drain.

Chlorophyll *a* (a measure of microalgae in the water column) was higher than the Australian & New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000a) default trigger values for physical and chemical stressors for south-west Australia for slightly disturbed ecosystems (inshore marine environment) at Ref 1 and 2 during winter, at Bin_Lag in spring, at Ref 2 in summer and all sites (except Bin_Reef) in autumn. During the April 2020 sampling occasion *Trichodesmium* (a blue-green microalga that fixes nitrogen) was observed floating on the water surface. *Trichodesmium* is commonly found in oligotrophic (nutrient poor) waters, often when waters are calm, the mixed layer depth is shallow (Capone *et al*. 1997) and the water temperature is above 20°C (Bergman *et al.* 2013).

Physico-chemical parameters (salinity, dissolved oxygen, temperature, pH and turbidity) were typical of the well mixed inshore marine water in this area (Water Corporation 2008).

4.2 Sediment quality

All metals/metalloids in sediment were below the Simpson et al. (2013) sediment quality guidelines (SQG) where guidelines were available, at all sites sampled (Bin_Lag, Bin_Reef and SG) and all sampling occasions. For some metals (aluminium, arsenic, barium, beryllium, boron, chromium, iron, manganese, nickel, strontium and zinc) and total phosphorus, concentrations were similar within a site over time but were quite different between sites and were generally two to three times higher at Bin_Lag than SG or Bin_Reef. The only exception being barium, which was consistently higher at site SG. The

sediments at Bin_Lag were comprised of higher percentages of small particle size fractions (i.e. silt) than the other two sites.

The chemically active fraction of sediment is usually cited as that portion which is smaller than 63 µm (silt + clay) fraction (UNEP/WHO 1996). Problem contaminants are most often associated with fine sediment because this fraction consists of particles with relatively large ratios of surface to volume and may be charged, which increase the sorptive capacity for contaminants (Power and Chapman 1992). For phosphorus and metals, particle size is of primary importance due to the large surface area of very small particles. Phosphorus and metals tend to be highly attracted to ionic exchange sites that are associated with clay and silt particles and with the iron and manganese coatings that commonly occur on these small particles.

Total petroleum hydrocarbon concentrations were measured in sediments during the last sampling occasion (April 2020) for the sites Bin_Lag, Bin_Reef and SG. All results were below the Simpson *et al.* (2013) SQG and the laboratory LORs.

4.3 Settlement plates

The macroalgal growth on the settlement plates differed over time and between sites with the November 2019 – February 2020 deployment showing the highest macroalgal biomass and species types and sites Bin_Lag and Bin_Reef higher biomass and species diversity than other sites. This is not unusual as the summer period provides increased light and temperature and calmer conditions more conducive for algal growth. In addition, the Binningup sites being close to reef had a larger number of different types of algal propagules to settle on the plates as opposed to sites HRD and SG which were mainly comprised of large sandy areas.

The propagules of macroalgae consist principally of the unicellular products of sexual or asexual processes such as zygotes, parthenogenetic gametes and spores formed as a result of meiosis and/or mitosis. They have several essential functions in the life history of a species, being the means of dispersal, settlement, attachment, survival and the initiation of new individuals (Clayton 1992).

This period of deployment also consisted of the greatest amount of sediment on the plates and it is thought that the mainly filamentous macroalgal species that attached to the plates, bound the sediment particles to the plates. Measurement of beach profiles indicated that the beaches around Binningup are regularly eroded by winter storms and rebuilt during summer (UWA 2008b) while UWA (2008a) noted that “sediment sheets and megaripples were observed midshore suggesting sediment was highly mobile”. Therefore, this time coincided with high algal growth and highly mobile sand movement

and the resultant material on the plates from Bin_Reef and Bin_Lag had a definite sludge-like appearance.

Some researchers have qualitatively suggested that there is an important connection between macroalgal growth and sediment that requires further study; Smith et al. (2001) and Belliveau and Paul (2002), for example, noted that sediment accumulation was positively correlated with increases in macroalgal biomass. In addition, there is evidence that macroalgae benefit from nutrients attached to sediment that land on thalli (Schaffelke, 1999).

Many algal propagules are associated at some stage of their life with a coating of mucilage, a transparent, sticky material containing various polysaccharides and some proteins. Among the varied functions attributed to mucilage are entrapment, desiccation resistance, adhesion and defense (Clayton 1992). Mucilage surrounding propagules adheres readily to all objects and possibly functions as a primary attachment mechanism prior to the production of adhesive compounds and can remain intact for several weeks (Clayton 1992). The relatively, large, non-motile spores of the brown algal order Dictyotales, frequently retain a thin coating of mucilage by means of which they adhere to other spore, sand grains, algal fronds and other bodies (Clayton 1992). This mucilage may have contributed to capturing sediment and contributed to the visual sludge-like appearance of material on the plates.

Metal concentrations were generally higher in the macroalgae/sediment attached to the settlement plates, than in the sediment or water. There are no metal guidelines for settlement on plates but in comparison to the sediment guidelines; all the values were below the guidelines. Hydrocarbon analysis of the material on the plates determined that the main compounds were plant waxes, biogenic fatty acids or other biogenic organic carbons. The only non-biogenic source was from the plasticiser from the PVC settlement plates. Petroleum hydrocarbons were not identified.

4.4 Visual transects

Video transects were taken of sites Bin_Lag, Bin_Reef and SG on four occasions. Site SG was comprised of sandy substrates with very little macroalgal growth, not surprising as macroalgae require hard substrate to attached to. The macroalgae of the Bin_Lag and Bin_Reef sites changed over the seasons as part of the dynamic, diverse and highly competitive intertidal reef community.

Macroalgal plants are affected by numerous natural pressures, including light, temperature, nutrient availability, water movement, biological interactions such as competition and herbivory, and disturbances such as storms. These influences are seen in the major differences in the macroalgal community changes during the summer and winter periods.

Macroalgae, like any plants, require minimum levels of nutrients to grow. Natural sources of background nutrients for inshore reef macroalgae include upwelling of nutrient-rich, deep waters, flood-plumes from coastal rivers, resuspension during storms and cyclones, and nitrogen fixation by blue-green algae. However, problems arise when human activities add nutrients far in excess of natural levels, disturbing the balance of these nutrient dynamics. This effect is known as eutrophication, and potentially leads to increases in algal growth and reef degradation.

Increased nutrients are probably the most important human impact on inshore macroalgal reefs. Non-point sources of rainfall run-off or groundwater influx of nutrients from agriculture and grazing lands, residential septic tanks and garden fertilization and maintenance of golf course greens are localised sources suggested to be causing increases in biomass and shifts in species composition and decrease of species diversity of the natural macroalgal flora of inshore reefs.

However, despite the fact that the Binningup township has had all of the above non-point sources, the macroalgal and seagrass assemblages on the inshore reef in front of the township are similar to the other inshore reef areas in the Bunbury area.

4.5 Monitoring dumping of spoil

On the 13 March 2020, while dredging of the Bunbury Port was occurring, MAFRL monitored the dredge plume at the Spoil Ground (SG) while dumping was in progress, to determine the extent of the plume. The direction of the current was in a westerly direction and therefore the plume moved away from shore. The analysis of the water column samples shows that by approximately 350 m from the initial disposal of the plume, turbidity, TSS and total and filtered metals returned to background concentrations.

Anecdotal evidence for the selection of the Bunbury spoil ground, took into account that it was dispersive allowing nourishment of the local beaches to the east. As the net sediment movement is onshore in summer and offshore in winter and the dredge plume influence is very localised, it is highly unlikely that dredge material could maintain a consistent stimulus at the Binningup area.

Conclusion

Concentrations of nutrients and metals were low and petroleum hydrocarbons were not detected in the water, sediment and on the settlement plates at sites in the study area over the sampling period. The influence of the dredge plume during the dumping of spoil on the spoil ground was very localised. The November 2019 – February 2020 settlement plate deployment coincided with high algal growth and highly mobile sand movement and the resultant algal/sediment material on the plates from Bin_Reef and Bin_Lag had a

definite sludge-like appearance. In addition, the mucilage associated with macroalgal propagules that settled on the plates may have contributed to capturing sediment and to the visual sludge-like appearance of material on the plates. Therefore, it was determined that the formation of material on the settlement plates was due to natural processes.

5.0 References

ANZECC/ARMCANZ (2000a) National Water Quality Management Strategy: Paper No 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 1 – The Guidelines (Chapters 1–7). Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, Canberra, Australian Capital Territory, October 2000.

ANZECC/ARMCANZ (2000b) National Water Quality Management Strategy: Paper No 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Volume 2 – Aquatic Ecosystems – Rationale and Background Information (Chapter 8). Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, Canberra, Australian Capital Territory, October 2000.

ANZG (2018). http://www.waterquality.gov.au/anz-guidelines Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia.

Belliveau, S.A and Paul, V.J. (2002). Effects of herbivory and nutrients on the early colonization of crustose coralline and fleshy algae Marine Ecology Progress Series. 232:105-114.

Bergman, B. Sandh, G. Lin, S. Larsson, J. and Carpenter E.J. (2013). *Trichodesmium*, a widespread marine cyanobacterium with unusual nitrogen fixing properties. FEMS Microbiology Reviews. 37(3): 286–302.

Burdin, K.S. and K.T. Bird (1994). Heavy metal accumulation by carrageenan and agar producing algae. Bot. Marina. 37: 467–470.

Capone D.G.; Zehr J.P.; Paerl H.W.; Bergman B.; Carpenter E.J. (1997). *Trichodesmium*, a globally significant marine cyanobacterium. Science. 276 (5316): 1221–1229.

Clayton, M.N. (1992) Propagules of marine macroalgae: Structure and development. British Phycological Journal, 27 (3): 219-232

Golding, L.A. Angel, B.M. Batley, G.E. Apte, S.C. Krassoi, R. and Doyle, C.J. (2015). Derivation of a water quality guideline for aluminium in marine waters. Environmental Toxicology and Chemistry, 34, 141-151.

EPA (2005). *Manual of Standard Operating Procedures for Environmental Monitoring against the Cockburn Sound Environmental Quality Criteria (2003-2004).* A supporting document to the State Environmental (Cockburn Sound) Policy 2005. Environmental Protection Authority, WA. December 2004.

EPA (2017). *Environmental Quality Criteria Reference Document for Cockburn Sound. A supporting document to the State Environmental (Cockburn Sound) Policy 2015.* Perth, The Government of Western Australia.

Power, E.A. and P.M. Chapman (1992) Assessing sediment quality. In Burton, G.A Jr (ed). Sediment Toxicity Assessment. Lewis, Chelsea.

Salgado, L.T., L.R. Andrade, and G.M. Amado Filho (2005). Localisation of specific monosaccharides in cells of the brown alga *Padina gymnospora* and the relation to heavy-metal accumulation. Protoplasma. 225: 132−128.

Simpson SL, Batley GB and Chariton AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07. CSIRO Land and Water.

Stauber JL, Binet M, Jones R, King C, Krassoi R and Smith R. (2008). Toxicity of manganese to marine biota: derivation of a manganese water quality guideline for tropical ecosystems. Proceedings of Society for Environmental Toxicology and Chemistry 5th World Congress, 3-7 August 2008, Sydney, Australia

Rockwater (2009). Dawesville to Binningup Technical Environmental Studies: Hydrogeological Study. Report for Department of Environment and Conservation by Rockwater Pty Ltd. December 2009.

Schaffelke B. (1999). Particulate organic matter as an alternate nutrient source for tropical Sargassum species (Fucales, Phaeophyceae). Journal of Phycology 35: 1150-1157.

Smith, J.E. Smith, C.M. and Hunter C.L. (2001). An experimental analysis of the effects of herbivory and nutrient enrichment on benthic community dynamics on a Hawaiian reef Coral Reefs. 19: 332-342.

UNEP/WHO (1996) Water Quality Monitoring – A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programs. J Bartram and R Balance (Eds). Published on behalf of United Nations Environment Programme and the World Health Organisation.

UWA 2008a. Characterising the marine benthic habitats of the proposed Southern Seawater Desalination Plant (SSDP) Site: Interpretation from Underwater Towed Video and Map Interpolation. University of Western Australia, Nedlands. Report MRG 2008-1 to Kellogg Brown and Root.

UWA 2008b. Southern Seawater Desalination Plant: Oceanographic Forcing. University of Western Australia, Nedlands.

Water Corporation (2008). Southern Seawater Desalination Project Operation Environmental Management Framework. January 2009.

Appendix A: Laboratory Reports

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, 6230

Date of Issue: 7/08/2019
Date Received: 16/07/2019
Our Reference: SPA19-5

METHOD	Sampling	2000	4100	2100	4700	2700	6000	3000	3000	2540D
SAMPLE CODE	Date	AMMONIA µg.N/L	ORTHO-P µg.P/L	NO3+NO2 µg.N/L	TOTAL-P µg.P/L	TOTAL-N µg.N/L	NPTOC mg.C/L	CHLOROPHYLL'a' µg/L	PHAEOPHYTIN'a' µg/L	TSS mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.5	<0.1	<0.2	<1
Analysis Date			26/07/2019		25/07/2019		24/07/2019	19/07/2019		18/07/2019
File			19072602		19072501		19072401	19071901		190718
HRD	16/07/2019	<3	3	<2	14	90	1.2	0.3	<0.2	2.5
SSDP	16/07/2019	<3	3	<2	13	90	1.3	0.4	<0.2	3.0
BIN-REEF	16/07/2019	<3	3	4	14	120	1.4	0.3	0.3	3.6
BIN-LAG	16/07/2019	<3	4	3	14	110	1.7	0.3	0.2	2.8
KEM	16/07/2019	<3	2	<2	14	120	1.6	0.4	<0.2	1.7
SG	16/07/2019	<3	3	<2	14	100	1.6	0.7	0.3	2.5
REF-1	16/07/2019	<3	2	2	17	120	1.5	1.8	0.9	5.8
REF-2	16/07/2019	<3	3	3	18	120	1.6	2.0	1.0	6.9

Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Lirong Han
Date: 7/08/2019

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, 6230

Date of Issue: 7/08/2019
Date Received: 16/07/2019
Our Reference: SPA19-5

METHOD	Sampling	ICP001	ICP001	ICP001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	B	Li	Sr	Filtered Be	Filtered Al	Filtered V	Filtered Cr	Filtered Mn	Filtered Fe	Filtered Co	Filtered Ni
		mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Reporting Limit		<0.006	<0.01	<0.001	<1	<5	<0.3	<0.2	<0.5	<1	<0.05	<0.3
File		25/07/2019 19072502	25/07/2019 19072502	25/07/2019 19072502	24/07/2019 19072401	24/07/2019 19072401	24/07/2019 19072401	24/07/2019 19072401	24/07/2019 19072401	24/07/2019 19072401	24/07/2019 19072401	24/07/2019 19072401
HRD	16/07/2019	4.7	0.15	7.9	<1	<5	1.5	<0.2	0.6	<1	<0.05	<0.3
SSDP	16/07/2019	4.8	0.15	8.0	<1	<5	1.5	<0.2	0.6	<1	<0.05	<0.3
BIN-REEF	16/07/2019	4.9	0.15	7.7	<1	<5	1.5	<0.2	0.8	<1	<0.05	<0.3
BIN-LAG	16/07/2019	4.9	0.16	7.8	<1	<5	1.5	<0.2	0.8	<1	<0.05	<0.3
KEM	16/07/2019	4.9	0.15	8.0	<1	<5	1.5	<0.2	0.6	<1	<0.05	<0.3
SG	16/07/2019	4.8	0.15	7.8	<1	<5	1.5	<0.2	0.6	<1	<0.05	<0.3
REF-1	16/07/2019	4.8	0.15	7.9	<1	<5	1.4	<0.2	0.9	<1	<0.05	<0.3
REF-2	16/07/2019	4.9	0.16	7.8	<1	<5	1.5	<0.2	0.9	<1	<0.05	<0.3

Note: Reporting Limits raised due to sample matrix
Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Lirong Han
Date: 7/08/2019

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

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Research Laboratory
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The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, 6230

Date of Issue: 7/08/2019
Date Received: 16/07/2019
Our Reference: SPA19-5

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Se µg/L	Filtered Mo µg/L	Filtered Ag µg/L	Filtered Cd µg/L	Filtered Sb µg/L	Filtered Ba µg/L	Filtered Pb µg/L	Filtered Bi µg/L
Reporting Limit		**<0.2**	**<1**	**<0.5**	**<1**	**<0.5**	**<0.1**	**<0.1**	**<0.5**	**<0.5**	**<0.1**	**<0.1**
File		**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**	**24/07/2019 19072401**
HRD	16/07/2019	<0.2	<1	1.6	<1	11	<0.1	<0.1	<0.5	5.4	<0.1	<0.1
SSDP	16/07/2019	<0.2	<1	1.6	<1	11	<0.1	<0.1	<0.5	5.3	<0.1	<0.1
BIN-REEF	16/07/2019	<0.2	<1	1.5	<1	11	<0.1	<0.1	<0.5	5.5	<0.1	<0.1
BIN-LAG	16/07/2019	<0.2	<1	1.6	<1	11	<0.1	<0.1	<0.5	5.5	<0.1	<0.1
KEM	16/07/2019	<0.2	<1	1.6	<1	10	<0.1	<0.1	<0.5	5.6	<0.1	<0.1
SG	16/07/2019	<0.2	<1	1.5	<1	11	<0.1	<0.1	<0.5	6.6	<0.1	<0.1
REF-1	16/07/2019	<0.2	<1	1.6	<1	10	<0.1	<0.1	<0.5	5.8	<0.1	<0.1
REF-2	16/07/2019	<0.2	<1	1.6	<1	11	<0.1	<0.1	<0.5	5.8	<0.1	<0.1

Note: Reporting Limits raised due to sample matrix
Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Lirong Han
Date: 7/08/2019

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
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Murdoch UNIVERSITY

SEDIMENT DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, 6230

Date of Issue: 7/08/2019
Date Received: 16/07/2019
Our Reference: SPA19-5

METHOD	Sampling	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002
SAMPLE CODE	Date	Total Ext Ag mg/kg	Total Ext Al mg/kg	Total Ext As mg/kg	Total Ext B mg/kg	Total Ext Ba mg/kg	Total Ext Be mg/kg	Total Ext Bi mg/kg	Total Ext Cd mg/kg	Total Ext Co mg/kg	Total Ext Cr mg/kg	Total Ext Cu mg/kg	Total Ext Fe mg/kg
Reporting Limit		<1	<20	<2	<1	<0.2	<0.01	<2	<0.1	<0.2	<0.2	<0.2	<5
Analysis Date		31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019	31/07/2019
File		19073101	19073101	19073101	19073101	19073101	19073101	19073101	19073101	19073101	19073101	19073101	19073101
BIN-LAG	16/07/2019	<1	840	12	25	9.9	0.05	<2	<0.1	1.6	8.2	0.4	3300
SG	16/07/2019	<1	670	7	11	18	0.03	<2	<0.1	1.0	5.5	0.4	2000

Note: Results expressed as dry weight basis.
Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
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Signatory: Lirong Han
Date: 7/08/2019

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SEDIMENT DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, 6230

Date of Issue: 7/08/2019
Date Received: 16/07/2019
Our Reference: SPA19-5

METHOD	Sampling	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	6200
SAMPLE CODE	Date	Total Ext Li mg/kg	Total Ext Mn mg/kg	Total Ext Mo mg/kg	Total Ext Ni mg/kg	Total Ext Pb mg/kg	Total Ext Sb mg/kg	Total Ext Se mg/kg	Total Ext Sr mg/kg	Total Ext V mg/kg	Total Ext Zn mg/kg	TOC % C
Reporting Limit		**<1**	**<0.05**	**<0.5**	**<0.7**	**<1**	**<2**	**<2**	**<0.1**	**<0.2**	**<0.5**	**<0.1**
Analysis Date		**31/07/2019**	**31/07/2019**	**31/07/2019**	**31/07/2019**	**31/07/2019**	**31/07/2019**	**31/07/2019**	**31/07/2019**	**31/07/2019**	**31/07/2019**	**1/08/2019**
File		**19073101**	**19073101**	**19073101**	**19073101**	**19073101**	**19073101**	**19073101**	**19073101**	**19073101**	**19073101**	**19080101**
BIN-LAG	16/07/2019	2	110	<0.5	1.4	2	<2	3	1600	8.6	2.5	0.2
SG	16/07/2019	<1	31	<0.5	<0.7	2	<2	3	640	9.3	1.6	<0.1

Note: Results expressed as dry weight basis.
Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
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Signatory: Lirong Han
Date: 7/08/2019

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PARTICLE SIZE ANALYSIS REPORT

Contact: Adelaide Bevilaqua
Customer: BMT
Address: Level 4/20 Parkland Road, Osborne Park WA 6017

Date of Issue: 22/08/2019
Date Received: 15/08/2019
Our Reference: SPA19-5

Sample Name:	SG
Sampling Date:	16/07/2019
Sample Type:	Sediment
MAFRL Job Code:	SPA19-5
Client Reference:	NA
Analysis Date	19/08/2019

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.00**
Very Fine Silt % (4-8µm)	0.00
Fine Silt % (8-16µm)	0.00
Medium Silt % (16-31µm)	0.01
Course Silt % (31-63µm)	0.29
Total Silt (4-63µm)	**0.31**
Very Fine sand % (63-125µm)	0.30
Fine sand % (125-250µm)	22.50
Medium sand % (250-500µm)	62.46
Coarse sand % (500-1000µm)	13.10
Very Coarse sand % (1000-2000µm)	1.17
Total Sand (63-2000µm)	**99.54**
Total Gravels (>2000µm)	**0.15**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	13.10
1000	1.17
2000	0.15
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	340.37
Minimum settling velocity of 50% of particles (mm s^1)	95.53
Time for 50% of particles to settle over 1 m (hours)	0.003
D10 (µm)	199.46
Minimum settling velocity of 90% of particles (mm s^1)	32.81
Time for 90% of particles to settle over 1 m (hours)	0.008

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Amy Dapson
Date: 22/08/2019

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PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury WA 6230

Date of Issue: 22/08/2019
Date Received: 16/07/2019
Our Reference: SPA19-5

Sample Name:	BIN-LAG
Sampling Date:	16/07/2019
Sample Type:	Sediment
MAFRL Job Code:	SPA19-5
Client Reference:	NA
Analysis Date	19/08/2019

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.03**
Very Fine Silt % (4-8µm)	0.19
Fine Silt % (8-16µm)	0.66
Medium Silt % (16-31µm)	0.02
Course Silt % (31-63µm)	13.16
Total Silt (4-63µm)	**14.04**
Very Fine sand % (63-125µm)	54.03
Fine sand % (125-250µm)	27.86
Medium sand % (250-500µm)	1.89
Coarse sand % (500-1000µm)	1.88
Very Coarse sand % (1000-2000µm)	0.18
Total Sand (63-2000µm)	**85.85**
Total Gravels (>2000µm)	**0.08**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.88
1000	0.18
2000	0.08
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	101.11
Minimum settling velocity of 50% of particles (mm s^1)	8.43
Time for 50% of particles to settle over 1 m (hours)	0.033
D10 (µm)	57.78
Minimum settling velocity of 90% of particles (mm s^1)	2.75
Time for 90% of particles to settle over 1 m (hours)	0.101

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Amy Dapson
Date: 22/08/2019

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F-S-A Reference: GOVE-1688532262-1168

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WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, WA 6230

Date of Issue: 10/12/2019
Date Received: 8/11/2019
Our Reference: SPA19-6
Your Reference: PO: 3194604

METHOD	Sampling	2000	4100	2100	4700	2700	6000	3000	3000	2540D
SAMPLE CODE	Date	AMMONIA µg.N/L	ORTHO-P µg.P/L	NO3+NO2 µg.N/L	TOTAL-P µg.P/L	TOTAL-N µg.N/L	NPTOC mg.C/L	CHLOROPHYLL'a' µg/L	PHAEOPHYTIN'a' µg/L	TSS mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.5	<0.1	<0.2	<0.5
Analysis Date			18/11/2019		13/11/2019		13/11/2019	20/11/2019		14/11/2019
File			19111802		19111301-120401		19111301	19112001		191114
HRD	8/11/2019	<3	3	<2	14	110	1.3	0.5	0.3	3.3
SSDP	8/11/2019	<3	3	<2	13	100	1.3	0.4	<0.2	2.4
BIN-REEF	8/11/2019	<3	4	<2	16	110	1.2	0.7	0.4	3.7
BIN-LAG	8/11/2019	<3	3	<2	17	160	1.6	1.0	0.4	5.6
KEM	8/11/2019	<3	3	<2	13	110	1.3	0.6	0.2	3.2
SG	8/11/2019	<3	3	<2	11	90	1.1	0.2	<0.2	1.5
REF-1	8/11/2019	<3	3	<2	11	90	1.4	0.5	<0.2	1.2
REF-2	8/11/2019	<3	4	<2	12	110	1.2	0.4	<0.2	1.0

Signatory: Jamie Woodward
Date: 10/12/2019

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WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, WA 6230

Date of Issue: 10/12/2019
Date Received: 8/11/2019
Our Reference: SPA19-6
Your Reference: PO: 3194604

METHOD	Sampling	ICP001	ICP001	ICP001	ICP006	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	B mg/L	Li mg/L	Sr mg/L	Hg mg/L	Filtered Be µg/L	Filtered Al µg/L	Filtered V µg/L	Filtered Cr µg/L	Filtered Mn µg/L	Filtered Fe µg/L	Filtered Co µg/L	Filtered Ni µg/L
Reporting Limit		<0.006	<0.01	<0.001	<0.0001	<1	<5	<0.3	<0.2	<0.5	<1	<0.05	<0.3
File		12/11/2019 19111201	12/11/2019 19111201	12/11/2019 19111201	14/11/2019 19111401	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302
HRD	8/11/2019	4.9	0.16	7.8	<0.0001	<1	<5	1.7	<0.2	0.7	<1	<0.05	<0.3
SSDP	8/11/2019	5.0	0.16	8.0	<0.0001	<1	<5	1.6	<0.2	0.7	<1	<0.05	<0.3
BIN-REEF	8/11/2019	5.1	0.16	7.9	<0.0001	<1	<5	1.6	<0.2	0.7	<1	<0.05	<0.3
BIN-LAG	8/11/2019	5.2	0.17	8.0	<0.0001	<1	<5	1.7	<0.2	0.9	<1	<0.05	<0.3
KEM	8/11/2019	5.0	0.17	7.9	<0.0001	<1	<5	1.7	<0.2	0.9	<1	<0.05	<0.3
SG	8/11/2019	5.1	0.16	7.9	<0.0001	<1	<5	1.7	<0.2	<0.5	<1	<0.05	<0.3
REF-1	8/11/2019	5.0	0.16	7.9	<0.0001	<1	<5	1.7	<0.2	0.6	<1	<0.05	<0.3
REF-2	8/11/2019	4.9	0.16	7.5	<0.0001	<1	<5	1.8	<0.2	0.6	<1	<0.05	<0.3

Signatory: Jamie Woodward
Date: 10/12/2019

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WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, WA 6230

Date of Issue: 10/12/2019
Date Received: 8/11/2019
Our Reference: SPA19-6
Your Reference: PO: 3194604

METHOD	Sampling	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	Filtered Cu µg/L	Filtered Zn µg/L	Filtered As µg/L	Filtered Se µg/L	Filtered Mo µg/L	Filtered Ag µg/L	Filtered Cd µg/L	Filtered Sb µg/L	Filtered Ba µg/L	Filtered Pb µg/L	Filtered Bi µg/L
Reporting Limit		<0.2	<1	<0.5	<1	<0.5	<0.1	<0.1	<0.5	<0.5	<0.1	<0.1
File		13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302	13/11/2019 19111302
HRD	8/11/2019	<0.2	<1	1.7	<1	11	<0.1	<0.1	<0.5	6.0	<0.1	<0.1
SSDP	8/11/2019	<0.2	<1	1.7	<1	11	<0.1	<0.1	<0.5	6.1	<0.1	<0.1
BIN-REEF	8/11/2019	<0.2	<1	1.7	<1	11	<0.1	<0.1	<0.5	6.0	<0.1	<0.1
BIN-LAG	8/11/2019	<0.2	<1	1.7	<1	10	<0.1	<0.1	<0.5	6.3	<0.1	<0.1
KEM	8/11/2019	<0.2	<1	1.7	<1	11	<0.1	<0.1	<0.5	6.6	<0.1	<0.1
SG	8/11/2019	<0.2	<1	1.7	<1	10	<0.1	<0.1	<0.5	5.9	0.1	<0.1
REF-1	8/11/2019	<0.2	<1	1.7	<1	10	<0.1	<0.1	<0.5	5.6	<0.1	<0.1
REF-2	8/11/2019	<0.2	<1	1.8	<1	10	<0.1	<0.1	<0.5	5.9	<0.1	<0.1

Signatory: Jamie Woodward
Date: 10/12/2019

The results only apply to the sample tested.
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SEDIMENT DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, WA 6230

Date of Issue: 10/12/2019
Date Received: 8/11/2019
Our Reference: SPA19-6
Your Reference: PO: 3194604

METHOD	Sampling	ICP007	6200	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002
SAMPLE CODE	Date	Total Ext Hg mg/kg	TOC % C	Total Ext Ag mg/kg	Total Ext Al mg/kg	Total Ext As mg/kg	Total Ext B mg/kg	Total Ext Ba mg/kg	Total Ext Be mg/kg	Total Ext Bi mg/kg	Total Ext Cd mg/kg	Total Ext Co mg/kg	Total Ext Cr mg/kg
Reporting Limit		**<0.01**	**<0.1**	**<1**	**<20**	**<2**	**<1**	**<0.2**	**<0.01**	**<2**	**<0.1**	**<0.2**	**<0.2**
Analysis Date		**27/11/2019**	**28/11/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**
File		**19112701**	**19112801**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**
BIN-LAG	8/11/2019	<0.01	0.2	<1	820	13	27	8.5	0.05	<2	<0.1	0.3	8.2
SG	8/11/2019	<0.01	<0.1	<1	390	4	5	14	0.02	<2	<0.1	0.4	5.8

Note: Sediment results expressed on a dry weight basis

Signatory: Jamie Woodward
Date: 10/12/2019

F-S-A Reference: GOVE-1688532262-1168

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Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury, WA 6230

Date of Issue: 10/12/2019
Date Received: 8/11/2019
Our Reference: SPA19-6
Your Reference: PO: 3194604

METHOD	Sampling	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002
SAMPLE CODE	Date	Total Ext Cu mg/kg	Total Ext Fe mg/kg	Total Ext Li mg/kg	Total Ext Mn mg/kg	Total Ext Mo mg/kg	Total Ext Ni mg/kg	Total Ext Pb mg/kg	Total Ext Sb mg/kg	Total Ext Se mg/kg	Total Ext Sr mg/kg	Total Ext V mg/kg	Total Ext Zn mg/kg
Reporting Limit		**<0.2**	**<5**	**<2**	**<0.05**	**<0.5**	**<0.7**	**<1**	**<2**	**<2**	**<0.1**	**<0.2**	**<0.5**
Analysis Date		**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**	**3/12/2019**
File		**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**	**19120301**
BIN-LAG	8/11/2019	0.4	3500	2	100	<0.5	0.9	1	<2	<2	1800	8.7	2.6
SG	8/11/2019	0.4	2100	<2	32	<0.5	<0.7	1	<2	<2	210	8.9	1.3

Note: Sediment results expressed on a dry weight basis
For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Jamie Woodward
Date: 10/12/2019

F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Murdoch UNIVERSITY

TEST REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 11/02/2020
Date Received: 8/11/2019
Our Reference: SPA19-7
Your Reference: SPA Sludge Monitoring

METHOD SAMPLE CODE	Deployment Date	Retrieval Date	Total Dry Weight	5400 % LOSS ON IGNITION AT 550°C
Analysis Date			**3/02/2020**	**7/02/2020**
File			**200203**	**20020701**
HRD 1	16/07/2019	8/11/2019	9.7	16.2
HRD 2	16/07/2019	8/11/2019	8.7	14.5
HRD 3	16/07/2019	8/11/2019	10.1	14.4
Bin-Reef 1	16/07/2019	8/11/2019	1.6	18.2
Bin-Reef 2	16/07/2019	8/11/2019	1.5	20.7
Bin-Reef 3	16/07/2019	8/11/2019	3.9	14.5
Bin-Lag 1	16/07/2019	8/11/2019	2.1	12.1
Bin-Lag 2	16/07/2019	8/11/2019	2.2	13.0
Bin-Lag 3	16/07/2019	8/11/2019	2.6	9.6
SG-1	16/07/2019	8/11/2019	4.2	17.3
SG-2	16/07/2019	8/11/2019	4.6	18.2
SG-3	16/07/2019	8/11/2019	5.5	15.6

Signatory: Jamie Woodward
Date: 11/02/2020

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F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
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Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
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Murdoch UNIVERSITY

PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 14/11/2019
Date Received: 8/11/2019
Our Reference: SPA19-6

Sample Name:	SG
Sampling Date:	8/11/2019
Sample Type:	Sediment
MAFRL Job Code:	SPA19-6
Client Reference:	NA
Analysis Date:	12/11/2019
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.00**
Very Fine Silt % (4-8µm)	0.00
Fine Silt % (8-16µm)	0.00
Medium Silt % (16-31µm)	0.00
Course Silt % (31-63µm)	0.00
Total Silt (4-63µm)	**0.00**
Very Fine sand % (63-125µm)	0.00
Fine sand % (125-250µm)	10.33
Medium sand % (250-500µm)	64.17
Coarse sand % (500-1000µm)	24.71
Very Coarse sand % (1000-2000µm)	0.76
Total Sand (63-2000µm)	**99.96**
Total Gravels (>2000µm)	**0.04**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	24.71
1000	0.76
2000	0.04
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	397.12
Minimum settling velocity of 50% of particles (mm s^1)	130.04
Time for 50% of particles to settle over 1 m (hours)	0.002
D10 (µm)	248.18
Minimum settling velocity of 90% of particles (mm s^1)	50.79
Time for 90% of particles to settle over 1 m (hours)	0.005

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Amy Dapson
Date: 14/11/2019

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

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PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 14/11/2019
Date Received: 8/11/2019
Our Reference: SPA19-6

Sample Name:	BIN-LAG
Sampling Date:	8/11/2019
Sample Type:	Sediment
MAFRL Job Code:	SPA19-6
Client Reference:	NA
Analysis Date:	12/11/2019
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.05**
Very Fine Silt % (4-8µm)	0.11
Fine Silt % (8-16µm)	0.79
Medium Silt % (16-31µm)	0.24
Course Silt % (31-63µm)	9.81
Total Silt (4-63µm)	**10.95**
Very Fine sand % (63-125µm)	48.34
Fine sand % (125-250µm)	34.30
Medium sand % (250-500µm)	5.41
Coarse sand % (500-1000µm)	0.86
Very Coarse sand % (1000-2000µm)	0.08
Total Sand (63-2000µm)	**88.99**
Total Gravels (>2000µm)	**0.01**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	0.86
1000	0.08
2000	0.01
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	111.48
Minimum settling velocity of 50% of particles (mm s^1)	10.25
Time for 50% of particles to settle over 1 m (hours)	0.027
D10 (µm)	61.37
Minimum settling velocity of 90% of particles (mm s^1)	3.11
Time for 90% of particles to settle over 1 m (hours)	0.089

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Amy Dapson
Date: 14/11/2019

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F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
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Murdoch UNIVERSITY

TEST REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 6/04/2020
Date Received: 25/02/2020
Our Reference: SPA20-1
Your Reference: Plate Collectors, Sludge Monitoring, PO: 3194604

METHOD			Total	5400	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003
SAMPLE CODE	Deployment Date	Retrieval Date	Dry Weight g	% LOSS ON IGNITION AT 550°C	Total Ext Ag mg/kg	Total Ext Al mg/kg	Total Ext As mg/kg	Total Ext B mg/kg	Total Ext Ba mg/kg	Total Ext Be mg/kg	Total Ext Bi mg/kg	Total Ext Cd mg/kg	Total Ext Co mg/kg	Total Ext Cr mg/kg	Total Ext Cu mg/kg
Reporting Limit			<0.1	AT 550°C	<1	<3	<2	<1	<0.2	<0.01	<2	<0.1	<0.2	<0.5	<0.2
Analysis Date			5/03/2020	12/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020
File			200305	200312	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701
HRD-R1	8/11/2019	26/02/2020	11.2	9.6	<1	1400	16	45	12	0.07	<2	0.2	1.0	14	1.6
HRD-R2	8/11/2019	26/02/2020	8.8	8.5	<1	1500	17	44	12	0.07	<2	0.3	0.7	9.4	1.3
HRD-R3	8/11/2019	26/02/2020	5.9	10.2	<1	1800	19	51	13	0.08	<2	0.2	1.0	67	1.6
BIN-REEF-R1	8/11/2019	26/02/2020	26.7	6.5	<1	1200	16	38	11	0.07	<2	<0.1	0.9	72	1.3
BIN-REEF-R2	8/11/2019	26/02/2020	40.8	6.7	<1	1100	17	38	11	0.07	<2	0.1	0.7	11	0.9
BIN-REEF-R3	8/11/2019	26/02/2020	34.1	6.1	<1	1200	15	38	11	0.07	<2	0.1	0.8	11	0.9
BIN-LAG-R1	8/11/2019	26/02/2020	25.3	8.7	<1	1400	17	49	11	0.08	<2	0.1	0.9	16	1.2
BIN-LAG-R2	8/11/2019	26/02/2020	20.4	14.8	<1	1200	16	38	11	0.08	<2	<0.1	0.8	10	1.0
BIN-LAG-R3	8/11/2019	26/02/2020	21.6	11.5	<1	1500	17	56	10	0.07	<2	<0.1	0.8	8.6	1.2
SG-R1	8/11/2019	26/02/2020	2.3	22.9	<1	3300	17	330	20	0.12	<2	0.2	1.7	53	4.9
SG-R2	8/11/2019	26/02/2020	2.2	22.3	<1	3500	19	290	20	0.13	<2	0.2	1.8	33	4.9
SG-R3	8/11/2019	26/02/2020	3.1	21.9	<1	3600	19	320	19	0.13	<2	0.2	1.8	34	4.7

Signatory: Jamie Woodward
Date: 6/04/2020

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F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Murdoch UNIVERSITY

TEST REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 6/04/2020
Date Received: 25/02/2020
Our Reference: SPA20-1
Your Reference: Plate Collectors, Sludge Monitoring, PO: 3194604

METHOD			ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP003	ICP007
SAMPLE CODE	Deployment Date	Retrieval Date	Total Ext Fe mg/kg	Total Ext Li mg/kg	Total Ext Mn mg/kg	Total Ext Mo mg/kg	Total Ext Ni mg/kg	Total Ext Pb mg/kg	Total Ext Sb mg/kg	Total Ext Se mg/kg	Total Ext Sr mg/kg	Total Ext V mg/kg	Total Ext Zn mg/kg	Total Ext Hg mg/kg
Reporting Limit			<1	<2	<0.1	<0.4	<0.7	<1	<2	<2	<0.1	<0.2	<2	<0.01
Analysis Date			17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	17/03/2020	3/04/2020
File			20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20031701	20040301
HRD-R1	8/11/2019	26/02/2020	4200	3	110	0.9	1.9	1	<2	<2	2100	15	8	<0.01
HRD-R2	8/11/2019	26/02/2020	4100	4	98	0.6	1.7	2	<2	<2	2200	20	8	<0.01
HRD-R3	8/11/2019	26/02/2020	5300	4	110	6.9	7.1	2	<2	<2	2100	25	8	<0.01
BIN-REEF-R1	8/11/2019	26/02/2020	4600	3	150	5.3	6.2	2	<2	<2	1700	26	4	<0.01
BIN-REEF-R2	8/11/2019	26/02/2020	4200	3	140	0.5	1.7	2	<2	<2	1800	20	4	<0.01
BIN-REEF-R3	8/11/2019	26/02/2020	4300	3	140	0.5	1.9	2	<2	<2	1800	22	4	<0.01
BIN-LAG-R1	8/11/2019	26/02/2020	4600	3	160	0.8	2.4	2	<2	<2	1700	19	7	<0.01
BIN-LAG-R2	8/11/2019	26/02/2020	4600	3	160	<0.4	1.5	2	<2	<2	1700	17	4	<0.01
BIN-LAG-R3	8/11/2019	26/02/2020	4100	3	130	<0.4	2.0	2	<2	<2	2600	21	5	<0.01
SG-R1	8/11/2019	26/02/2020	7600	6	190	8.5	7.2	4	<2	<2	1300	21	10	<0.01
SG-R2	8/11/2019	26/02/2020	7400	6	190	4.6	6.8	3	<2	<2	1400	22	10	<0.01
SG-R3	8/11/2019	26/02/2020	8000	6	200	1.6	5.5	3	<2	<2	1400	22	11	<0.01

Signatory: Jamie Woodward
Date: 6/04/2020

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Murdoch UNIVERSITY

WATER QUALITY DATA

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 2/04/2020
Date Received: 26/02/2020
Our Reference: SPA20-2
Your Reference: Sludge Monitoring, PO: 3194604

METHOD	Sampling	2000	4100	2100	4700	2700	6000	3000	3000	2540D
SAMPLE CODE	Date	AMMONIA	ORTHO-P	NO3+NO2	TOTAL-P	TOTAL-N	NPTOC	CHLOROPHYLL'a'	PHAEOPHYTIN'a'	TSS
		µg.N/L	µg.P/L	µg.N/L	µg.P/L	µg.N/L	mg.C/L	µg/L	µg/L	mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.5	<0.1	<0.2	<0.5
Analysis Date			27/02/2020		6/03/2020		27/02/2020	4/03/2020		21/03/2020
File			20022701		20030601		20022701	20030404		200321
HRD	26/02/2020	<3	<2	<2	13	100	0.8	0.2	<0.2	0.8
SSDP	26/02/2020	3	3	<2	12	130	1.0	0.2	<0.2	1.3
BIN-REEF	26/02/2020	<3	2	<2	12	100	0.9	0.2	<0.2	0.6
BIN-LAG	26/02/2020	<3	2	<2	12	100	0.9	0.2	<0.2	0.7
KEM	26/02/2020	<3	<2	<2	11	100	0.8	0.2	<0.2	0.6
SG	26/02/2020	<3	2	<2	10	100	0.9	0.3	<0.2	<0.5
REF-1	26/02/2020	<3	2	<2	10	90	0.9	0.3	<0.2	<0.5
REF-2	26/02/2020	<3	3	<2	10	90	0.8	0.2	<0.2	<0.5

Signatory: Jamie Woodward
Date: 2/04/2020

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WATER QUALITY DATA

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 2/04/2020
Date Received: 26/02/2020
Our Reference: SPA20-2
Your Reference: Sludge Monitoring, PO: 3194604

METHOD	Sampling	ICP001	ICP001	ICP001	ICP006	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	B	Li	Sr	Hg	Filtered Be	Filtered Al	Filtered V	Filtered Cr	Filtered Mn	Filtered Fe	Filtered Co	Filtered Ni
		mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Reporting Limit		<0.006	<0.01	<0.001	<0.0001	<1	<5	<0.3	<0.2	<0.5	<1	<0.05	<0.3
File		4/03/2020 20030401	4/03/2020 20030401	4/03/2020 20030401	6/03/2020 20030601	9/03/2020 20030902	9/03/2020 20030902	9/03/2020 20030902	9/03/2020 20030902	9/03/2020 20030902	9/03/2020 20030902	9/03/2020 20030902	9/03/2020 20030902
HRD	26/02/2020	4.7	0.19	7.6	<0.0001	<1	<5	1.4	<0.2	1.1	<1	<0.05	<0.3
SSDP	26/02/2020	4.8	0.19	7.7	<0.0001	<1	<5	1.3	<0.2	1.3	<1	<0.05	0.6
BIN-REEF	26/02/2020	4.9	0.19	7.9	<0.0001	<1	<5	1.2	<0.2	1.7	<1	<0.05	<0.3
BIN-LAG	26/02/2020	4.8	0.19	7.7	<0.0001	<1	<5	1.1	<0.2	1.4	<1	<0.05	<0.3
KEM	26/02/2020	4.8	0.19	7.8	<0.0001	<1	<5	1.3	<0.2	1.5	<1	<0.05	<0.3
SG	26/02/2020	4.7	0.19	7.6	<0.0001	<1	<5	1.3	<0.2	1.3	<1	<0.05	<0.3
REF-1	26/02/2020	4.8	0.19	7.7	<0.0001	<1	<5	1.3	<0.2	0.8	<1	<0.05	<0.3
REF-2	26/02/2020	4.8	0.19	7.7	<0.0001	<1	<5	1.3	<0.2	0.9	<1	<0.05	<0.3

Signatory: Jamie Woodward
Date: 2/04/2020

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

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WATER QUALITY DATA

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 2/04/2020
Date Received: 26/02/2020
Our Reference: SPA20-2
Your Reference: Sludge Monitoring, PO: 3194604

METHOD SAMPLE CODE	Sampling Date	MS001 Filtered Cu µg/L	MS001 Filtered Zn µg/L	MS001 Filtered As µg/L	MS001 Filtered Se µg/L	MS001 Filtered Mo µg/L	MS001 Filtered Ag µg/L	MS001 Filtered Cd µg/L	MS001 Filtered Sb µg/L	MS001 Filtered Ba µg/L	MS001 Filtered Pb µg/L	MS001 Filtered Bi µg/L
Reporting Limit		**<0.2**	**<1**	**<0.5**	**<1**	**<0.5**	**<0.1**	**<0.1**	**<0.5**	**<0.5**	**<0.1**	**<0.1**
Analysis Date		**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**	**9/03/2020**
File		**20030902**	**20030902**	**20030902**	**20030902**	**20030902**	**20030902**	**20030902**	**20030902**	**20030902**	**20030902**	**20030902**
HRD	26/02/2020	<0.2	<1	1.8	<1	11	<0.1	<0.1	<0.5	6.2	<0.1	<0.1
SSDP	26/02/2020	<0.2	1	1.8	<1	11	<0.1	<0.1	<0.5	6.5	0.3	<0.1
BIN-REEF	26/02/2020	0.3	<1	1.7	<1	11	<0.1	<0.1	<0.5	6.9	<0.1	<0.1
BIN-LAG	26/02/2020	0.3	<1	1.7	<1	11	<0.1	<0.1	<0.5	7.0	<0.1	<0.1
KEM	26/02/2020	0.3	<1	1.7	<1	11	<0.1	<0.1	<0.5	8.0	<0.1	<0.1
SG	26/02/2020	0.4	<1	1.8	<1	11	<0.1	<0.1	<0.5	6.2	<0.1	<0.1
REF-1	26/02/2020	<0.2	<1	1.8	<1	11	<0.1	<0.1	<0.5	5.5	<0.1	<0.1
REF-2	26/02/2020	0.2	<1	1.9	<1	11	<0.1	<0.1	<0.5	5.6	<0.1	<0.1

Signatory: Jamie Woodward
Date: 2/04/2020

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F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
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SEDIMENT DATA

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 2/04/2020
Date Received: 26/02/2020
Our Reference: SPA20-2
Your Reference: Sludge Monitoring, PO: 3194604

METHOD	Sampling	ICP007	6200	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002
SAMPLE CODE	Date	Total Ext Hg	TOC	Total Ext Ag	Total Ext Al	Total Ext As	Total Ext B	Total Ext Ba	Total Ext Be	Total Ext Bi	Total Ext Cd	Total Ext Co	Total Ext Cr
		mg/kg	% C	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Reporting Limit		<0.01	<0.1	<1	<20	<2	<1	<0.2	<0.01	<2	<0.1	<0.2	<0.2
Analysis Date		6/03/2020	5/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020
File		20030602	20030501	20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901
BIN-LAG	26/02/2020	<0.01	0.2	<1	820	15	30	8.9	0.05	<2	0.1	0.4	8.7
SG	26/02/2020	<0.01	<0.1	<1	450	5	8	11	0.02	<2	<0.1	0.4	5.6

Note: Sediment results expressed on a dry weight basis

Signatory: Jamie Woodward
Date: 2/04/2020

F-S-A Reference: GOVE-1688532262-1168

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SEDIMENT DATA

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 2/04/2020
Date Received: 26/02/2020
Our Reference: SPA20-2
Your Reference: Sludge Monitoring, PO: 3194604

METHOD	Sampling	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002	ICP002
SAMPLE CODE	Date	Total Ext Cu mg/kg	Total Ext Fe mg/kg	Total Ext Li mg/kg	Total Ext Mn mg/kg	Total Ext Mo mg/kg	Total Ext Ni mg/kg	Total Ext Pb mg/kg	Total Ext Sb mg/kg	Total Ext Se mg/kg	Total Ext Sr mg/kg	Total Ext V mg/kg	Total Ext Zn mg/kg
Reporting Limit		<0.2	<5	<2	<0.05	<0.5	<0.7	<1	<2	<2	<0.1	<0.2	<0.5
Analysis Date		19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020	19/03/2020
File		20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901	20031901
BIN-LAG	26/02/2020	0.5	3600	2	130	<0.5	0.9	2	<2	<2	1900	8.7	2.6
SG	26/02/2020	0.4	2000	<2	31	<0.5	<0.7	1	<2	<2	340	8.8	1.5

Note: Sediment results expressed on a dry weight basis
For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Jamie Woodward
Date: 2/04/2020

F-S-A Reference: GOVE-1688532262-1168

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PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 11/03/2020
Date Received: 26/02/2020
Our Reference: SPA20-2

Sample Name:	SG
Sampling Date:	26/02/2020
Sample Type:	Sediment
MAFRL Job Code:	SPA20-2
Client Reference:	Sludge Monitoring, PO: 3194604
Analysis Date:	3/03/2020
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.00**
Very Fine Silt % (4-8µm)	0.00
Fine Silt % (8-16µm)	0.00
Medium Silt % (16-31µm)	0.00
Course Silt % (31-63µm)	0.81
Total Silt (4-63µm)	**0.81**
Very Fine sand % (63-125µm)	0.38
Fine sand % (125-250µm)	16.20
Medium sand % (250-500µm)	63.32
Coarse sand % (500-1000µm)	18.33
Very Coarse sand % (1000-2000µm)	0.86
Total Sand (63-2000µm)	**99.09**
Total Gravels (>2000µm)	**0.10**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	18.33
1000	0.86
2000	0.10
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	366.96
Minimum settling velocity of 50% of particles (mm s^1)	111.04
Time for 50% of particles to settle over 1 m (hours)	0.003
D10 (µm)	216.22
Minimum settling velocity of 90% of particles (mm s^1)	38.55
Time for 90% of particles to settle over 1 m (hours)	0.007

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Jamie Woodward
Date: 11/03/2020

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Spare test items will be held for two months unless otherwise requested.

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PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 11/03/2020
Date Received: 26/02/2020
Our Reference: SPA20-2

Sample Name:	BIN-LAG
Sampling Date:	26/02/2020
Sample Type:	Sediment
MAFRL Job Code:	SPA20-2
Client Reference:	Sludge Monitoring, PO: 3194604
Analysis Date:	3/03/2020
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.19**
Very Fine Silt % (4-8µm)	0.21
Fine Silt % (8-16µm)	0.85
Medium Silt % (16-31µm)	0.16
Course Silt % (31-63µm)	11.87
Total Silt (4-63µm)	**13.09**
Very Fine sand % (63-125µm)	55.65
Fine sand % (125-250µm)	30.22
Medium sand % (250-500µm)	0.79
Coarse sand % (500-1000µm)	0.07
Very Coarse sand % (1000-2000µm)	0.00
Total Sand (63-2000µm)	**86.72**
Total Gravels (>2000µm)	**0.00**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	0.07
1000	0.00
2000	0.00
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	101.46
Minimum settling velocity of 50% of particles (mm s^1)	8.49
Time for 50% of particles to settle over 1 m (hours)	0.033
D10 (µm)	58.58
Minimum settling velocity of 90% of particles (mm s^1)	2.83
Time for 90% of particles to settle over 1 m (hours)	0.098

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with no other noticeable sediment types present.

Signatory: Jamie Woodward
Date: 11/03/2020

The results only apply to the sample tested.
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WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury WA 6230

Date of Issue: 3/04/2020
Date Received: 13/03/2020
Our Reference: SPA20-3
Your Reference: Dredge Plume Monitoring, PO: 3203899

METHOD	Sampling	5060	2540D	2540E	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	Turbidity NTU	TSS mg/L	% LOSS ON IGNITION	Filtered Cu µg/L	Filtered Zn µg/L	Unfiltered Cu µg/L	Unfiltered Zn µg/L
Reporting Limit		<0.1	<1	AT 550°C	<0.2	<1	<0.2	<1
Analysis Date		13/03/2020	23/03/2020	23/03/2020	18/03/2020	18/03/2020	20/03/2020	20/03/2020
File		200313	200323	200323	20031801	20031801	20032001	20032001
1	13/03/2020	4.8	16	31	<0.2	<1	0.7	45
2	13/03/2020	2.7	8.3	32	<0.2	<1	0.6	3
3	13/03/2020	0.8	2.8	29	<0.2	<1	0.5	<2
4	13/03/2020	0.6	2.2	37	0.2	<1	0.5	<2
5	13/03/2020	0.5	0.9	46	<0.2	<1	<0.2	<1
6	13/03/2020	0.4	1.4	33	<0.2	<1	<0.2	<1

Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
Tables for measurement uncertainity are available online at www.mafrl.murdoch.edu.au

Signatory: Jamie Woodward
Date: 3/04/2020

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

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WATER QUALITY DATA

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 18/05/2020
Date Received: 24/04/2020
Our Reference: SPA20-4
Your Reference: Sludge Monitoring

METHOD	Sampling	2000	4100	2100	4700	2700	6000	3000	3000	2540D
SAMPLE CODE	Date	AMMONIA	ORTHO-P	NO3+NO2	TOTAL-P	TOTAL-N	NPTOC	CHLOROPHYLL'a'	PHAEOPHYTIN'a'	TSS
		µg.N/L	µg.P/L	µg.N/L	µg.P/L	µg.N/L	mg.C/L	µg/L	µg/L	mg/L
Reporting Limit		<3	<2	<2	<5	<50	<0.5	<0.1	<0.2	<0.5
Analysis Date			28/04/2020			29/04/2020	6/05/2020		6/05/2020	30/04/2020
File			20042801			20042901	20050601		20050601	20043001
HRD	23/04/2020	<3	3	<2	12	100	1.0	1.0	0.3	2.4
SSDP	23/04/2020	<3	<2	<2	14	110	1.0	0.9	0.3	2.4
BIN-REEF	23/04/2020	<3	4	4	14	110	0.8	0.5	0.5	4.3
BIN-LAG	23/04/2020	<3	3	<2	17	130	1.3	1.0	0.3	2.5
KEM	23/04/2020	<3	3	<2	15	110	1.0	1.3	0.5	3.9
SG	23/04/2020	<3	4	4	13	120	1.0	1.7	0.5	3.9
REF-1	23/04/2020	<3	3	<2	15	120	0.8	2.3	0.7	2.9
REF-2	23/04/2020	<3	3	5	16	140	0.9	1.8	0.5	2.5

Note: For results for compliance purposes uncertainity of measurement (MU) will sometimes affect the interpretation whether the result passes or fails the compliance limit.
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Signatory: Jamie Woodward
Date: 18/05/2020

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WATER QUALITY DATA

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 18/05/2020
Date Received: 24/04/2020
Our Reference: SPA20-4
Your Reference: Sludge Monitoring

METHOD	Sampling	ICP001	ICP001	ICP001	ICP006	MS001	MS001	MS001	MS001	MS001	MS001	MS001	MS001
SAMPLE CODE	Date	B	Li	Sr	Hg	Filtered Be	Filtered Al	Filtered V	Filtered Cr	Filtered Mn	Filtered Fe	Filtered Co	Filtered Ni
		mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Reporting Limit		<0.006	<0.01	<0.001	<0.0001	<1	<5	<0.3	<0.2	<0.5	<1	<0.05	<0.3
File		11/05/2020 20051101	11/05/2020 20051101	11/05/2020 20051101	13/05/2020 20051301	30/04/2020 20043001	30/04/2020 20043001	30/04/2020 20043001	30/04/2020 20043001	30/04/2020 20043001	30/04/2020 20043001	30/04/2020 20043001	30/04/2020 20043001
HRD	23/04/2020	5.1	0.19	8.0	<0.0001	<1	<5	1.6	<0.2	1.0	<1	<0.05	<0.3
SSDP	23/04/2020	5.1	0.20	8.1	<0.0001	<1	<5	1.6	<0.2	1.1	<1	<0.05	<0.3
BIN-REEF	23/04/2020	5.1	0.19	8.3	<0.0001	<1	<5	1.6	<0.2	1.0	1	<0.05	<0.3
BIN-LAG	23/04/2020	5.0	0.18	8.2	<0.0001	<1	<5	1.6	<0.2	0.9	<1	<0.05	<0.3
KEM	23/04/2020	4.9	0.18	8.4	<0.0001	<1	<5	1.6	<0.2	2.8	<1	<0.05	<0.3
SG	23/04/2020	5.0	0.18	8.1	<0.0001	<1	<5	1.6	<0.2	0.6	<1	<0.05	<0.3
REF-1	23/04/2020	5.1	0.18	8.2	<0.0001	<1	<5	1.5	<0.2	0.9	<1	<0.05	<0.3
REF-2	23/04/2020	5.0	0.18	8.0	<0.0001	<1	<5	1.5	<0.2	0.7	<1	<0.05	<0.3

Signatory: Jamie Woodward
Date: 18/05/2020

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WATER QUALITY DATA

Contact: Duncan Gordan
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 18/05/2020
Date Received: 24/04/2020
Our Reference: SPA20-4
Your Reference: Sludge Monitoring

METHOD SAMPLE CODE	Sampling Date	MS001 Filtered Cu µg/L	MS001 Filtered Zn µg/L	MS001 Filtered As µg/L	MS001 Filtered Se µg/L	MS001 Filtered Mo µg/L	MS001 Filtered Ag µg/L	MS001 Filtered Cd µg/L	MS001 Filtered Sb µg/L	MS001 Filtered Ba µg/L	MS001 Filtered Pb µg/L	MS001 Filtered Bi µg/L
Reporting Limit		**<0.2**	**<1**	**<0.5**	**<1**	**<0.5**	**<0.1**	**<0.1**	**<0.5**	**<0.5**	**<0.1**	**<0.1**
File		**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**	**30/04/2020 20043001**
HRD	23/04/2020	<0.2	<1	1.9	<1	11	<0.1	<0.1	<0.5	5.8	<0.1	<0.1
SSDP	23/04/2020	<0.2	<1	2.0	<1	12	<0.1	<0.1	<0.5	5.7	<0.1	<0.1
BIN-REEF	23/04/2020	<0.2	<1	1.8	<1	12	<0.1	<0.1	<0.5	6.1	<0.1	<0.1
BIN-LAG	23/04/2020	<0.2	<1	1.8	<1	11	<0.1	<0.1	<0.5	5.9	<0.1	<0.1
KEM	23/04/2020	<0.2	<1	1.7	<1	11	<0.1	<0.1	<0.5	9.2	<0.1	<0.1
SG	23/04/2020	<0.2	<1	1.9	<1	11	<0.1	<0.1	<0.5	6.0	<0.1	<0.1
REF-1	23/04/2020	<0.2	<1	1.8	<1	11	<0.1	<0.1	<0.5	6.1	<0.1	<0.1
REF-2	23/04/2020	<0.2	<1	1.8	<1	12	<0.1	<0.1	<0.5	6.1	<0.1	<0.1

Signatory: Jamie Woodward
Date: 18/05/2020

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Murdoch UNIVERSITY

TEST REPORT

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date Received: 24/04/2020
Date of Issue: 25/05/2020
Our Reference: SPA20-8
Your Reference: Plate Collectors, Sludge Monitoring

METHOD SAMPLE CODE	Deployment Date	Retrieval Date	Total Dry Weight g	5400 % LOSS ON IGNITION AT 550°C	ICP003 Total Ext Ag mg/kg	ICP003 Total Ext Al mg/kg	ICP003 Total Ext As mg/kg	ICP003 Total Ext B mg/kg	ICP003 Total Ext Ba mg/kg	ICP003 Total Ext Be mg/kg	ICP003 Total Ext Bi mg/kg	ICP003 Total Ext Cd mg/kg	ICP003 Total Ext Co mg/kg	ICP003 Total Ext Cr mg/kg	ICP003 Total Ext Cu mg/kg
Reporting Limit			**<0.1**	**<0.1**	**<1**	**<3**	**<2**	**<1**	**<0.2**	**<0.01**	**<2**	**<0.1**	**<0.2**	**<0.5**	**<0.2**
Analysis Date			**1/05/2020**	**6/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**
File			**200501**	**200506**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**
HRD-R1	26/02/2020	24/04/2020	3.5	10.6	<1	1100	20	48	13	0.07	<2	0.2	0.7	14	1.6
HRD-R2	26/02/2020	24/04/2020	4.0	9.2	<1	1100	21	50	13	0.07	<2	0.2	0.8	9.4	1.2
HRD-R3	26/02/2020	24/04/2020	2.0	15.3	<1	1200	22	65	13	0.07	<2	0.4	0.7	8.6	1.5
BIN-REEF-R1	26/02/2020	24/04/2020	4.2	6.2	<1	1500	15	44	13	0.09	<2	0.2	0.8	14	1.5
BIN-REEF-R2	26/02/2020	24/04/2020	5.7	5.7	<1	1300	14	44	14	0.07	<2	0.1	2.1	610	7.1
BIN-REEF-R3	26/02/2020	24/04/2020	5.7	5.2	<1	1300	13	37	15	0.08	<2	0.1	1.2	13	1.3
BIN-LAG-R1	26/02/2020	24/04/2020	7.5	3.8	<1	890	10	28	13	0.08	<2	0.1	0.8	13	1.1
BIN-LAG-R2	26/02/2020	24/04/2020	5.8	4.6	<1	950	10	31	17	0.08	<2	0.3	0.8	14	1.2
BIN-LAG-R3	26/02/2020	24/04/2020	7.3	4.0	<1	910	11	29	13	0.08	<2	0.2	0.6	13	1.2
SG-R1,2,3	26/02/2020	24/04/2020		16.6	<1	3300	17	260	58	0.12	<2	0.2	2.2	280	6.9
SG-R1	26/02/2020	24/04/2020	0.4												
SG-R2	26/02/2020	24/04/2020	0.2												
SG-R3	26/02/2020	24/04/2020	0.3												

Signatory: Jamie Woodward
Date: 25/05/2020

The results only apply to the sample as received and to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Murdoch UNIVERSITY

TEST REPORT

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date Received: 24/04/2020
Date of Issue: 25/05/2020
Our Reference: SPA20-8
Your Reference: Plate Collectors, Sludge Monitoring

METHOD SAMPLE CODE	Deployment Date	Retrieval Date	ICP003 Total Ext Fe mg/kg	ICP003 Total Ext Li mg/kg	ICP003 Total Ext Mn mg/kg	ICP003 Total Ext Mo mg/kg	ICP003 Total Ext Ni mg/kg	ICP003 Total Ext Pb mg/kg	ICP003 Total Ext Sb mg/kg	ICP003 Total Ext Se mg/kg	ICP003 Total Ext Sr mg/kg	ICP003 Total Ext V mg/kg	ICP003 Total Ext Zn mg/kg	ICP007 Total Ext Hg mg/kg
Reporting Limit			**<1**	**<2**	**<0.1**	**<0.4**	**<0.7**	**<1**	**<2**	**<2**	**<0.1**	**<0.2**	**<2**	**<0.01**
Analysis Date			**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**7/05/2020**	**22/05/2020**	**13/05/2020**
File			**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20050701**	**20052201**	**20051302**
HRD-R1	26/02/2020	24/04/2020	4200	3	120	1.3	2.1	1	<2	<2	1800	25	8	<0.01
HRD-R2	26/02/2020	24/04/2020	4400	3	130	0.5	1.7	2	<2	<2	2000	25	6	<0.01
HRD-R3	26/02/2020	24/04/2020	4400	3	120	0.7	2.7	3	<2	<2	1700	42	8	0.02
BIN-REEF-R1	26/02/2020	24/04/2020	5400	4	160	0.8	2.3	4	<2	<2	1600	19	6	<0.01
BIN-REEF-R2	26/02/2020	24/04/2020	5400	3	150	75	36	3	<2	<2	1600	16	5	<0.01
BIN-REEF-R3	26/02/2020	24/04/2020	4800	3	160	0.5	1.9	3	<2	<2	1600	13	5	<0.01
BIN-LAG-R1	26/02/2020	24/04/2020	4500	2	180	<0.4	1.3	5	<2	<2	1400	20	4	<0.01
BIN-LAG-R2	26/02/2020	24/04/2020	4700	3	190	<0.4	1.4	5	<2	<2	1400	19	5	<0.01
BIN-LAG-R3	26/02/2020	24/04/2020	4600	2	190	<0.4	1.3	5	<2	<2	1400	20	4	<0.01
SG-R1,2,3	26/02/2020	24/04/2020	8300	6	190	25	21	4	<2	<2	1400	25	13	<0.01

Signatory: Jamie Woodward
Date: 25/05/2020

The results only apply to the sample as received and to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

ChemCentre
Residues Laboratory
Report of Examination

ACCREDITED FOR TECHNICAL COMPETENCE

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Purchase Order: SPA 20-7
ChemCentre Reference: 19S4601 R0

Marine and Freshwater Research Laboratory
Murdoch University
Environmental Science
Murdoch WA 6150

Attention: Kris Wienczugow

Report on: 3 samples received on 28/04/2020

LAB ID	Material	Client ID and Description
19S4601 / 001	sediment	BIN-LAG
19S4601 / 002	sediment	BIN-REEF
19S4601 / 003	sediment	SG

LAB ID				001	002	003
Client ID				BIN-LAG	BIN-REEF	SG
Sampled				24/04/2020	24/04/2020	24/04/2020
Analyte	Method	LOR	Unit			
TPH C6-C9	ORG015S	25	mg/kg	<25	<25	<25
TPH C10-C14 in soil	ORG007S	25	mg/kg	<25	<25	<25
TPH C15-C28 in soil	ORG007S	100	mg/kg	<100	<100	<100
TPH C29-C36 in soil	ORG007S	100	mg/kg	<100	<100	<100
Total TPHs	ORG007SlegC	250	mg/kg	<250	<250	<250
TRH C6-C10	ORG015S	25	mg/kg	<25	<25	<25
TRH >C10-C16	ORG007S	25	mg/kg	<25	<25	<25
TRH >C16-C34	ORG007S	100	mg/kg	<100	<100	<100
TRH >C34-C40	ORG007S	100	mg/kg	<100	<100	<100
Total TRHs	ORG007SPTC	250	mg/kg	<250	<250	<250

Method	Method Description
ORG007S	Total Recoverable Hydrocarbons in Soil
ORG007SlegC	Total Petroleum Hydrocarbons in soil (legacy fractions)
ORG007SPTC	Sum of TRHs in Soils with C6-C10 by Purge and Trap
ORG015S	BTEX and C6 - C10 in soil

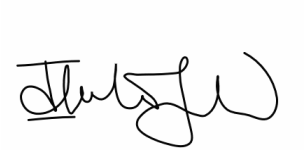
"<" signifies a result is less than the limit of quantitation for the method.

These results apply only to the sample(s) as received.

Unless requested otherwise, sample(s) will be disposed of after 30 days of the issue of this report.

F-S-A Reference: GOVE-1688532262-1168

*Analysis not covered by scope of ChemCentre's NATA accreditation.



Ibrahim Jambol
Senior Chemist and Research Officer
SSD Organic Chemistry
12-May-2020

ChemCentre
Scientific Services Division
Report of Examination

Accredited for compliance with ISO/IEC 17025 - Testing, Accreditation No. 8

Purchase Order:
ChemCentre Reference: 19S4920 R0

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Marine and Freshwater Research Laboratory
Murdoch University
Environmental Science
Murdoch WA 6150

Attention: Kris Wienczugow

Report on: 8 samples received on 22/05/2020

LAB ID	Material	Client ID and Description
19S4920 / 001	sediment	HRD-R4
19S4920 / 002	sediment	SG-R4
19S4920 / 003	sediment	BIN-LAG-R4
19S4920 / 004	sediment	BIN-REEF-R4
19S4920 / 005	sediment	HRD-R4
19S4920 / 006	sediment	SG-R4
19S4920 / 007	sediment	BIN-LAG-R4
19S4920 / 008	sediment	BIN-REEF-R4

LAB ID				001	002	003	004
Client ID				HRD-R4	SG-R4	BIN-LAG-R4	BIN-REEF-R4
Sampled				26/02/2020	26/02/2020	26/02/2020	26/02/2020
Analyte	Method	LOR	Unit				
TRH C6-C10	ORG015S	25	mg/kg	<25	<25	<25	<25
TRH >C10-C16	ORG007S	25	mg/kg	140	380	140	51
TRH >C16-C34	ORG007S	100	mg/kg	1200	2500	970	280
TRH >C34-C40	ORG007S	100	mg/kg	<100	<100	<100	<100
Total TRHs	ORG007SPTC	250	mg/kg	1300	2900	1100	330
TRH >C10-C16	ORG007SSil	25	mg/kg	110	280	89	40
TRH >C16-C34	ORG007SSil	100	mg/kg	1200	2500	1100	340
TRH >C34-C40	ORG007SSil	100	mg/kg	<100	<100	<100	<100

LAB ID				005	006	007	008
Client ID				HRD-R4	SG-R4	BIN-LAG-R4	BIN-REEF-R4
Sampled				24/04/2020	24/04/2020	24/04/2020	24/04/2020
Analyte	Method	LOR	Unit				
TRH C6-C10	ORG015S	25	mg/kg	<25	<25	<25	<25
TRH >C10-C16	ORG007S	25	mg/kg	160	450	46	40
TRH >C16-C34	ORG007S	100	mg/kg	1600	1200	<100	120
TRH >C34-C40	ORG007S	100	mg/kg	<100	370	<100	<100

LAB ID				005	006	007	008
Client ID				HRD-R4	SG-R4	BIN-LAG-R4	BIN-REEF-R4
Sampled				24/04/2020	24/04/2020	24/04/2020	24/04/2020
Analyte	Method	LOR	Unit				
Total TRHs	ORG007SPTC	250	mg/kg	1800	2000	<250	<250
TRH >C10-C16	ORG007SSil	25	mg/kg	120	250	<25	<25
TRH >C16-C34	ORG007SSil	100	mg/kg	1600	860	<100	130
TRH >C34-C40	ORG007SSil	100	mg/kg	<100	<100	<100	<100

Method	Method Description
ORG007S	Total Recoverable Hydrocarbons in Soil
ORG007SPTC	Sum of TRHs in Soils with C6-C10 by Purge and Trap
ORG007SSil	Total Recoverable Hydrocarbons in Soil - Silica Gel clean up
ORG015S	BTEX and C6 - C10 in soil

"<" signifies a result is less than the limit of quantitation for the method.

These results apply only to the sample(s) as received.

Results may not be reproduced except in full.

Unless requested otherwise, sample(s) will be disposed of after 30 days of the issue of this report.

*Analysis not covered by scope of ChemCentre's NATA accreditation.

Ibrahim Jambol
Team Leader
SSD Organic Chemistry
8-Jun-2020

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
Accredited for compliance with ISO/IEC 17025 - Testing.
The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

Murdoch UNIVERSITY

PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 8/05/2020
Date Received: 24/04/2020
Our Reference: SPA20-7

Sample Name:	SG
Sampling Date:	24/04/2020
Sample Type:	Sediment
MAFRL Job Code:	SPA20-7
Client Reference:	Sludge Monitoring
Analysis Date:	30/04/2020
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.00**
Very Fine Silt % (4-8µm)	0.00
Fine Silt % (8-16µm)	0.00
Medium Silt % (16-31µm)	0.00
Course Silt % (31-63µm)	0.33
Total Silt (4-63µm)	**0.33**
Very Fine sand % (63-125µm)	0.19
Fine sand % (125-250µm)	12.56
Medium sand % (250-500µm)	62.33
Coarse sand % (500-1000µm)	22.72
Very Coarse sand % (1000-2000µm)	1.68
Total Sand (63-2000µm)	**99.47**
Total Gravels (>2000µm)	**0.20**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	22.72
1000	1.68
2000	0.20
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	389.90
Minimum settling velocity of 50% of particles (mm s^1)	125.36
Time for 50% of particles to settle over 1 m (hours)	0.002
D10 (µm)	234.26
Minimum settling velocity of 90% of particles (mm s^1)	45.25
Time for 90% of particles to settle over 1 m (hours)	0.006

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with some shell present.

Signatory: Jamie Woodward
Date: 8/05/2020

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
Environmental Science
Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
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Murdoch UNIVERSITY

PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 8/05/2020
Date Received: 24/04/2020
Our Reference: SPA20-7

Sample Name:	BIN_LAG
Sampling Date:	24/04/2020
Sample Type:	Sediment
MAFRL Job Code:	SPA20-7
Client Reference:	Sludge Monitoring
Analysis Date:	30/04/2020
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.23**
Very Fine Silt % (4-8µm)	0.17
Fine Silt % (8-16µm)	0.58
Medium Silt % (16-31µm)	0.02
Course Silt % (31-63µm)	9.50
Total Silt (4-63µm)	**10.27**
Very Fine sand % (63-125µm)	46.28
Fine sand % (125-250µm)	34.46
Medium sand % (250-500µm)	7.17
Coarse sand % (500-1000µm)	1.48
Very Coarse sand % (1000-2000µm)	0.10
Total Sand (63-2000µm)	**89.49**
Total Gravels (>2000µm)	**0.00**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	1.48
1000	0.10
2000	0.00
4000	0.00
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	114.67
Minimum settling velocity of 50% of particles (mm s^1)	10.84
Time for 50% of particles to settle over 1 m (hours)	0.026
D10 (µm)	62.15
Minimum settling velocity of 90% of particles (mm s^1)	3.18
Time for 90% of particles to settle over 1 m (hours)	0.087

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

Sample visual assessment
Sand with no other noticeable sediment type present.

Signatory: Jamie Woodward
Date: 8/05/2020

The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

Marine and Freshwater
Research Laboratory
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Tel: 08 93602907 Address: 90 South St, Murdoch, WA, 6150

Accreditation Number: 10603
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The results of the tests, calibrations and/or measurements included is this document are traceable to Australian/national standards.

PARTICLE SIZE ANALYSIS REPORT

Contact: Duncan Gordon
Customer: Southern Ports Authority
Address: 54 Casuarina Drive, Bunbury 6230

Date of Issue: 8/05/2020
Date Received: 24/04/2020
Our Reference: SPA20-7

Sample Name:	BIN_REEF
Sampling Date:	24/04/2020
Sample Type:	Sediment
MAFRL Job Code:	SPA20-7
Client Reference:	Sludge Monitoring
Analysis Date:	30/04/2020
Method Number:	9400

Wentworth Size Classifications	
Total Clay % (0-4µm)	**0.00**
Very Fine Silt % (4-8µm)	0.00
Fine Silt % (8-16µm)	0.00
Medium Silt % (16-31µm)	0.00
Course Silt % (31-63µm)	1.23
Total Silt (4-63µm)	**1.23**
Very Fine sand % (63-125µm)	2.72
Fine sand % (125-250µm)	3.41
Medium sand % (250-500µm)	69.50
Coarse sand % (500-1000µm)	15.54
Very Coarse sand % (1000-2000µm)	3.14
Total Sand (63-2000µm)	**94.32**
Total Gravels (>2000µm)	**4.45**

Extended range by sieving

Extended size, µm	Extended percent retained at size
500	15.54
1000	3.14
2000	3.16
4000	1.29
8000	0.00
16000	0.00

Settling Velocity calculations using Stokes Law	
Parameters	
Particle density (ρp)(g/cm^3)	2.65
Liquid density (ρf) (g/cm^3)	1.025
Acceleration due to Gravity (g) (ms^{-2})	9.81
Liquid viscosity (η) (cp)	1.074
*Liquid parameters based on seawater of 35ppt @ 20°C	
Calculations	
D50 (µm)	415.53
Minimum settling velocity of 50% of particles (mm s^1)	142.38
Time for 50% of particles to settle over 1 m (hours)	0.002
D10 (µm)	267.66
Minimum settling velocity of 90% of particles (mm s^1)	59.08
Time for 90% of particles to settle over 1 m (hours)	0.005

Settings	
SOP Name	SOP-LV-3REPS-default.msop
Analysis Model	General Purpose
Result Units	Volume
Instrument	Mastersizer3000
RI/ABS:	2.74 / 1
Dispersant	Water
Additives	10mL Sodium Hexametaphosphate
Sonication (s)	300

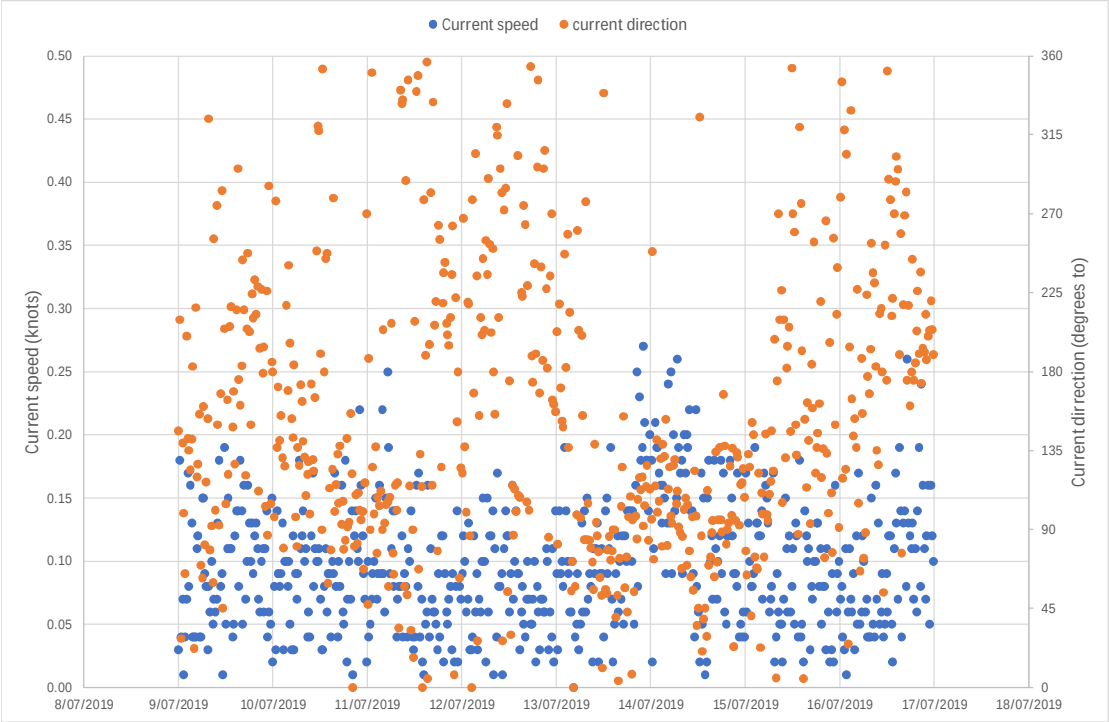
Sample visual assessment
Sand with some shell and rock present.

Signatory: Jamie Woodward
Date: 8/05/2020

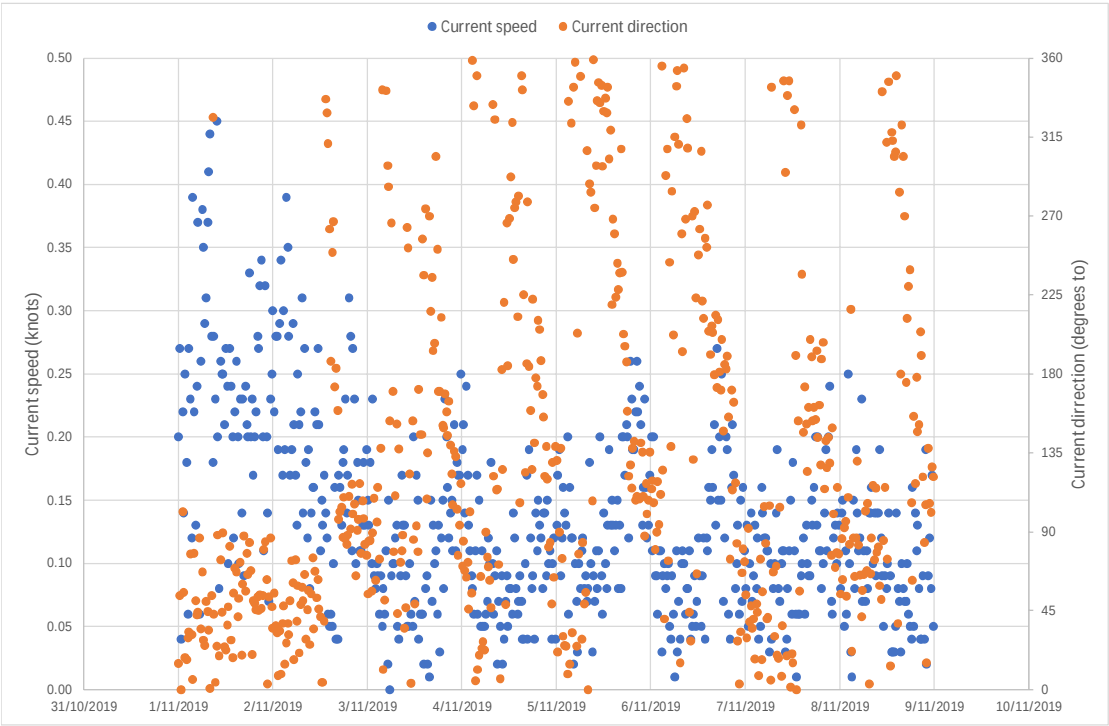
The results only apply to the sample tested.
Spare test items will be held for two months unless otherwise requested.

F-S-A Reference: GOVE-1688532262-1168

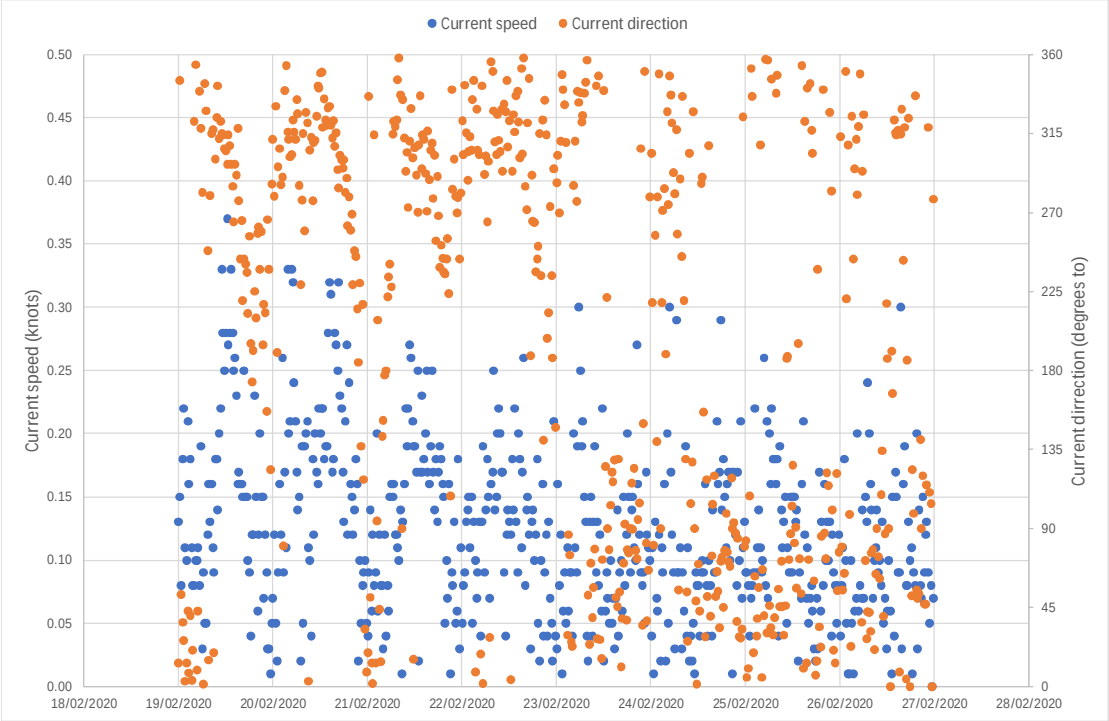
Appendix B: Currents and Wave Heights Graphs



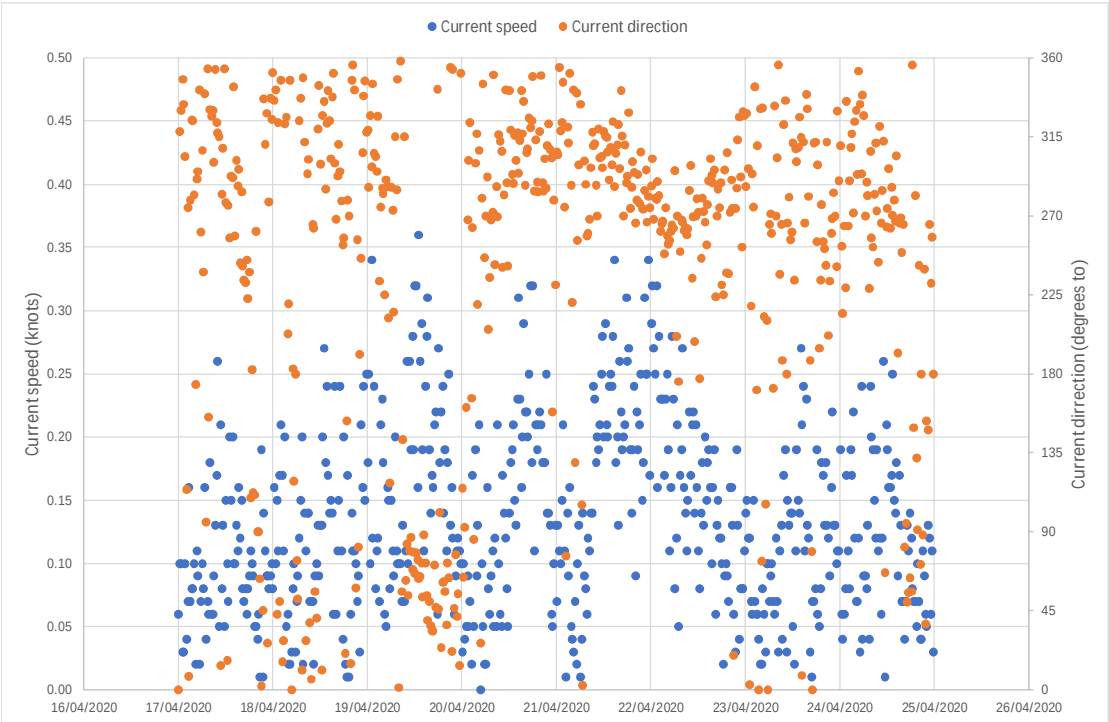
Current speed and direction 9-17 July 2019



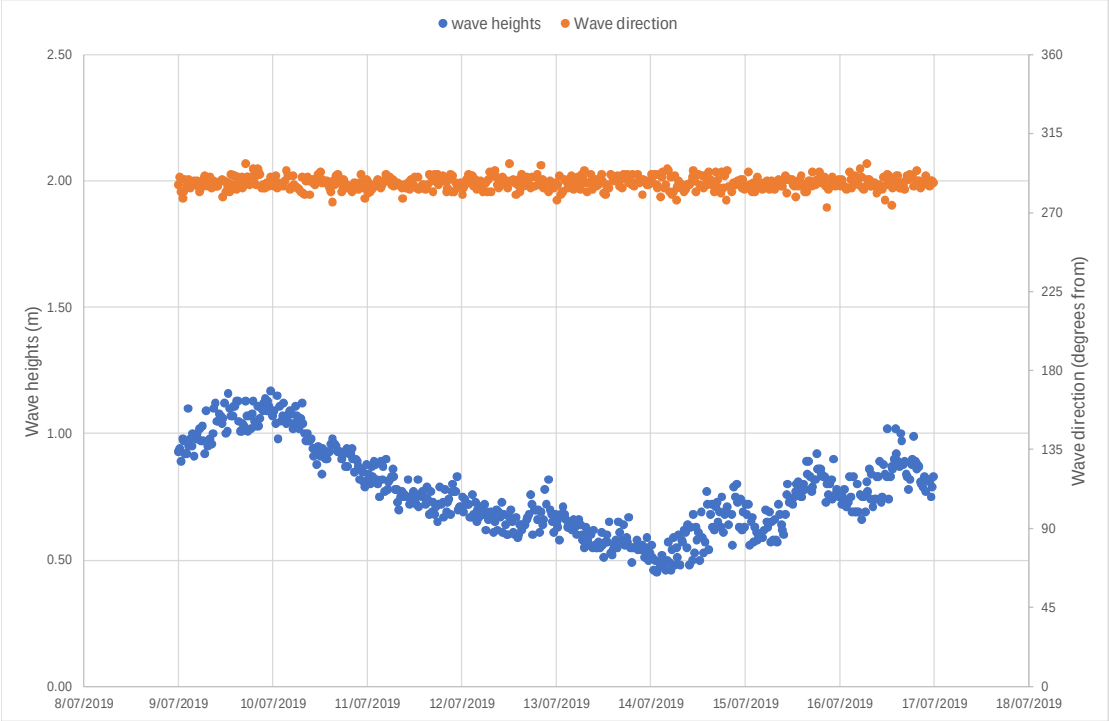
Current speed and direction 1-8 November 2019



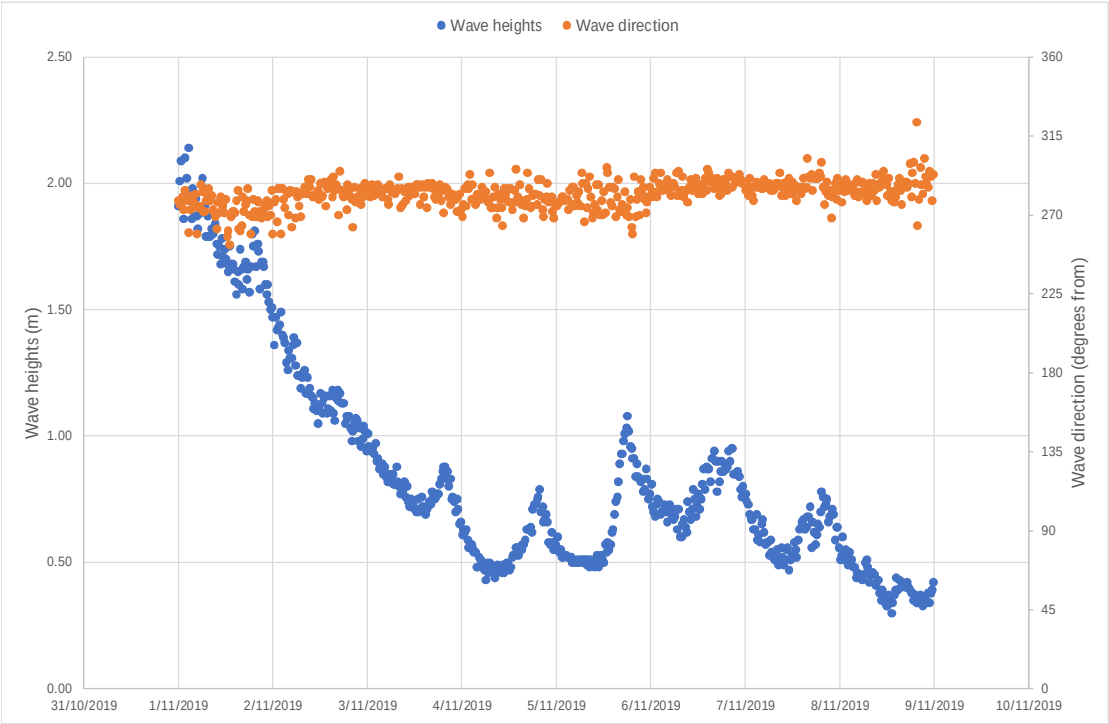
Current speed and direction 19-27 February 2020



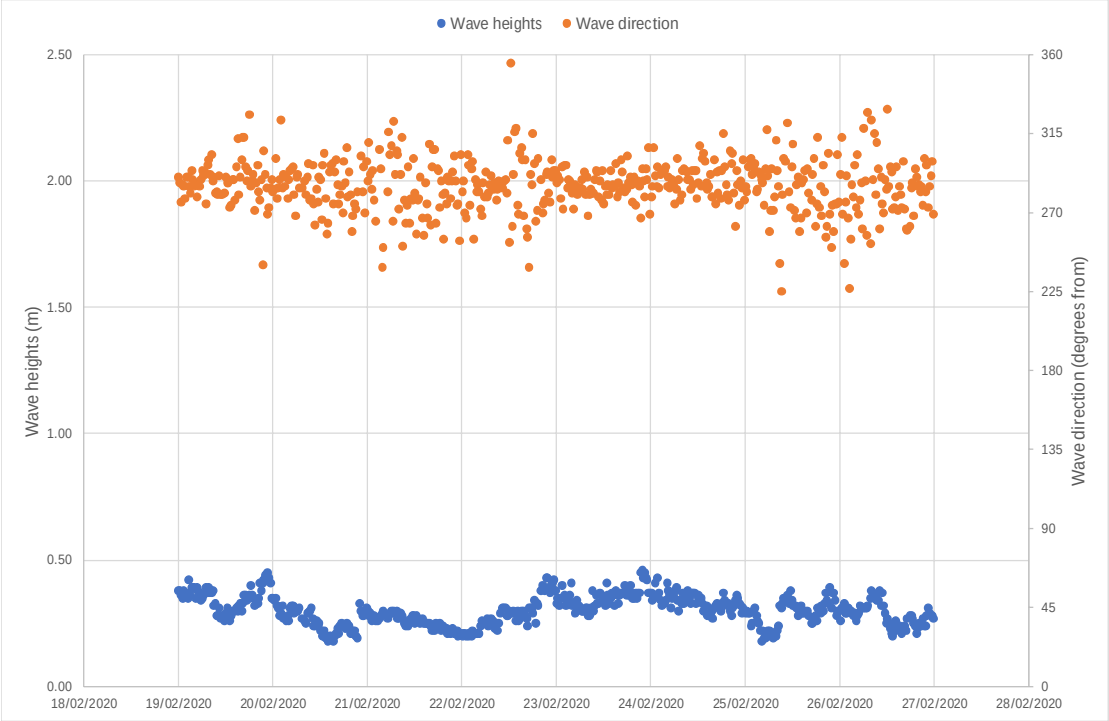
Current speed and direction 17-25 April 2020



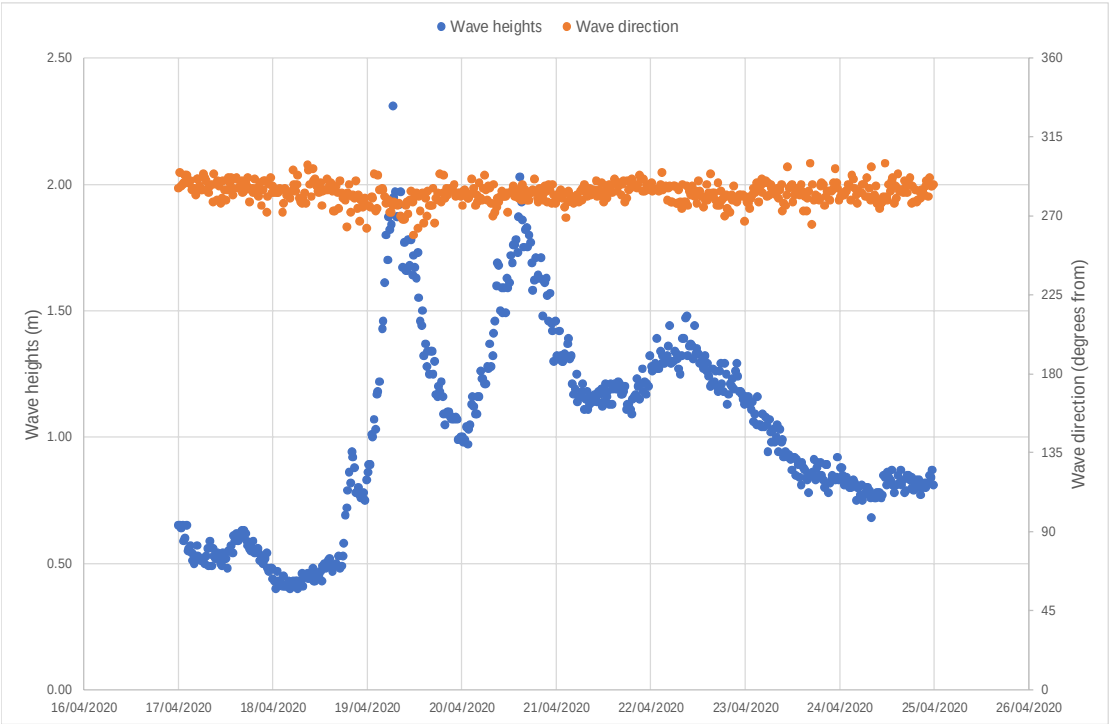
Significant wave heights and direction 9-17 July 2019



Significant wave heights and direction 1-9 November 2019

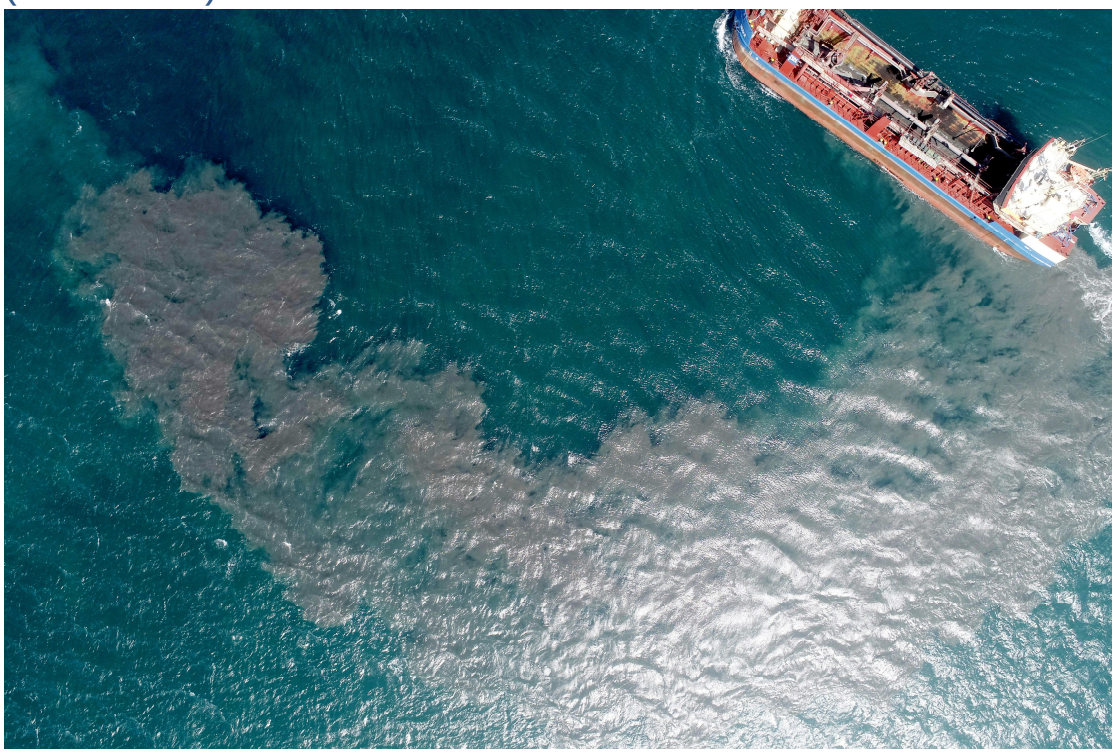


Significant wave heights and direction 19-27 February 2020



Significant wave heights and direction 17-25 April 2020

Appendix C: Drone Photos of the Dredge Plume Monitoring (13/3/2020)



Initial spoil dump from the dredge

Sampling vessel in the plume