KBMS Casuarina Boat Harbour Phase 1 DSDMP Water Quality Monitoring

5 September 2024

Monitoring Summary Report 2

Document Information

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Disclaimer

Acronyms and Abbreviations

Abbreviation	Definition
BCH	Benthic Communities and Habitats
CBH	Casuarina Boat Harbour
CEMP	Construction Environmental Management Plan
CoC	Chain of Custody
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DDC	Dolphin Discovery Centre
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
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 is being implemented in accordance with an approved Dredge Spoil Disposal Management Plan (DSDMP). 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 following the requirements of the DSDMP during a 589 m^3 spoil disposal event on 02 September 2024.

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

$$TSS = 1.62*NTU$$

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.

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 will be 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 177,000 m^3 of capital dredging material is proposed to be disposed offshore at the approved spoil ground during Phase 1.

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 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.

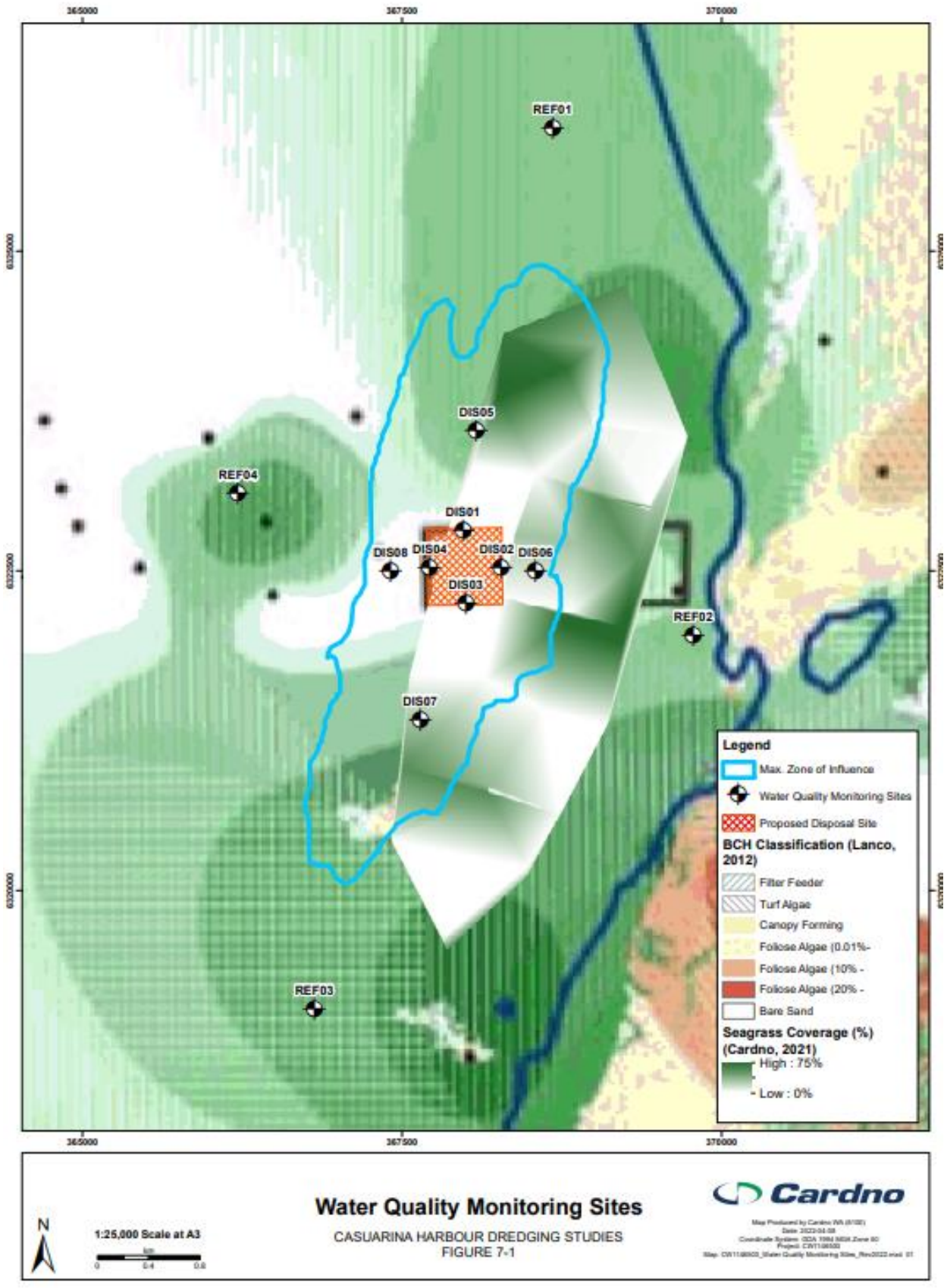


Figure 1-1. DSDMP water quality monitoring locations

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.	• 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 *Posidonia* and *Amphibolis* 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: o Dispose in different portion of disposal site; o Dispose in certain portions of the site for certain metocean conditions (i.e. 'upstream side'); and o Consider additional monitoring campaign to confirm effectiveness of varied placement; and o Consider reduction in disposal rate during daylight hours.

1.3 Previous Survey

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

Table 1-2. Previous monitoring campaign summary

Campaign #	Date	Summary
1	22 August 2024	• NTU-TSS relationship established (TSS = 1.62*NTU) • Data showed Trigger 1 and Trigger 2 TSS exceedences at one site each (DIS-03 and DIS-07) • 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 and was not considered dredge related.

1.4 Document Purpose

This report provides:

- A summary of the second disposal action monitoring campaign data.

In accordance with DSDMP instructions, summary data includes:

- Summary of disposal rates associated with the monitoring campaign;
- 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 pre-disposal and first disposal monitoring campaigns; 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).

On the day of sampling, the dredge disposed of spoil in daylight hours at 0903 and 1346. In good weather it takes, on average, 1h30 to complete a full sampling round due to the distance between sites. The short four-hour turnaround of the dredge vessel returning to the spoil ground (refer to Section 3.1) was such that four sampling rounds could not be completed.

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 water quality monitoring campaign was carried out on 02 September 2024. All parameters were recorded at a surface (0.5 m), mid-water column (depth/2) and bottom (1-2 m off the seabed) depth profile at each monitoring site (Figure 1-1). Data collection occurred first at the near-disposal monitoring sites, then the far-disposal sites and finally the reference sites. Data was collected immediately after an individual disposal event at 0903, for three complete sampling rounds at all sites.

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 365™ or Statistica 11 (StatSoft Inc 2011).

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

$$TSS = 1.62*NTU$$

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 DISPOSAL MONITORING CAMPAIGN DATA SUMMARY

3.1 Dredge Disposal Summary

A summary of the dredge spoil disposal activities on 02 September 2024 has been provided in Table 3-1. The monitoring campaign commenced immediately after disposal of Load#2, at 0903hrs.

Table 3-1. Dredge disposal summary for 02 September 2024

Load# for Project		43	44	45	46
Load# for Day		1	2	3	4
Load start time		23:03	2:50	10:22	14:58
Load stop time		0:15	5:36	12:25	19:00
Discharge start time		1:55	9:03	13:47	20:10
Discharge stop time		2:00	9:10	13:58	20:15
Discharge Location	**N**	33 13.71	33 13.71	33 13.71	33 13.71
	E	115 35.05	115 35.05	115 35.05	115 35.05
Load Discharge Total (m^3)		620	589	950	510
Daily Discharge Total (m^3)		2,669			
Project Discharge Total (m^3)		44,358			

3.2 Metocean Conditions

Weather conditions on 02 September 2024 were fine with light easterly winds at <10 knots which continued throughout the monitoring period (Figure 3-1). Seas were low (<1m). The tidal range for the day was 0.48 m, with low tides of 0.47 m in the early morning and 0.31 m in the late afternoon. There was a 0900hrs high tide of 0.79 m at the commencement of the monitored dump.

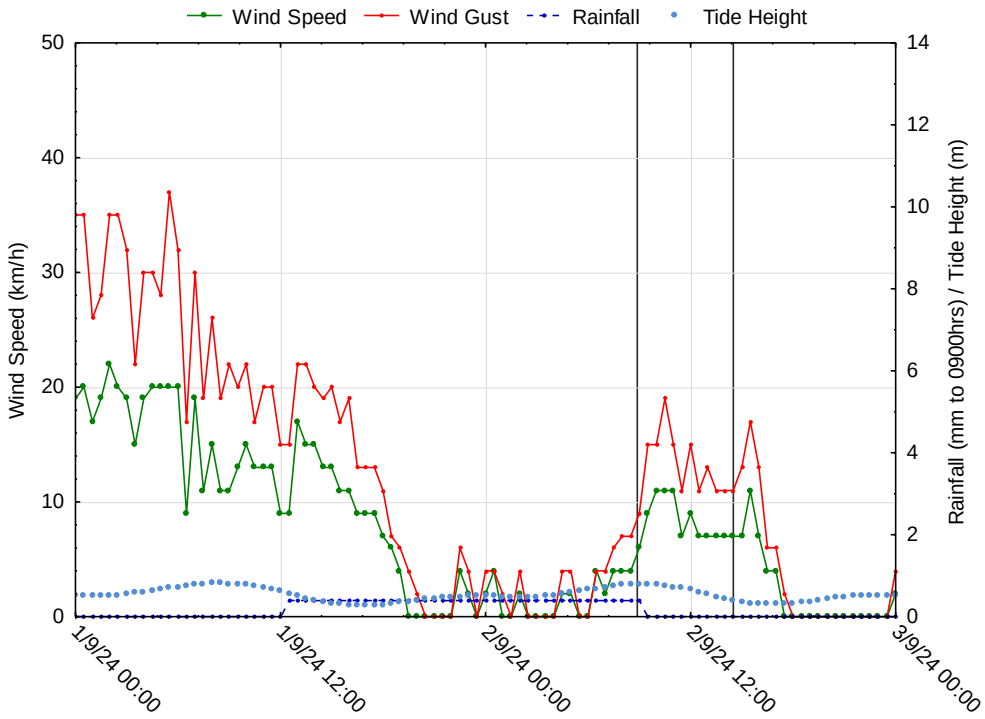


Figure 3-1. Metocean conditions on the day of the disposal monitoring campaign

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 3-2.

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

Table 3-2. Depth- and time-averaged estimates of TSS (mg/L) for all sites

Near Disposal Sites	
Site	TSS (mg/L)
DIS-01	1.0
DIS-02	0.8
DIS-03	0.9
DIS-04	0.9

Far Disposal Sites	
Site	TSS (mg/L)
DIS-05	0.9
DIS-06	0.9
DIS-07	0.8
DIS-08	0.9

Reference Sites		
Site	TSS (mg/L)	Average TSS (mg/L)
REF-01	1.0	0.8
REF-02	0.8	
REF-03	0.6	
REF-04	0.8	

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

Mean turbidity was <0.7 NTU at all monitoring sites (Figure 3-2). Reference site REF-01 reported the highest mean turbidity and site REF-03 reported the lowest mean turbidity. Most sites showed little variability in NTU through the water column (Appendix C), although turbidity was sometimes slightly higher in bottom samples (generally 0.5 NTU difference between surface and bottom readings).

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 3-3) was generally consistent across sites with most sites showing a depth-time averaged mean of between 10 to 15%. The highest percent surface irradiance (17%) was recorded at both the near disposal site DIS-01 and reference site REF-03.

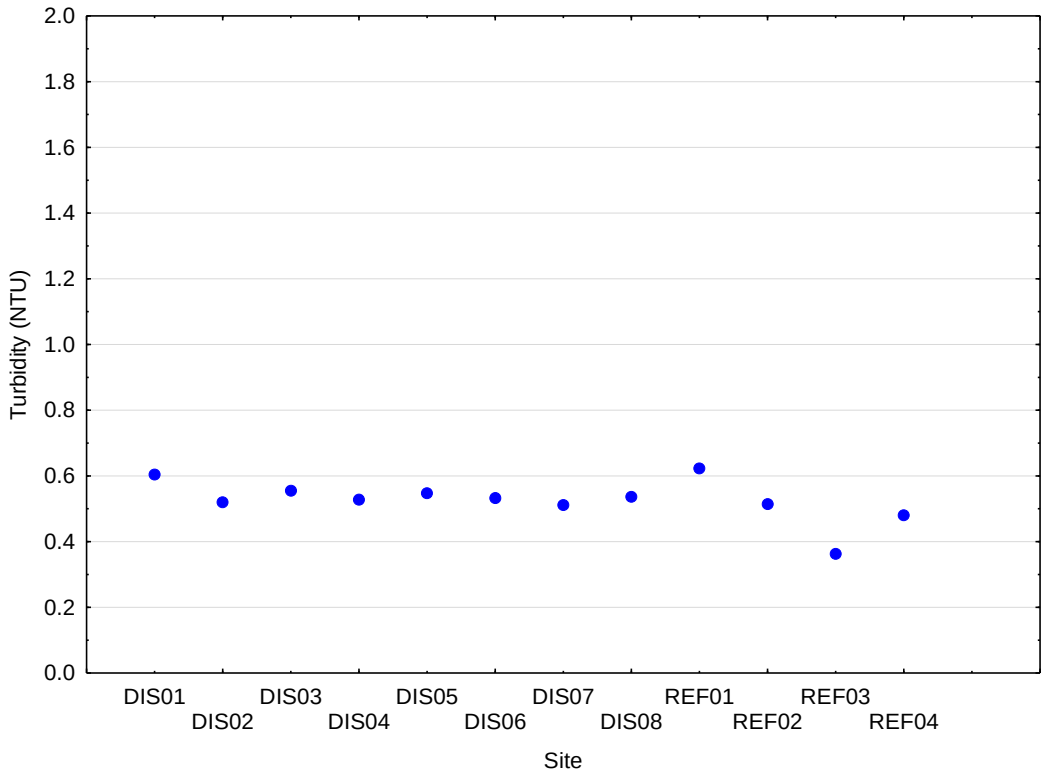


Figure 3-2. Turbidity means (time and depth averaged) at sites in the disposal monitoring campaign.

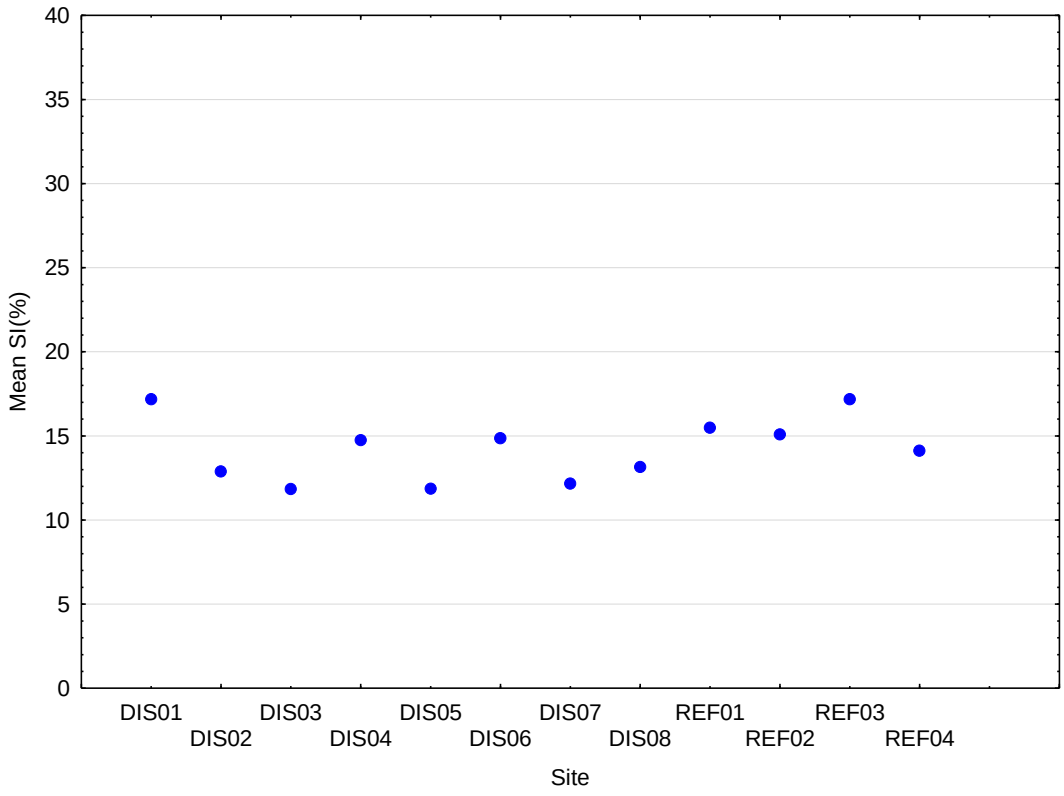


Figure 3-3. Mean percent surface irradiance at sites in the disposal monitoring campaign

3.3.4 Temperature, Conductivity, Dissolved Oxygen

Temperature varied by less than 0.5°C across all sites (Appendix B). Most monitoring sites showed little (0.6°C difference) stratification through the water column (Appendix C). Variation between readings at the same profile was as large as that between profiles.

Conductivity showed little variation and little stratification at all sites, although

Dissolved oxygen levels suggest waters are generally well oxygenated and quite uniform (including across depth profiles, Appendix C) with only a 2 – 3 % difference in dissolved oxygen levels between surface and bottom readings at all sites. Dissolved oxygen saturation was close to 100% in all readings.

4 ASSESSMENT OF TRIGGER EXCEEDANCE AND RECOMMENDATIONS

4.1 Exceedance Investigation

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

4.2 Response Recommendation

Following the prescriptions of the DSDMP, if impact to seagrass quality is predicted, the following actions should be undertaken:

- Dispose in different portion of disposal site;
- Dispose in certain portions of the site for certain metocean conditions (i.e. 'upstream side');
- Consider additional monitoring campaign to confirm effectiveness of varied placement; and
- Consider reduction in disposal rate during daylight hours.

No impact to seagrass quality is predicted as a result of the present sampling data, as such, none of the above 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

Chanson H, Takeuchi M, Trevethan M (2006) Using turbidity and acoustic backscatter intensity as surrogate measures of suspended sediment concentration. Application to a subtropical estuary (Eprapah creek). Report: Report CH60/06, Division of Civil Engineering, University of Queensland, Brisbane, QLD

Gray JR, Glysson GD, Turcios LM, Schwarz GE (2000) Comparability of Suspended-sediment Concentration and Total Suspended Solids Data. Report: Report No WRIR 00-4191, U.S. Department of the Interior, U.S. Geological Survey

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

ProDSS pH / CON / SAL / ORP / DO / Turbidity

PERTH SCIENTIFIC PTY LTD

Form EV-SR20-50

Customer:	Customer Order No.	Date:
MScience	TBA	30 Aug 24
Meter:	**Equipment ID:**	**Serial Number:**
YSI	ProDSSPSE2	21K100422

METER

INITIAL INSPECTION / CONDITION:	COMMENT
Case	OK
Keypad	OK
LCD	OK
Connector	OK
Battery(s)	OK
Cable	OK - 21E103882

pH ELECTRODE

Condition of Electrode	S/N: 21F103484 - OK		
Asymmetry Potential	-23.0 mV		
Response in pH4 / ~~pH10~~	148.6 mV	*Acceptable (±)177.5mV ±20mV ± Asy. Pot.*	Pass ☑ Fail ☐
Slope	57.79 mV/pH		Pass ☑ Fail ☐
Response Time	6 secs	*Excellent - < 15 secs* ☑ *Acceptable 30 – 45 secs* ☐ *Poor >60 secs* ☐	
Calibration Batch # pH7 427975 11/25 Batch # pH4 429847 12/25 ~~Batch # pH10~~	1 Pt ☐ 2 Pt ☑ 3 Pt ☐ 5 Pt ☐	Buffer 1.65 ☐ 4.01 ☑ 6.86 ☐ 7.00 ☑ 9.18 ☐ 10.01 ☐ 12.43 ☐	
Confirmation	pH4.01 = 4.00 pH6.86 =	pH7.00 = 7.00 pH 9.18 =	pH10.01 =

Meter and Electrode is Calibrated and Conforms to Manufacturer's Specifications YES ☑ NO ☐

CONDUCTIVITY / SALINITY ELECTRODE

Condition of Electrode	S/N: 21F101915 - OK	
Temperature	Is Correct Temperature Displayed and Responds Accordingly YES ☑ NO ☐ If NO, Probe Requires Replacement. If YES, continue with Calibration	
Calibration Batch # 422219 07/25	Single Pt ☑ Multiple Pt ☐	Cond. (µS/cm) 84 ☐ 1,413 ☐ 2,764 ☐ 12,880 ☑ 54,400 ☐ 111,900 ☐ Salinity (ppt) 2.0 ☐ 35.0 ☐ 36.0 ☐ Other ☐ Salinity (mS/cm) 54.4 ☐ 56.0 ☐ 58.0 ☐ Other ☐
Linearity Checked	1,413 12,880 54,400 111,900 180,000 uS/cm	
Does Electrode Calibrate Correctly according to above parameter specification? YES ☑ NO ☐ New Cell K (if Displayed) 5.345		

Meter and Electrode is Calibrated and Conforms to Manufacturer's Specifications YES ☑ NO ☐

Service Technician: HOWARD Signed: H Jones Date: 30 Aug 24

ProDSS pH / CON / SAL / ORP / DO / Turbidity

PERTH SCIENTIFIC PTY LTD

Form EV-SR20-50

ORP ELECTRODE

Condition of Electrode	S/N: 21F103484 – OK		
		RESULT	
Response Check. *Use one or more of the Test Solutions to Confirm Response. Cost dependant Item* *Batch # Zobell A* 24/1807 *Batch # Zobell B* 24/1807	**Quinhydrone** +86mV (*New H_2 Reference +296mV*) ☐		Pass ☐ Fail ☐
	Quinhydrone + 263mV (*New H_2 Reference +473mV*) ☐		Pass ☐ Fail ☐
	Zobell's +229mV ☑	229mV	Pass ☑ Fail ☐
	Light's + 475mV ☐		Pass ☐ Fail ☐
Response Time 5 secs	*Excellent - < 15 secs* ☑ *Acceptable 30 – 45 secs* ☐ *Poor >60 secs* ☐		
Meter and Electrode is Calibrated and Conforms to Manufacturer's Specifications			YES ☑ NO ☐

DO ELECTRODE

Condition of Electrode	S/N: 21G1014444 – OK
Calibration Batch # Sodium Sulfite N/A	Zero ☑ 100% ☑ Salinity Correction: 0.00 Value: 100.1% Slope Value (if Displayed): 1.06
Does Electrode Calibrate Correctly according to above parameter specification?	YES ☑ NO ☐
Meter and Electrode is Calibrated and Conforms to Manufacturer's Specifications	YES ☑ NO ☐

TURBIDITY SENSOR

Condition of Electrode	S/N: 21F101802 – OK
Pre-calibration checks	Readings of any Specific Standards prior to recalibration 0.0 FNU Reads 0.63 FNU 124.0 FNU Reads 115.52 FNU
Calibration. Check with customer for operational range Batch # 124NTU 24B24009095 02/25	Zero ☑ Mandatory to check. Turbidity Value(s) of Calibration: 0.00 FNU 124.00 FNU _____ FNU _____ Read Value(s) AFTER Calibration: 0.00 FNU 124.00 FNU _____ FNU _____ Specify Turbidity Value of Validation: _____ FNU Reads _____ FNU Specify Turbidity Value of Validation: _____ FNU Reads _____ FNU
Does Sensor Calibrate Correctly according to above parameter specification?	YES ☑ NO ☐
Meter and Sensor is Calibrated and Conforms to Manufacturer's Specifications	YES ☑ NO ☐

Service Technician: HOWARD Signed: HJones Date: 30 Aug 24

ProDSS pH / CON / SAL / ORP / DO / Turbidity

PERTH SCIENTIFIC PTY LTD

Form EV-SR20-50

Accessories	Shipped	Returned
Case	☑	☐
Handheld meter	☑	☐
Cable (70 m)	☑	☐
Sensors	☑	☐
Manual (on USB drive)	☑	☐
USB 2.0 cable (2m) black	☑	☐
USB 2.0 OTG cable (15cm) ~~white~~ BLACK	☑	☐
Report sheet (client copy)	☑	☐
Terms and Conditions	☑	☐
Quick Guide	☑	☐
Charger and Battery Pack	☑	☐

Service Technician: HOWARD Signed: H Jones Date: 30 AUG 24

7 APPENDIX B – DETAILED WATER QUALITY STATISTICS BY SITE

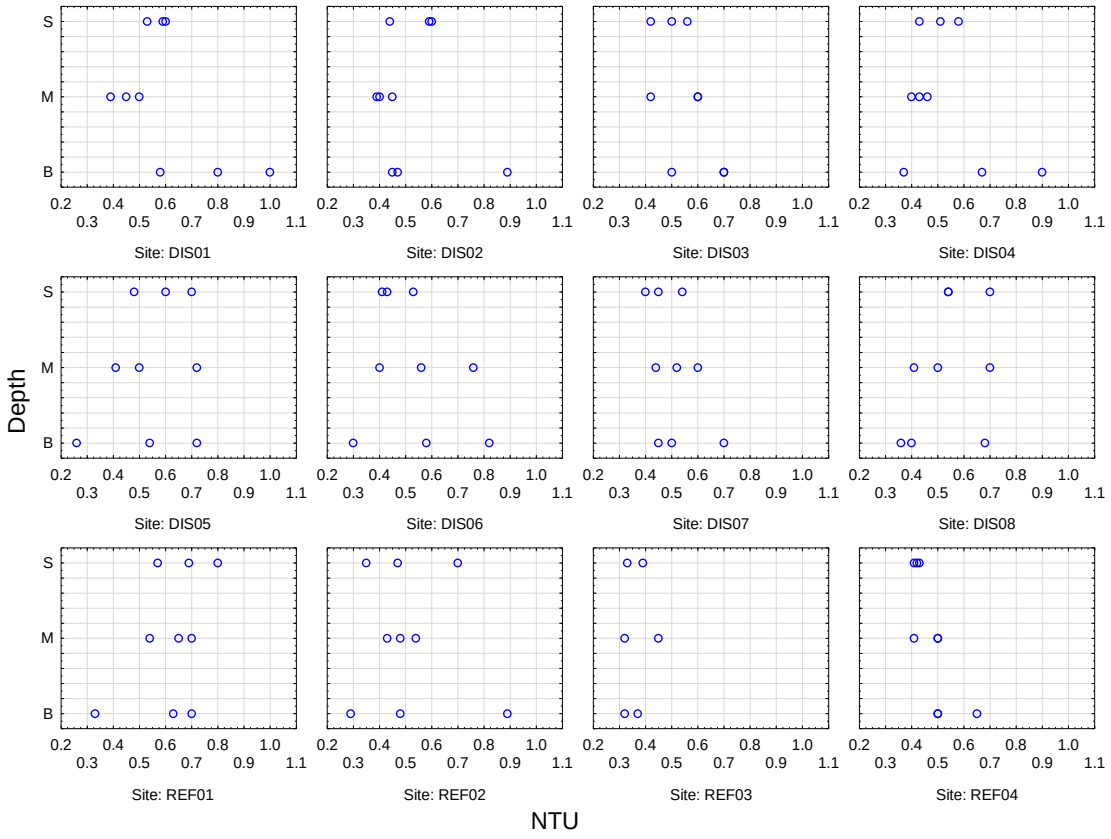
Site		Turbidity (NTU)	PAR (µMol/m²/s)	Conductivity (µS)	Temperature (°C)	Dissolved Oxygen (%)
DIS-01	N	9	9	9	9	8
	Mean	0.6	199.1	44663	15.8	101.5
	Median	0.6	27.8	44385	15.8	102.2
	Minimum	0.4	1.0	44030	15.6	98.2
	Maximum	1.0	677.0	45810	16.2	104.4
	20th %ile	0.5	3.0	44121	15.6	99.1
	80th %ile	0.8	598.0	45590	16.0	103.1
	Std. Dev	0.2	268.6	647.2	0.2	2.2
DIS-02	N	9	9	9	9	9
	Mean	0.5	164.0	44626	15.9	101.7
	Median	0.5	18.5	44365	15.9	102.3
	Minimum	0.4	1.1	44128	15.6	97.9
	Maximum	0.9	627.0	45742	16.2	103.9
	20th %ile	0.4	3.4	44266	15.6	99.5
	80th %ile	0.6	483.0	45394	16.2	103.2
	Std. Dev	0.2	243.4	567.1	0.3	1.9
DIS-03	N	9	9	9	9	7
	Mean	0.6	147.3	44640	15.9	101.8
	Median	0.6	25.8	44560	15.8	102.3
	Minimum	0.4	1.0	44136	15.6	97.4
	Maximum	0.7	558.0	45670	16.4	104.1
	20th %ile	0.4	2.7	44144	15.6	101.0
	80th %ile	0.7	525.0	45082	16.2	103.1
	Std. Dev	0.1	229.2	493.0	0.3	2.2
DIS-04	N	9	9	9	9	9
	Mean	0.5	174.6	44681	15.9	101.6
	Median	0.5	38.0	44443	15.8	102.2

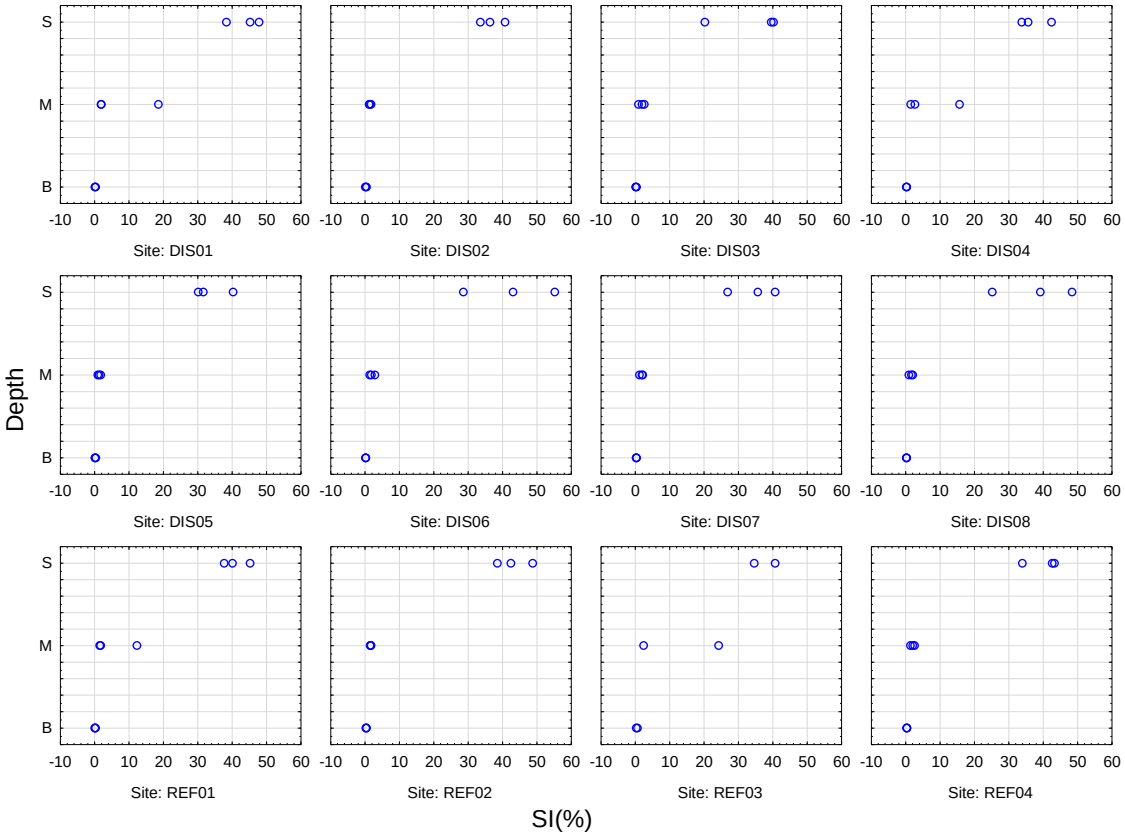
Site		Turbidity (NTU)	PAR (µMol/m²/s)	Conductivity (µS)	Temperature (°C)	Dissolved Oxygen (%)
	Minimum	0.4	1.9	43940	15.6	98.7
	Maximum	0.9	590.0	45480	16.4	104.6
	20th %ile	0.4	3.4	44395	15.6	99.3
	80th %ile	0.7	437.0	45290	16.2	103.2
	Std. Dev	0.2	222.6	494.3	0.3	2.1
DIS-05	N	9	9	9	9	9
	Mean	0.5	154.3	44640	16.0	101.8
	Median	0.5	18.0	44511	15.8	101.8
	Minimum	0.3	1.4	43840	15.7	98.5
	Maximum	0.7	550.0	45670	16.6	105.9
	20th %ile	0.4	3.0	44348	15.7	98.8
	80th %ile	0.7	436.0	44939	16.3	104.7
	Std. Dev	0.2	222.2	498.9	0.3	2.5
DIS-06	N	9	9	9	9	9
	Mean	0.5	193.5	44683	15.9	101.7
	Median	0.5	24.9	44400	15.8	102.5
	Minimum	0.3	1.4	44048	15.6	98.2
	Maximum	0.8	769.0	45720	16.6	104.4
	20th %ile	0.4	3.1	44221	15.6	98.5
	80th %ile	0.8	584.0	45478	16.2	103.5
	Std. Dev	0.2	293.4	587.2	0.4	2.2
DIS-07	N	9	9	9	9	9
	Mean	0.5	153.4	44660	15.9	102.0
	Median	0.5	21.9	44822	15.9	102.1
	Minimum	0.4	2.8	44182	15.6	99.6
	Maximum	0.7	550.0	45012	16.5	104.4
	20th %ile	0.4	3.9	44196	15.6	100.5
	80th %ile	0.6	455.0	44960	15.9	103.1
	Std. Dev	0.1	220.3	337.4	0.3	1.5

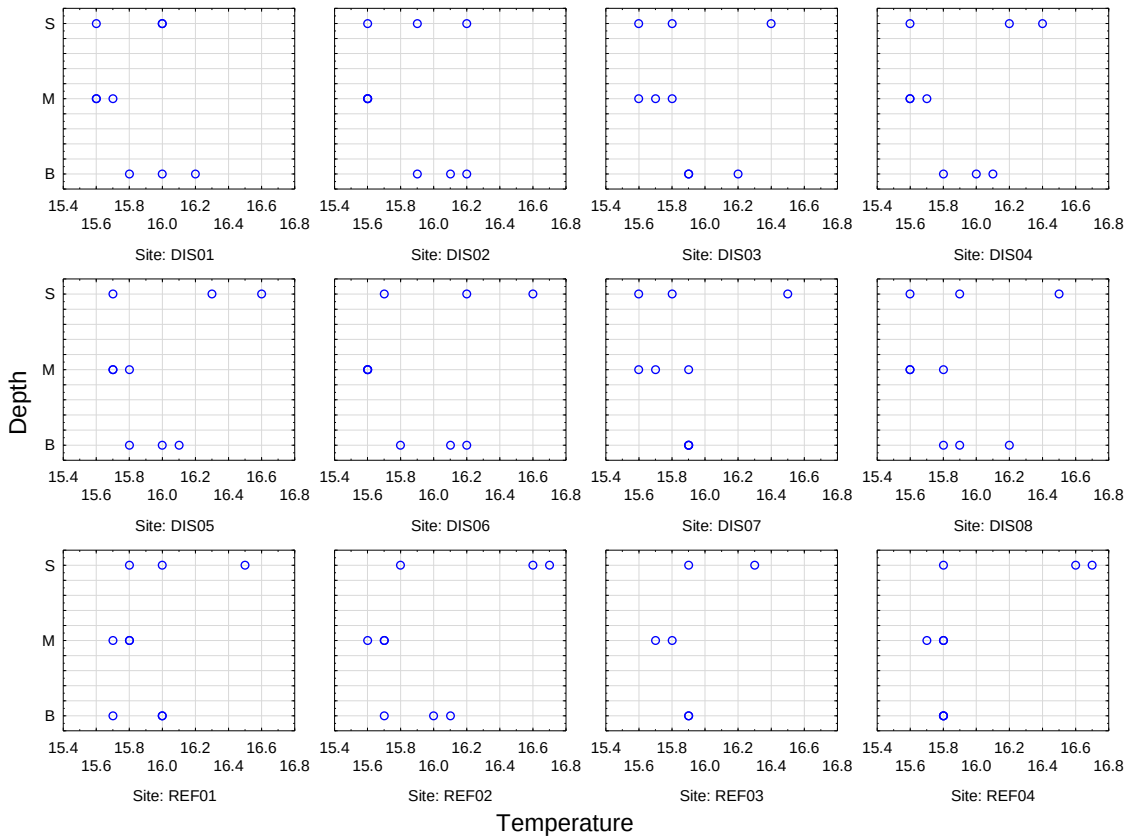
Site		Turbidity (NTU)	PAR (µMol/m²/s)	Conductivity (µS)	Temperature (°C)	Dissolved Oxygen (%)
DIS-08	N	9	9	9	9	9
	Mean	0.5	167.1	44671	15.9	101.3
	Median	0.5	17.4	44632	15.8	101.6
	Minimum	0.4	1.7	44006	15.6	98.5
	Maximum	0.7	647.0	45670	16.5	104.6
	20th %ile	0.4	3.5	44228	15.6	99.0
	80th %ile	0.7	532.0	45230	16.2	103.4
	Std. Dev	0.1	254.5	527.5	0.3	2.0
REF-01	N	9	9	9	9	9
	Mean	0.6	197.4	44457	15.9	101.9
	Median	0.7	21.2	44506	15.8	102.1
	Minimum	0.3	1.7	43911	15.7	99.2
	Maximum	0.8	602.0	45097	16.5	104.9
	20th %ile	0.5	2.0	44068	15.7	99.4
	80th %ile	0.7	512.0	44624	16.0	104.6
	Std. Dev	0.1	251.1	339.2	0.2	2.2
REF-02	N	9	9	9	9	9
	Mean	0.5	191.3	44634	16.0	101.8
	Median	0.5	20.5	44439	15.8	102.3
	Minimum	0.3	3.5	44003	15.6	97.6
	Maximum	0.9	582.0	45334	16.7	104.9
	20th %ile	0.4	4.1	44246	15.7	97.6
	80th %ile	0.7	568.0	45312	16.6	104.6
	Std. Dev	0.2	268.9	475.9	0.4	2.8
REF-03	N	6	6	6	6	6
	Mean	0.4	230.0	45083	15.9	101.5
	Median	0.4	187.4	44938	15.9	101.4
	Minimum	0.3	4.3	44717	15.7	100.7
	Maximum	0.5	498.0	45950	16.3	103.3

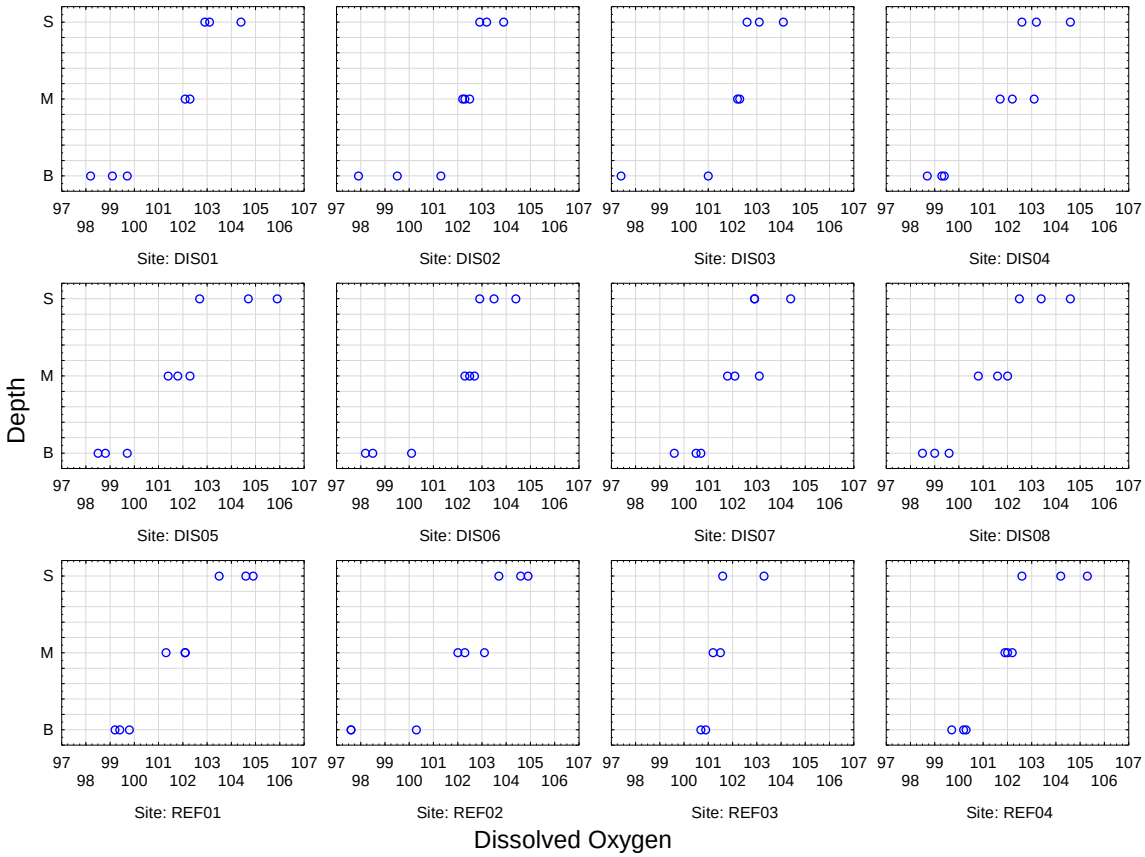
Site		Turbidity (NTU)	PAR (µMol/m²/s)	Conductivity (µS)	Temperature (°C)	Dissolved Oxygen (%)
	20th %ile	0.3	9.8	44735	15.8	100.9
	80th %ile	0.4	493.0	45221	15.9	101.6
	Std. Dev	0.1	242.3	463.8	0.2	0.9
REF-04	N	9	9	9	9	9
	Mean	0.5	187.5	44637	16.0	102.0
	Median	0.5	25.2	44662	15.8	102.0
	Minimum	0.4	3.8	44176	15.7	99.7
	Maximum	0.7	646.0	44934	16.7	105.3
	20th %ile	0.4	4.1	44512	15.8	100.2
	80th %ile	0.5	517.0	44919	16.6	104.2
	Std. Dev	0.1	263.3	226.8	0.4	1.9

8 APPENDIX C – VERTICAL PROFILES






Depth
S
M
B
15.4 15.8 16.2 16.6
15.6 16.0 16.4 16.8
Site: DIS01
Site: DIS02
Site: DIS03
Site: DIS04
Site: DIS05
Site: DIS06
Site: DIS07
Site: DIS08
Site: REF01
Site: REF02
Site: REF03
Site: REF04
Temperature


Depth
S
M
B
97 99 101 103 105 107
98 100 102 104 106
Site: DIS01
Site: DIS02
Site: DIS03
Site: DIS04
Site: DIS05
Site: DIS06
Site: DIS07
Site: DIS08
Site: REF01
Site: REF02
Site: REF03
Site: REF04
Dissolved Oxygen