

KBMS Casuarina Boat Harbour Phase 1 DSDMP Water Quality Monitoring



3 December 2024

Monitoring Summary Report 7 – Post
Disposal Monitoring Campaign

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Acronyms and Abbreviations

Abbreviation	Definition
BCH	Benthic Communities and Habitats
CBH	Casuarina Boat Harbour
CCL	Cockburn Cement Limited
CEMP	Construction Environmental Management Plan
CoC	Chain of Custody
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DDC	Dolphin Discovery Centre
DoT	Department of Transport (WA)
DSDMP	Dredge Spoil Disposal Management Plan
EP Act	Environmental Protection Act 1986
GIS	Geographical Information System
KBMS	Koombana Bay Marine Structures
KBSC	Koombana Bay Sailing Club
LAT	Lowest Astronomical Tide
Nephelometer	Instrument for measuring turbidity
NTU	Nephelometric Turbidity Units
PAR	Photosynthetically Active Radiation
PSU	Practical salinity unit approximates g/l
QA/QC	Quality Assurance and Quality Control
SDP	Sea Dumping Permit
SI	Surface Irradiance
TSHD	Trailing Suction Hopper Dredge
TSS	Total Suspended Solids – sediment weight/volume in a subsample of water collected
WAL/IS JV	WA Limestone / Italia Stone Joint Venture
ZoI	Zone of Impact
ZoMI	Zone of Medium Impact
ZoHI	Zone of High Impact

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EXECUTIVE SUMMARY

The Koombana Bay Marine Structures (KBMS) is a Strategic Proposal (Ministerial Statement 1226) approved under Part IV of the *Environmental Protection Act 1986* (EP Act) for the construction and operation of small craft marine infrastructure in Koombana Bay, located in Bunbury, Western Australia.

The Casuarina Boat Harbour (CBH) proposal was approved as a Derived Proposal under the Strategic Proposal. The CBH Proposal includes a dredging and dredge spoil disposal component. Construction is proposed to be completed in two phases.

Capital dredging for Phase 1 of the CBH Proposal was implemented in accordance with an approved Dredge Spoil Disposal Management Plan (DSDMP) during the period 15 August and 12 November 2024. Dredging targeted consolidated material with a trailer suction hopper dredge (TSHD) between 15 August and 10 September, 11 and 14 October, and 02 and 12 November 2024. A backhoe dredge and hopper barge operated concurrently with the TSHD between 28 August and 08 November 2024. All spoil reported to an existing spoil ground and comprised a total of 124,088 m³.

The DSDMP includes a water quality monitoring program at near-disposal, far-disposal and reference locations in the vicinity of the dredge spoil disposal site. Triggers for total suspended sediment (TSS) concentrations have been established in the DSDMP to monitor the accuracy of the disposal plume modelling predictions.

A survey was undertaken on 28 November 2024, two week's post completion of spoil disposal activities, following the requirements of the DSDMP.

NTU data was transformed into estimated TSS values using the relationship:

$$\text{TSS} = 1.62 * \text{NTU}$$

The data collected showed no exceedance of either the Trigger 1 (TSS at a near disposal monitoring site >2 mg/L above the average of the reference site data) or Trigger 2 (TSS at a far disposal monitoring site >2 mg/L above the average of the reference site data) criterion at any site.

Mean turbidity was lower and mean percent surface irradiance was generally higher than that seen during the pre-dredging monitoring campaign.

Other parameters (temperature, conductivity and dissolved oxygen) showed the water column was well mixed.

No impact to seagrass quality is predicted as a result of the present sampling data, as such, none of the management actions presented in the DSDMP require implementation.

1 INTRODUCTION

1.1 Project Background

The Koombana Bay Marine Structures (KBMS) is a Strategic Proposal (Ministerial Statement 1226) approved under Part IV of the *Environmental Protection Act 1986* (EP Act) for the construction and operation of small craft marine infrastructure in Koombana Bay, located in Bunbury, Western Australia.

The future proposals identified under the Strategic Proposal include the construction and operation of:

- Casuarina Boat Harbour (CBH);
- Koombana Bay Sailing Club (KBSC) marina; and
- Dolphin Discovery Centre (DDC) finger jetty.

The CBH Proposal was approved as a Derived Proposal under the Strategic Proposal. The CBH Proposal includes a dredging and dredge spoil disposal component, a piling component, land reclamation and construction of breakwater and revetment walls. The marine infrastructure includes the construction and operation of a wharf, jetties, boat ramps and boat pens. Construction is proposed to be completed in two phases. The CBH Phase 1 dredge and construction program includes the northern breakwater, associated reclamation area and internal jetties and boat pens.

Capital dredging for Phase 1 of the CBH Proposal was implemented in accordance with an approved Dredge Spoil Disposal Management Plan (DSDMP) and associated Sea Dumping Permit (SDP) (SD2022/4034) issued under the Commonwealth *Environment Protection (Sea Dumping) Act 1981*, administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW). Up to 124,088 m³ of capital dredging material was disposed offshore at the approved spoil ground during the period 15 August and 12 November 2024.

The approved DSDMP outlines the management and monitoring actions required to minimise the environmental impact of dredge spoil disposal activities associated with construction of the proposals identified under the KBMS Strategic Proposal (Cardno 2023). This report covers the post disposal component of the DSDMP's water quality monitoring program at near-disposal, far-disposal and reference locations in the vicinity of the dredge spoil disposal site.

1.2 DSDMP Water Quality Monitoring Program

1.2.1 Intent

- Demonstrate measured total suspended solids (TSS) concentrations (inferred from turbidity [NTU] data using a TSS~NTU relationship) remain within the expected range predicted by sediment plume dispersion modelling (model validation);
- Measure NTU and additional physical water quality parameters within disposal plumes for comparison against background condition (reference sites);
- Inform ongoing spoil disposal activities and any requirement to manage these; and
- Assess potential impacts to benthic community habitats (BCH e.g. seagrass shading) should measurements be outside of the modelled range (trigger exceedance).

1.2.2 Frequency

Monitoring is to be conducted fortnightly for the duration of dredge spoil disposal activities, including a monitoring campaign prior to the start of dredging and two weeks post- disposal activities.

During dredge spoil disposal activities, data will be collected immediately after an individual disposal action and then at three equally spaced periods as the turbid plume disperses, until just prior to the next disposal action (4 sampling repeats in total).

1.2.3 Monitoring locations

Profiling of the water column will occur at 12 monitoring sites (Figure 1-1):

- Eight sites within the modelled dredge plume extent;
 - Four near-disposal sites (DIS01, DIS02, DIS03 and DIS04).
 - Four far-disposal sites (DIS05, DIS06, DIS07 and DIS08).
- Four sites beyond the modelled dredge plume extent (background, REF01, REF02, REF03 and REF04).

1.2.4 Analysis

Parameters to be measured are those of Section 7.1.2 of the DSDMP. These include:

- Turbidity (NTU);
- Photosynthetically active radiation (PAR);
- Conductivity;
- Temperature;
- Dissolved Oxygen; and
- Depth

In addition, 48 water samples will be collected at a range of locations and water depths alongside a turbidity sensor **during the first monitoring campaign only** and analysed for TSS concentration. The results from this data will be used to establish a NTU~TSS relationship to infer TSS from future NTU profiling.

1.2.5 Test Narrative

Thresholds for elevated TSS concentrations were developed within the Strategic Proposal for the purpose of mapping spatial zones of influence and impact for the project's dredging and disposal action, with respect to BCH. The thresholds/zones were defined as follows:

- Zone of Influence (ZoI): Elevated TSS at least once (i.e. instantaneous duration threshold).
- Zone of Medium Impact (ZoMI): Elevated TSS continually for 18 days.
- Zone of High Impact (ZoHI): Elevated TSS continually for 90 days.

The modelling suggested that ZoMI or ZoHI would not be formed during the disposal actions. Triggers were established to monitor the accuracy of the modelling predictions. Investigations will be triggered should monitoring infer that a ZoMI may exist, in areas where seagrass has been mapped. Triggers and their responses are outlined in Table 1-1.

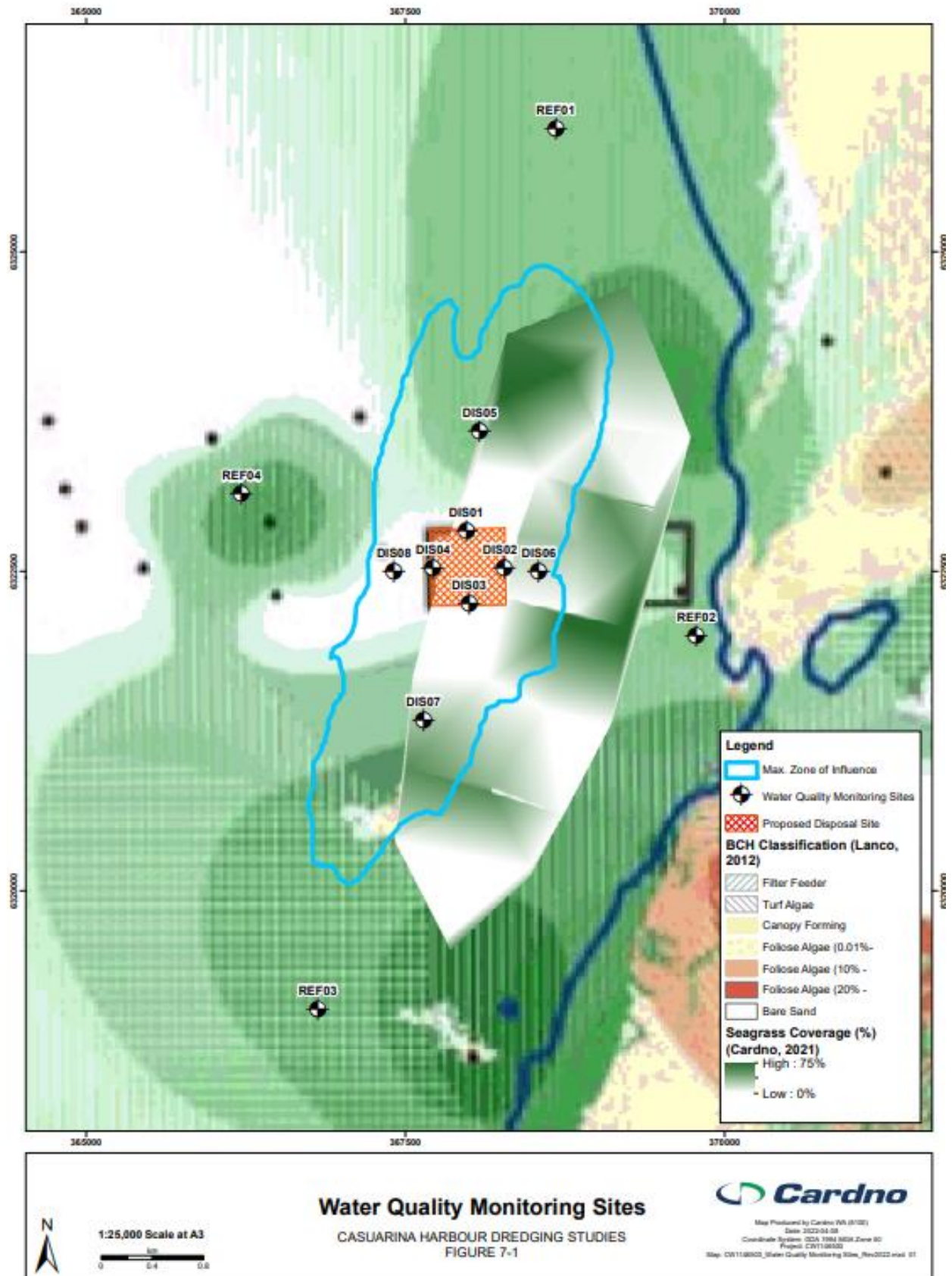


Figure 1-1. DSDMP water quality monitoring locations

Table 1-1. DSDMP triggers, tests and responses

Trigger Level	Test/Threshold	Response
Trigger 1	Depth- and time-averaged (across individual monitoring campaign) TSS concentration (inferred from NTU data) at any of the near disposal monitoring sites (DIS01 to DIS04) is greater than 2 mg/L above average background levels (average of sites REF01-REF04) for a measurement campaign.	Investigate if Trigger 2 has been exceeded for any sites
Trigger 2	Depth- and time-averaged (across individual monitoring campaign) TSS concentration (inferred from NTU data) at any of the far disposal monitoring sites (DIS05 to DIS08) is greater than 2 mg/L above average background levels (average of sites REF01-REF04) for a measurement campaign.	<ul style="list-style-type: none"> • Assess metocean condition data available from BoM and DoT to determine if the exceedance at the site(s) in question is likely to exist for a continuous period of greater than 18 days (e.g. continuous prevailing winds in one direction); • Investigate how the disposal rate during the monitoring campaign compares with historical and planned disposal rates (typical, higher than average, lower than average); • Further investigate light attenuation (PAR profile data) associated with site(s) of elevated TSS to determine if stress may be placed on seagrass, with respect to the light attenuation stress thresholds presented in RPS (2023) for <i>Posidonia</i> and <i>Amphibolis</i> species and PAR at reference sites. This should include temporal assessment of shading across the monitoring campaign, as the plume dissipates (i.e. is the average exceedance prolonged, or due to a short, very high elevation); • Provide a statement as to whether, based on the above, seagrass quality in the vicinity of the disposal site is likely to suffer permanent reduction in quality as a result of the ongoing and proposed disposal schedule. If impact to seagrass quality is predicted, the following actions should be undertaken: <ul style="list-style-type: none"> ○ Dispose in different portion of disposal site; ○ Dispose in certain portions of the site for certain metocean conditions (i.e. 'upstream side'); and ○ Consider additional monitoring campaign to confirm effectiveness of varied placement; and ○ Consider reduction in disposal rate during daylight hours.

1.3 Previous Survey

A summary of the all the previous disposal monitoring campaigns is provided in Table 1-2.

Table 1-2. Previous monitoring campaign summaries

Campaign #	Date	Summary
Pre-disposal	08 August 2024	<ul style="list-style-type: none"> Turbidity, temperature, conductivity and dissolved oxygen data showed little stratification of the water column, suggesting that the water column was well mixed.
1	22 August 2024	<ul style="list-style-type: none"> Trigger 1 and Trigger 2 TSS exceedances at one site each The exceedance investigation determined: <ul style="list-style-type: none"> TSS means were high mostly as a result of a single high sample from the bottom of the water column. The high bottom sample most likely occurred by very energetic wave conditions lifting bottom sediments into the sampling zone. The high TSS means appeared to occur only in sand bottom areas where no seagrass beds are noted. As reference sites are all on seagrass beds, the lifting of unconsolidated seabed doesn't occur there, thus the exceedance was more likely due to metocean conditions than the disposal plume. No impact to seagrass quality was predicted as a result of the sampling data.
2	02 September 2024	<ul style="list-style-type: none"> No exceedance of TSS triggers.
3	20 September 2024	<ul style="list-style-type: none"> No exceedance of TSS triggers.
4	01 October 2024	<ul style="list-style-type: none"> No exceedance of TSS triggers.
5	15 October 2024	<ul style="list-style-type: none"> No exceedance of TSS triggers.
6	31 October 2024	<ul style="list-style-type: none"> No exceedance of TSS triggers.

1.4 Document Purpose

This report provides:

- A summary of the two-week post disposal monitoring campaign data.

In accordance with DSDMP instructions, summary data includes:

- Summary of disposal rates associated with the CBH Proposal; and
- Plots and statistical summary of vertical profiling data for all parameters and profiles.
- Identification of any trigger exceedances;
- Assessment of trigger exceedance with respect to potential impacts to seagrass; and
- Recommendation for management should impacts be predicted.

1.4.1 Structure of this Document

The document lists:

- The background to the Project;
- A summary of the DSDMP;
- The monitoring methodology;
- Summary data for the two-week post disposal monitoring campaign; and
- Identification of trigger exceedances, assessment of impacts and management recommendations.

The document is current as at the date on the cover page and is referenced as Version 1 (Documents with a lower version number are superseded by this document).

2 METHODOLOGY

2.1 Monitoring Design

The monitoring design implemented was consistent with the prescriptions in Section 7 of the DSDMP (Cardno 2023).

2.1.1 Deviations from the DSDMP

The monitoring design in the DSDMP stipulates water quality profiles should be collected immediately after an individual disposal action, and then spaced equally in time as the plume disperses until just prior to the next disposal action, for 3 repeats (4 sample repeats total).

Dredging and disposal activities were completed two weeks prior to implementation of this post-disposal monitoring campaign, as such, no disposal actions took place. Data was collected for two complete sampling rounds at all sites.

2.1.2 Monitoring locations

During the monitoring campaigns, data was collected from locations as close as possible to the proposed monitoring site coordinates listed in the DSDMP (Cardno 2023), as shown in Figure 1-1.

2.2 Field Procedures

2.2.1 Physical Water Quality

Water quality records (NTU, PAR, conductivity, temperature, dissolved oxygen and depth) were obtained with a calibrated YSI ProDSS multiparameter sonde and Licor-192 Underwater Quantum PAR sensor (see Appendix A for YSI calibration sheet).

The post-disposal water quality sampling was carried out on 28 November 2024. All parameters were recorded at a surface (0.5 m), mid-water column (total depth/2) and bottom (1-2 m off the seabed) depth profile at each monitoring site (Figure 1-1) for two sampling rounds.

2.3 Data Analysis and QA/QC

Data analysis was completed as set out within Sections 7.1.3 and 8.1.3 of the DSDMP. Plots and statistical summary (including mean, median, minimum, maximum, 20th percentile, 80th percentile and standard deviation) of profiling data were calculated as recommended by the DSDMP and derived using either Microsoft Excel 365TM or Statistica 11 (StatSoft Inc 2011).

NTU data was transformed into estimated TSS values using the relationship:

$$\text{TSS} = 1.62 * \text{NTU}$$

QA/QC of physical water quality profile data included manual checks to remove any erroneous entries. For the current monitoring report, no data was removed.

3 POST-DISPOSAL MONITORING CAMPAIGN DATA SUMMARY

3.1 Project Dredge Disposal Summary

Dredging and disposal for Phase 1 of the CBH Proposal took place between 15 August and 12 November 2024. During that period, the TSHD, *Modi R*, and backhoe dredge with support from a hopper barge dredged and disposed a total of 124,088 m³:

- 93,615 m³ dredge spoil from the northern breakwater footprint and harbour entrance.
- 30,473 m³ dredge spoil from around existing timber jetty piles.

All dredged sediment was disposed to an existing spoil ground approved for use under SD2022/4034.

3.2 Metocean Conditions

Weather conditions on 28 November 2024 were fine and clear. Winds during the sampling period were easterly in the morning, at 10 kts, and became northerly (<5 kts) in the afternoon. Seas were 1 – 1.5 m. The tidal range for the day was 0.53 m, with a low tide of 0.39 m in the early morning and high tide of 0.92 m at 1924hrs.

3.3 Physical Water Quality

A statistical summary of the disposal campaign vertical profiling data for each monitoring site is provided in Appendix B. Plots of the vertical profiling data are shown in Appendix C where relevant.

3.3.1 Total Suspended Sediments

The depth- and time-averaged estimates of TSS for each monitoring site, and the average of the reference site data, during the monitoring campaign are shown in Table 3-1.

No site reported TSS concentrations >2 mg/L above the average of the reference site data.

Table 3-1. Depth- and time-averaged estimates of TSS (mg/L) for all sites

Near Disposal Sites		Far Disposal Sites		Reference Sites		
Site	TSS (mg/L)	Site	TSS (mg/L)	Site	TSS (mg/L)	Average TSS (mg/L)
DIS-01	0.20	DIS-05	0.02	REF-01	0.00	0.05
DIS-02	0.23	DIS-06	0.06	REF-02	0.17	
DIS-03	0.12	DIS-07	0.04	REF-03	0.02	
DIS-04	0.02	DIS-08	0.03	REF-04	0.01	

Green Cell = TSS threshold concentration (average of REF site data) for the individual monitoring campaign.

Orange Cells indicate TSS at a near disposal site is > 2mg/L above the trigger threshold value (Trigger 1)

Red Cells indicate TSS at a far disposal site is > 2mg/L above the trigger threshold value (Tigger 2).

3.3.2 Turbidity

Turbidity was <0.4 NTU in all samples and showed little variance through the water column at a site, although turbidity was sometimes slightly higher in bottom samples (Appendix C). Sites DIS-01, DIS-02 and REF-02 reported the highest mean turbidity between 0.11 and 0.15 NTU (Figure 3-1). Mean turbidity was lower than that seen in the pre-disposal data (MScience 2024), with most sites reporting at least one sample with 0 NTU (Appendix B).

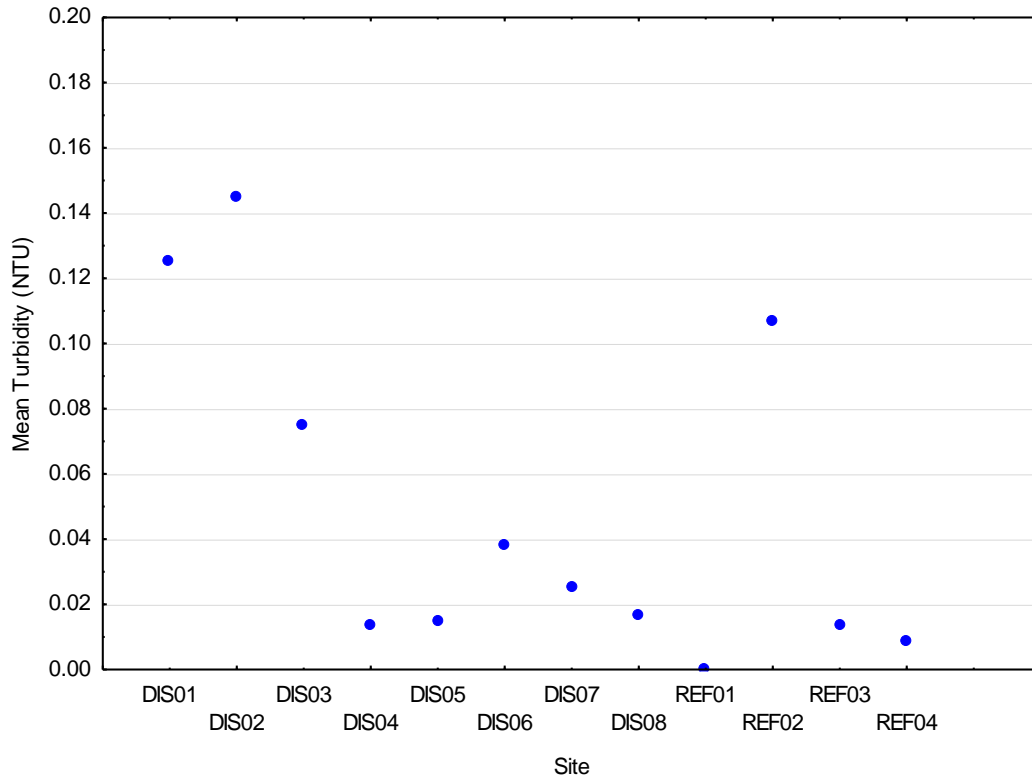


Figure 3-1. Turbidity means (time and depth averaged) at sites in the post-disposal monitoring campaign.

3.3.3 PAR

While light was recorded as PAR, it is best represented as the percentage of surface irradiance (SI(%)) to reflect the strength of the ambient light at the time of measurement. Mean percent surface irradiance (Figure 3-2) was generally higher than that seen in the pre-dredging data (MScience 2024) and was consistent across sites with most sites showing a depth-time averaged mean of between ~20 to ~30%. The percentage of surface irradiance recorded dropped sharply with depth and was often close to 0% in the bottom samples (Appendix C).

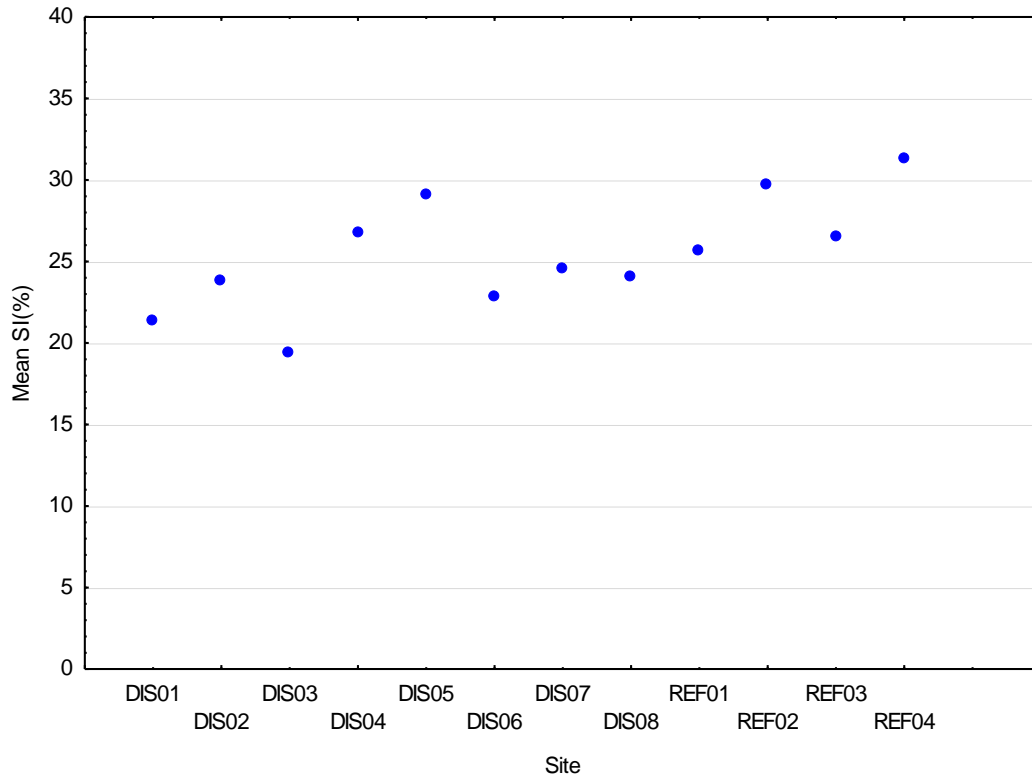


Figure 3-2. Mean percent surface irradiance at sites in the post-disposal monitoring campaign

3.3.4 Temperature, Conductivity, Dissolved Oxygen

Mean temperature varied by less than 0.3°C across all sites (Appendix B). All monitoring sites showed little stratification (0.5 °C difference) between surface and bottom samples (Appendix C).

Conductivity showed little variation and little stratification at all sites.

Dissolved oxygen levels suggest waters are generally well oxygenated and quite uniform (including across depth profiles, Appendix C) with a negligible difference in dissolved oxygen levels between surface and bottom readings at all sites. Dissolved oxygen saturation was over 100% in all readings.

4 ASSESSMENT OF TRIGGER EXCEEDANCE AND RECOMMENDATIONS

4.1 Exceedance Investigation

Results presented in Section 3.3.1 (Table 3-1) indicate there was no exceedance of the DSDMP Trigger 1 (>2mg/L above reference) at the near disposal monitoring sites or Trigger 2 (>2mg/L above reference) at the far disposal monitoring sites. As such, no exceedance investigation was required.

4.2 Response Recommendation

Response recommendations prescribed by the DSDMP relate only to actions that should be undertaken if impact to seagrass quality is predicted during dredging and disposal.

Dredging was completed two weeks prior to implementation of this post-disposal monitoring campaign and no impact to seagrass quality is predicted as a result of the present sampling data. As such, none of the DSDMP actions require implementation.

5 REFERENCES

Cardno (2023) Dredge Spoil Disposal Management Plan. Casuarina Harbour Dredging Studies. Report: CW1146500, Prepared for Department of Transport, West Perth, WA

MScience (2024) KBMS Casuarina Boat Harbour Phase 1 DSDMP Water Quality Monitoring. Monitoring Summary Report 1. Report: MSA343R02.01, Unpublished report to WA Limestone, Perth, Western Australia

RPS (2023) Benthic Communities and Habitat Study. Koombana Bay Marine Structures, Bunbury. Report: AU213001693.004, Prepared for South West Development Commission, Subiaco, Western Australia

StatSoft Inc (2011) STATISTICA (data analysis software system), Version 10.

6 APPENDIX A – YSI CALIBRATION SHEET



Calibration Report

Multi-Parameter Water Quality Instrument

Customer: M Science
 Contact: Matt
 Manufacturer: YSI
 Instrument: ProDSS
 Serial #: 16G103680
 Cable length: 30m (16G102376)

Item	Test	Pass	Comments
Battery	Rechargeable Lithium-Ion		Over 90%
	Battery Saver	✓	Automatically turns off after 30 minutes if not used
Connections	Condition	✓	Good, clean
Cable	Condition	✓	Clean, no tears
Display	Operation	✓	
Firmware	Version	✓	1.2.10
Keypad	Operational	✓	
Display	Screen	✓	
Unit	Condition, seals and O-rings	✓	
Monitor housing	Condition	✓	
pH			
	Condition	✓	Good, clean
	pH millivolts for pH7 calibration range 0 mV ± 50 mV	✓	
	pH 4 mV range + 165 to + 180 from 7 buffer mV value	✓	173.60 mV
	pH slope	✓	55 to 60 mV/pH, ideal 59mV 58.7
	Response time < 90 seconds	✓	
	Calibrated and conforms to manufacturer's specifications	✓	
Conductivity			
	Condition	✓	Good, clean
	Temperature	✓	°C
	Conductivity cell constant 4.5 - 6.5 in GLP file	✓	5.33
	Clean sensor reads less than 1 uS/cm in dry air	✓	
	Calibrated and conforms to manufacturer's specifications	✓	
Dissolved Oxygen			
	Condition	✓	Good, clean
	DO sensor in use	✓	Optical
	ODO gain in GLP file 0%	✓	(min 0.75 - max 1.50) 0.98
	ODO gain in GLP file 100%	✓	(min 0.75 - max 1.50) 0.95
	Calibrated and conforms to manufacturer's specifications	✓	

This is to certify that the above instrument has been calibrated to the following specifications:

Parameter	Standards	Reference	Calibration Point	Span	Units	Instrument Readings		
						Before	After	Units
Temperature (23F102023)	Check Temp NATA	Room Temp	17.7	-0.1	°C	NA	17.6	°C
pH (18K105215)	pH 7.00	398528	7.01	-32.50	mV	7.05	7.01	pH
pH (18K105215)	pH 4.00	401033	4.00	141.10	mV	3.87	4.00	pH
Conductivity (23F102023)	2764 µS/cm at 25°C	24/0107	2764	GLP	5.33	2749	2764	µS/cm
Zero Dissolved Oxygen (16G101365)	NaSO3 in distilled water	10175	0.0	0.98	NA	-0.9	0.0	%
100% Dissolved Oxygen (16G101365)	100% Air Saturation	Air	100.0	0.95	uA	104.4	100.0	%
Turbidity (16G103323)	distilled Water	distilled Water	0.00	0	NA	0.15	0.00	NTU
Turbidity (16G103323)	10 NTU	411301	10.00	10	NA	8.69	10.00	NTU
Turbidity (16G103323)	1000 NTU	384011	1000.00	1000	NA	1037	1000.00	NTU

Calibrated by: Gaurav Kanwar

Calibration Date: 29-Sep-24

Next Due: 28-Mar-25

7 APPENDIX B – DETAILED WATER QUALITY STATISTICS BY SITE

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
DIS-01	N	6	6	6	6	6
	Mean	0.13	377.50	50028.50	19.58	106.82
	Median	0.11	289.00	49936.00	19.50	106.85
	Minimum	0.00	167.00	49921.00	19.50	106.50
	Maximum	0.31	733.00	50349.00	19.90	107.00
	20th %ile	0.00	206.00	49924.00	19.50	106.70
	80th %ile	0.22	581.00	50105.00	19.60	107.00
	Std. Dev	0.1250	226.9438	172.2147	0.1602	0.2137
DIS-02	N	6	6	6	6	6
	Mean	0.15	433.33	50045.67	19.58	106.50
	Median	0.15	292.00	49955.50	19.50	106.45
	Minimum	0.00	107.00	49933.00	19.50	106.20
	Maximum	0.35	899.00	50397.00	19.90	106.90
	20th %ile	0.04	211.00	49936.00	19.50	106.40
	80th %ile	0.19	799.00	50097.00	19.60	106.60
	Std. Dev	0.1266	330.6585	182.8066	0.1602	0.2366
DIS-03	N	6	6	6	6	6
	Mean	0.08	362.67	50017.50	19.57	106.43
	Median	0.07	259.00	49929.00	19.50	106.55
	Minimum	0.00	176.00	49910.00	19.40	106.00
	Maximum	0.19	725.00	50387.00	19.90	106.80
	20th %ile	0.03	213.00	49911.00	19.50	106.00
	80th %ile	0.10	544.00	50039.00	19.60	106.70
	Std. Dev	0.0666	221.3384	187.4062	0.1751	0.3502
DIS-04	N	6	6	6	6	6
	Mean	0.01	481.33	50005.17	19.57	106.67
	Median	0.01	321.00	49914.50	19.50	106.70

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
	Minimum	0.00	158.00	49894.00	19.40	106.40
	Maximum	0.03	1074.00	50387.00	19.90	106.80
	20th %ile	0.00	228.00	49910.00	19.50	106.60
	80th %ile	0.03	786.00	50011.00	19.60	106.80
	Std. Dev	0.0151	365.3966	191.6908	0.1751	0.1506
DIS-05	N	6	6	6	6	6
	Mean	0.02	512.17	50071.17	19.62	106.18
	Median	0.00	327.50	49950.50	19.50	106.25
	Minimum	0.00	225.00	49932.00	19.50	105.60
	Maximum	0.08	1042.00	50481.00	20.00	106.60
	20th %ile	0.00	232.00	49933.00	19.50	105.90
	80th %ile	0.01	919.00	50180.00	19.70	106.50
	Std. Dev	0.0321	367.6310	222.4459	0.2041	0.3869
DIS-06	N	6	6	6	6	6
	Mean	0.04	413.00	50098.00	19.60	106.20
	Median	0.04	271.00	49975.50	19.50	106.40
	Minimum	0.00	169.00	49947.00	19.50	105.00
	Maximum	0.07	826.00	50573.00	20.00	106.70
	20th %ile	0.02	192.00	49960.00	19.50	106.10
	80th %ile	0.07	749.00	50157.00	19.60	106.60
	Std. Dev	0.0293	294.0789	245.4693	0.2000	0.6261
DIS-07	N	6	6	6	6	6
	Mean	0.03	403.67	49954.67	19.55	106.98
	Median	0.02	289.00	49885.00	19.50	107.10
	Minimum	0.00	139.00	49861.00	19.40	106.20
	Maximum	0.08	911.00	50316.00	19.90	107.40
	20th %ile	0.00	214.00	49877.00	19.50	106.80
	80th %ile	0.03	580.00	49904.00	19.50	107.30
	Std. Dev	0.0295	291.3751	177.6341	0.1761	0.4535

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
DIS-08	N	6	6	6	6	6
	Mean	0.02	436.50	49968.83	19.52	106.57
	Median	0.02	319.50	49895.00	19.50	106.70
	Minimum	0.00	186.00	49861.00	19.40	106.10
	Maximum	0.03	868.00	50331.00	19.80	106.90
	20th %ile	0.01	217.00	49879.00	19.40	106.20
	80th %ile	0.03	709.00	49952.00	19.50	106.80
	Std. Dev	0.0121	284.4227	180.2148	0.1472	0.3386
REF-01	N	6	6	6	6	6
	Mean	0.00	471.67	50026.00	19.58	106.37
	Median	0.00	340.50	49911.00	19.50	106.50
	Minimum	0.00	196.00	49872.00	19.40	106.00
	Maximum	0.00	924.00	50397.00	20.00	106.60
	20th %ile	0.00	268.00	49887.00	19.40	106.10
	80th %ile	0.00	761.00	50178.00	19.70	106.50
	Std. Dev	0.0000	296.7293	214.5926	0.2317	0.2503
REF-02	N	6	6	6	6	6
	Mean	0.11	532.17	50155.17	19.72	106.38
	Median	0.05	326.50	50066.00	19.60	106.60
	Minimum	0.00	228.00	49993.00	19.60	104.80
	Maximum	0.28	1095.00	50611.00	20.20	107.40
	20th %ile	0.00	236.00	49999.00	19.60	105.90
	80th %ile	0.27	981.00	50196.00	19.70	107.00
	Std. Dev	0.1350	395.7491	234.9642	0.2401	0.9239
REF-03	N	6	6	6	6	6
	Mean	0.01	437.50	49918.50	19.52	107.37
	Median	0.01	302.50	49879.00	19.50	107.30
	Minimum	0.00	200.00	49865.00	19.40	106.50
	Maximum	0.03	926.00	50130.00	19.70	108.30

Site		Turbidity (NTU)	PAR ($\mu\text{Mol}/\text{m}^2/\text{s}$)	Conductivity (μS)	Temperature ($^{\circ}\text{C}$)	Dissolved Oxygen (%)
	20th %ile	0.00	239.00	49878.00	19.50	106.90
	80th %ile	0.03	655.00	49880.00	19.50	107.90
	Std. Dev	0.0137	290.7609	103.7666	0.0983	0.6802
REF-04	N	6	6	6	6	6
	Mean	0.01	544.17	49900.83	19.47	106.50
	Median	0.00	509.00	49847.00	19.40	106.60
	Minimum	0.00	180.00	49836.00	19.40	105.90
	Maximum	0.04	1087.00	50160.00	19.70	106.80
	20th %ile	0.00	217.00	49838.00	19.40	106.40
	80th %ile	0.01	763.00	49877.00	19.50	106.70
	Std. Dev	0.0160	360.6125	127.8396	0.1211	0.3225

8 APPENDIX C – VERTICAL PROFILES

